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Aim and Scope

NeuroRegulation is a peer-reviewed journal providing an integrated, multidisciplinary perspective on clinically relevant research, treatment, and public policy for neurofeedback, neuroregulation, and neurotherapy. The journal reviews important findings in clinical neurotherapy, biofeedback, and electroencephalography for use in assessing baselines and outcomes of various procedures. The journal draws from expertise inside and outside of the International Society for Neuroregulation and Research to deliver material which integrates the diverse aspects of the field. Instructions for submissions and Author Guidelines can be found on the journal website (http://www.neuroregulation.org).

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Influence of Autonomous Sensory Meridian Response on Relaxation States: An Experimental Study

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Abstract

Multiple studies have stated that autonomous sensory meridian response (ASMR) induces relaxation. ASMR is defined as a static tingling-like sensation across the scalp and back of the head, experienced by some people in response to specific audio and visual triggers like tapping, whispering, and slow hand movements. This study explores the relaxation states and the stress states on which ASMR videos have the highest impact. Data from 60 college students with a mean age of 22 years and a standard deviation of 1.12 were collected for this study, among which 30 were assigned to an experimental group and 30 were assigned to a control group single blindly. The relaxation states and stress states were measured using Smith Relaxation Scale Inventory (SRSI) for the pretest and Smith Relaxation Posttest Inventory (SRPI) for the posttest. The experimental group watched an ASMR video, and the control group watched a neutral video between the pretest and posttest. SPSS version 16 was used for data analysis. The result suggested a significant increase in sleepiness after watching the ASMR video (significant difference).

Keywords: autonomous sensory meridian response, relaxation, relaxation techniques, Psychological stress, sleepiness

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Introduction

Stress is an innate part of life, and no individual is spared from its deleterious consequences. According to some experts, around 75% of all medical disorders are caused by stress (Hughes et al., 1984). Stress is associated with physiological and psychological changes like increased heart and breathing rate, high blood pressure, tensed muscles and anger, anxiety, and irritability. Severe stress lasting for a long time can result in several physical and psychological health problems such as Type 2 diabetes (Kelly & Ismail, 2015), cardiovascular diseases (Dimsdale, 2008), anxiety, depression (Holahan et al., 2017), and skin disorders such as eczema (Anveden Berglind et al., 2011). Several relaxation techniques, including meditation, autogenic training, and guided imagery, are used to handle highly stressful situations (Smith, 2001).

A barrier in providing effective relaxation is that not everyone has the same effect for every relaxation technique. Instead, in some cases, certain relaxation can induce paradoxical reactions where the technique increases anxiety instead of reducing it (Heide & Borkovec, 1983). Individual differences and situational factors in the effectiveness of the relaxation techniques are factors that have profound implications. Techniques that induce relaxation for one person are not necessarily relaxing for others. For instance, some prefer meditation, while others prefer music. A study indicated that personality plays a vital role in relaxation, where introverts are more difficult to relax than extroverts (Sharma, 2011). Another study conducted using secondary data indicated that men are more likely to choose relaxation techniques that include concrete physical techniques like progressive muscle relaxation and autogenic training. At the same time, women prefer techniques like meditation, imagery, and prayer (Smith, 2001). A comparative study with six relaxation techniques indicated that preference for different relaxation techniques among patients with respiratory diseases depends upon factors like familiarity, ease of implementation, and previous experience with the particular technique (Hyland et al., 2016). For more than a hundred thousand people, specific videos leave them in an engrossed, tranquilized, and mesmerized state (Garro, 2017). What made these videos famous was the shared experience of a pleasurable tingling sensation arising from the scalp, triggered from the particular visual and auditory events included in the particular recordings (Garro, 2017). In the early years, terms for these sensations ranged from *weird tingling sensation* to attention-induced brain orgasm (AIHO) or attention-induced observed euphoria. Autonomous sensory meridian response (ASMR) was popularized and coined by Jennifer Allen in 2010. According to Barratt and Davis (2015), ASMR is a sensory phenomenon that causes static, tingling sensations that originate in the scalp and often spread to the neck and sometimes other regions of the body and is elicited in response to certain visual or auditory stimuli. It is also defined as brain tingles or brain orgasms. Though the above mentioned is the most common path, studies indicate that it is not necessary that every individual experience ASMR in the same route (Barratt & Davis, 2015). There are currently over 13 million ASMR videos on YouTube, from medical examinations or brushing hair to whispering (University of Sheffield, 2018**).** While ASMR had this rapidly growing popularity among online communities, numerous reputed international media have reported the growing global attention and lack of scientific explanation this phenomenon receives.

According to Giulia Poerio from the Department of Psychology at the University of Sheffield, "lots of people report experiencing ASMR since childhood, and awareness of the sensation has risen dramatically over the past decade due to Internet sites such as YouTube and Reddit. However, ASMR has gone virtually unnoticed in scientific research, which is why we wanted to examine whether watching ASMR videos reliably produces feelings of relaxation and accompanying changes in the body —such as decreased heart rate." (University of Sheffield, 2018).

In the introductory study of ASMR by Barrett and Davis, it is stated that, though the triggers of ASMR can vary upon individual differences, it can be induced in susceptible individuals, and 98% of the participants agreed that they consider ASMR as an opportunity to bring relaxation (Barratt & Davis, 2015). Most of them also stated that ASMR acts as a stress buster and helps them induce sleep. They identified whispering, attention, crisp sounds, and slow movements as the most common ASMR triggers. The study also added that, though it is momentary, ASMR does alleviate symptoms of depression, anxiety, and chronic pain (Barratt & Davis, 2015). The tone of the most viewed ASMR videos is where close attention is given to the viewer. Others include acts with a similar focus directed towards a particular object rather than the viewer, such as the Ephemeral Rift (Barratt & Davis, 2015).

Though the replies were diverse, when people watching ASMR videos were asked about their motivating factor behind watching them, a large part of the population (98%) strongly agreed that ASMR primarily induces relaxation. 82% reported that ASMR helps them to sleep, and 70% used it as a stress buster. A small part of the population (5%) stated that ASMR media induced sexual stimulation, while the majority of participants (82%) disagreed with this statement. Moreover, 50% of the participants reported their improvement in mood even when the tingling sensations were absent, while 30% stated that achieving the tingling sensation was essential for mood enhancement (Barratt & Davis, 2015). Viewer preferences and motivations in the survey results of another study concluded that viewers watch ASMR videos to relax, fall asleep, and reduce stress and anxiety, which aligns with Barratt and Davis's study results (McErlean & Banissy, 2017).

There is evidence of increased skin conductance and decreased heart rate while watching ASMR videos, which altogether indicates that ASMR is a physiologically-rooted activating as well as calming experience inducing positive effect (calmness and excitement; Poerio et al., 2018). An eye-tracking study published in 2019 supports the above finding by stating that, along with skin conductance, ASMR videos lead to pupil dilation, which indicates arousal (Valtakari et al., 2019). The fact that conflicting self-reported emotions (i.e., excitation and relaxation) and physiology appeared concurrently while watching ASMR videos is indicative of the emotional complexity associated with ASMR. Complex interpersonal interactions often entail the combination of emotional elements that are typically considered to be polar opposites (Berrios et al., 2015; Lindquist & Barrett, 2008). The neurological studies done on ASMR have strengthened the results of these studies. A study by Smith et al. (2017) to examine the default mode network (DMN) of ASMR-sensitive individuals found that the DMN network in ASMR-sensitive individuals showed significantly less connectivity than ASMR nonsensitive individuals. The study also added that ASMR-sensitive individuals have increased connectivity in areas associated with multiple resting networks (Smith et al., 2017). A more recent fMRI study conducted by the same researchers in 2019 stated that ASMR videos activate the anterior cingulate cortex, right paracentral lobule, precuneus, and bilateral thalamus, which are related to movement sensation, emotion, and attention. This finding points out that ASMR is not merely a sensory or emotional phenomenon; instead, it has sensory, motoric, attentional, and affective components associated with it (Smith et al., 2019). During ASMR, increased activation in nucleus accumbens (NAcc) was observed, which is associated with reward, insula and dorsal anterior cingulate cortex, which in turn are associated with emotional arousal, and secondary somatosensory cortex (Lochte et al., 2018).

An online exploratory study indicated that ASMR is related to mindfulness (Fredborg et al., 2018). Mindfulness is a Buddhist-based practice that highlights the acceptance of thoughts and experience without judgment, and this is used as a treatment for multiple psychological conditions like anxiety (Lancaster et al., 2016). While for ASMR, nonsensitive participants reported the videos as strange, odd, and even stressful. The study also stated that ASMR is consistent with Huron’s Contrastive Valence Theory of music-induced frisson (Huron, 2006) and strongly resembles musical frisson (Kovacevich & Huron, 2019).

According to the origin theory of ASMR, an evolving theory proposed by Dr. Craig Richard, triggers that stimulate ASMR in individuals might stimulate the biological pathways of interpersonal relationships and affiliative behaviors like parent–infant, family member bonding, and friendship bonding. Both ASMR and these bonding behaviors share similar triggers such as comfort, relaxed, and secure feelings. Foundational biological explanations of bonding behaviors are already established, which indicates the stimulation of the release of endorphins, dopamine, oxytocin, and serotonin. It's assumed that both these behaviors and molecules can provide a good explanation of the whole phenomenon of ASMR (Young & Blansert, 2015).

The current study was designed to determine the impact of ASMR in 14 different relaxation states and three stress states using the Smith Relaxation States Inventory (SRSI) and Smith Relaxation Posttest Inventory (SRPI) based on ABC Relaxation theory by Jonathan C. Smith. Sleepiness, disengagement, physical relaxation, mental quiet, at ease, rested and refreshed, strength and awareness, joy, love and thankfulness, prayerfulness, childlike innocence, awe and wonder, mystery and timeless/infinite were the relaxation states; and somatic stress, worry, and negative emotions were the stress states that were explored in the study.

Until 2015, there was a lack of scientific evidence supporting ASMR, and most of the literature appears to be anecdotal in nature. Interest in ASMR has grown since then, leading to a need for more robust studies on the effectiveness of ASMR. This study's central hypothesis was identifying the influence of ASMR on relaxation states and stress states among the experimental group. The primary assumption around which the study was organized was there would be a considerable difference in the relaxation states and stress states on exposure to ASMR video. One of the first neuroscientific studies of ASMR indicates that ASMR-sensitive individuals have increased connectivity in areas associated with multiple resting networks (Smith et al., 2017). This indicates that ASMR might activate the blending of numerous resting-state networks. This experimental study was designed to indicate whether ASMR has a significant impact on the relaxation states.

Materials and Method

Study Design

This is a quantitative study with an experimental design. The study employed both between-group and within-group pretest and posttest experimental designs using an ASMR and a neutral video as an intervention in the experimental and control groups.

Study Duration

The study was conducted over a period of 1 year with a 4-month period of data collection.

Study Settings

The study is conducted among 60 college students from both graduation and postgraduation courses between 18 to 25 years, among which 43 were females and 17 were males. The convenient sampling method was used for acquiring the sample which was from different colleges across Kerala and Karnataka. Thirty among them were assigned to the experimental group, and the remaining 30 were in the control group using a random assignment method. The experimental and control group experiment settings were uniform and conducted in a room during the daytime between 2pm and 4 pm. The room in which the study was conducted was silent with no external distractions.

Descriptive

The mean age and standard deviation of the participants were 22 and 1.12, respectively.

Screening

Individuals with a history of psychiatric, neurological, or neurosurgical illness and individuals with perceptual disturbances were excluded from the study. This study could not screen or distinguish ASMR-sensitive and nonsensitive participants, as there was no established measure or scale to do so, which is one of the study's limitations.

Study Materials

Tools used were Smith Relaxation States Inventory (SRSI) for pretest, Smith Relaxation Posttest Inventory (SRPI) for posttest (Smith, 2001), General Health Questionnaire (GHQ; GL Assessment, 2020) for screening and two videos of 16-min duration, among which one is an ASMR video and the other is a neutral video. ASMR video was selected from the YouTube channel *Gentle Whispering ASMR*, an ASMR channels with 2.02 million subscribers. This video was used with the permission of the content owner. While the neutral video was made from multiple small videos under a Creative Commons license, allowing users to use the content freely. Three experts validated both videos. Both SRSI and SRPI consist of 30 self-reporting items that assess 14 relaxation states and three stress states. Both questionnaires used a 4-point Likert scale. Thirty Items ask the participant to rate how they feel "right now" on a four-point Likert scale, from 1 (*not at all*) to 4 (*very much*). The videos were used with the content creators' permission and validated by three experts in psychology. GHQ was used for screening individuals with significant psychiatric conditions. All of the data was collected through Google Forms.

Study Procedure

After collecting written informed consent and basic demographic details, the participants were provided with the GHQ to determine whether they meet the inclusion criteria of the study. Once they were selected for the study, they were asked to complete the SRSI as a pretest. The experimental group was then instructed to watch the provided ASMR video, and the control group was instructed to watch the neutral video. For both the groups, videos were played on a laptop with headphones. Disturbed or complex sleep patterns were screened using GHQ. At posttest, the SRPI was administered to determine whether the videos create any significant difference between the pretest and posttest scores.

After receiving approval from the Institutional Review Board, the study was conducted, and all the participants were provided with written informed consent before the recruitment that explained the potential risks and benefits of the study. Participants were also informed of their right to withdraw at any time.

Results

Data were entered into a Microsoft Excel spreadsheet and analyzed using SPSS version 16. Since the data was not normally distributed, Wilcoxon Signed Rank Test was be used for within-group comparison and Mann-Whitney *U* test for between-group comparisons.

Table 1 and Table 2 show the mean and standard deviation of the experimental and control groups.

Table 1
Mean and SD of Experimental Group

Relaxation & Stress States		Mean	*SD*
Sleepiness	Pretest	3.50	1.33
	Posttest	5.40	1.96
Disengagement	Pretest	3.67	1.21
	Posttest	4.07	1.34
Physical Relaxation	Pretest	4.07	1.51
	Posttest	4.53	1.85
Mental Quiet	Pretest	4.23	1.17
	Posttest	4.63	1.49
At Ease & Peace	Pretest	6.83	1.58
	Posttest	7.13	1.87
Rested & Refreshed	Pretest	2.33	0.71
	Posttest	2.27	0.91
Strength & Awareness	Pretest	4.80	1.03
	Posttest	4.50	1.61
Joy	Pretest	5.13	0.97
	Posttest	4.33	1.60

Table 1
Mean and SD of Experimental Group

Relaxation & Stress States		Mean	*SD*
Love & Thankfulness	Pretest	5.13	0.94
	Posttest	4.33	1.60
Prayerfulness	Pretest	2.23	0.77
	Posttest	1.77	1.04
Childlike Innocence	Pretest	2.07	0.91
	Posttest	2.00	0.91
Awe & Wonder	Pretest	1.83	0.87
	Posttest	2.00	0.95
Mystery	Pretest	1.83	0.79
	Posttest	1.70	0.88
Timeless, Boundless, Infinite	Pretest	1.70	0.70
	Posttest	1.83	0.91
Somatic Stress	Pretest	4.67	1.52
	Posttest	4.43	1.65
Worry	Pretest	2.10	0.71
	Posttest	1.60	0.67
Negative Emotion	Pretest	5.37	1.73
	Posttest	4.63	1.63

Table 2
Mean and SD of Control Group

Relaxation & Stress States		Mean	*SD*
Sleepiness	Pretest	3.67	1.37
	Posttest	3.47	1.43
Disengagement	Pretest	3.30	1.29
	Posttest	4.20	1.85
Physical Relaxation	Pretest	4.00	1.62
	Posttest	4.43	1.50
Mental Quiet	Pretest	4.33	1.09
	Posttest	5.57	1.52
At Ease & Peace	Pretest	7.07	1.46
	Posttest	8.40	2.09
Rested & Refreshed	Pretest	2.30	0.70
	Posttest	2.63	0.89

Table 2
Mean and SD of Control Group

Relaxation & Stress States		Mean	*SD*
Strength & Awareness	Pretest	4.77	0.94
	Posttest	4.50	1.41
Joy	Pretest	5.13	0.94
	Posttest	5.43	1.45
Love & Thankfulness	Pretest	5.23	0.89
	Posttest	5.43	1.45
Prayerfulness	Pretest	2.23	0.73
	Posttest	2.30	1.06
Childlike Innocence	Pretest	2.03	0.85
	Posttest	2.37	1.07
Awe & Wonder	Pretest	2.00	0.79
	Posttest	2.43	1.19
Mystery	Pretest	2.03	0.85
	Posttest	2.13	0.89
Timeless, Boundless, Infinite	Pretest	1.90	0.84
	Posttest	2.37	1.13
Somatic Stress	Pretest	4.40	1.45
	Posttest	4.03	1.22
Worry	Pretest	2.00	0.69
	Posttest	1.47	0.68
Negative Emotion	Pretest	4.93	1.82
	Posttest	3.80	1.37

Table 3 results suggest that there is no significant difference between the scores of any relaxation states and stress states in the pretest of both the groups.

Table 3
Results of Mann-Whitney U Test for Pretest Scores of the Experimental and Control Groups at Baseline

Relaxation & Stress States	*U* Value
Sleepiness	418.5
Disengagement	365.5
Physical Relaxation	441.5
Mental Quiet	423.0

Table 3
Results of Mann-Whitney U Test for Pretest Scores of the Experimental and Control Groups at Baseline

Relaxation & Stress States	*U* Value
At Ease & Peace	410.5
Rested & Refreshed	437.0
Strength & Awareness	429.5
Joy	446.0
Love & Thankfulness	424.5
Prayerfulness	446.5
Childlike Innocence	439.5
Awe & Wonder	397.5
Mystery	391.0
Timeless, Boundless, Infinite	394.5
Somatic Stress	404.0
Worry	415.5
Negative Emotion	382.0

Table 4 results suggest a significant difference in three relaxation states' scores (sleepiness, joy, love and thankfulness) and one stress state (worry) in the experimental group's pre- and posttest.

Table 4
Wilcoxon Signed Rank Test of the Experimental Group

Relaxation & Stress States	*Z* Value
Sleepiness	−4.12**
Disengagement	−1.51
Physical Relaxation	−1.07
Mental Quiet	−1.11
At Ease & Peace	−0.94
Rested & Refreshed	−0.41
Strength & Awareness	−0.79
Joy	−2.26*
Love & Thankfulness	−2.40*
Prayerfulness	−1.72
Childlike Innocence	−0.28
Awe & Wonder	−0.91
Mystery	−0.82
Timeless, Boundless, Infinite	−0.66
Somatic Stress	−0.75
Worry	−2.69**
Negative Emotion	−1.68

Table 4
Wilcoxon Signed Rank Test of the Experimental Group

*$p < .05$; ** $p < .01$

Table 5 results suggest a significant difference in three relaxation states' scores (disengagement, mental quiet, and at ease and peace) and two stress states (worry and negative emotion) the pre- and posttest of the control group.

Table 5
Results of Wilcoxon Signed Rank Test of Pretest and Posttest Scores of the Control Group

Relaxation & Stress States	*Z* Value
Sleepiness	−0.66
Disengagement	−2.29*
Physical Relaxation	−1.37
Mental Quiet	−3.23**
At Ease & Peace	−2.98**
Rested & Refreshed	−1.72
Strength & Awareness	−1.29
Joy	−0.76
Love & Thankfulness	−0.69
Prayerfulness	−0.45
Childlike Innocence	−1.69
Awe & Wonder	−1.82
Mystery	−0.55
Timeless, Boundless, Infinite	−1.86
Somatic Stress	−1.68
Worry	−2.99**
Negative Emotion	−2.95**

*$p < .05$; ** $p < .01$

Table 6 results suggest a significant difference between the scores of three relaxation states (sleepiness, mental quiet, and at ease and peace) and two stress states (worry and negative emotion) in the posttest of both the groups.

Table 6
Results of Mann-Whitney U test for Change Scores of the Experimental and the Control Group

Relaxation & Stress States		Mean Ranks	*U* Value
Sleepiness	ASMR	39.43	182.0**
	Neutral	21.57	
Disengagement	ASMR	27.92	372.5
	Neutral	33.08	
Physical Relaxation	ASMR	30.65	445.5
	Neutral	30.35	
Mental Quiet	ASMR	26.73	337.0
	Neutral	34.27	
At Ease & Peace	ASMR	26.77	338.0
	Neutral	34.23	
Rested & Refreshed	ASMR	27.92	372.5
	Neutral	33.08	
Strength & Awareness	ASMR	30.48	449.5
	Neutral	30.52	
Joy	ASMR	24.87	281.0**
	Neutral	36.13	
Love & Thankfulness	ASMR	24.72	276.5**
	Neutral	36.28	
Prayerfulness	ASMR	25.40	297.0*
	Neutral	35.60	
Childlike Innocence	ASMR	26.97	344.0
	Neutral	34.03	
Awe & Wonder	ASMR	28.60	393.0
	Neutral	32.40	
Mystery	ASMR	28.27	383.0
	Neutral	32.73	
Timeless, Boundless, Infinite	ASMR	28.43	388.0
	Neutral	32.57	
Somatic Stress	ASMR	30.32	444.5
	Neutral	30.68	
Worry	ASMR	30.63	446.0
	Neutral	20.37	
Negative Emotion	ASMR	31.20	429.0
	Neutral	29.80	

Table 6
Results of Mann-Whitney U test for Change Scores of the Experimental and the Control Group

**p* < .05; ** *p* < .01

Figure 1. *Summary of the Differences of Relaxation States of the Experimental and Control Groups After Watching ASMR and Control Videos*.

Discussion

The current study aimed to determine whether there would be a considerable difference in the relaxation states and stress states on exposure to ASMR video. From the Table 3 results, it is clear that there is no significant difference between the relaxation states and stress states of the participants of both groups, which indicates that the sample population of both the group are similar.

The Table 4 results indicated that there is a significant difference in the scores of three relaxation states (sleepiness, joy, love and thankfulness) and one stress state (worry) in the pre- and posttest of the experimental group after watching the ASMR video. There is an increment in the relaxation state of sleepiness and a decrease in joy, love and thankfulness, while there is a decrement in a stress state of worry after watching the ASMR video. One possible reason might be that the brain neutralizes the emotions rather than being overwhelmed by them, thereby reducing worry and increasing relaxation by being in the present moment.

Previous studies also strengthen this finding that ASMR videos induce relaxation, and thousands of people reported using them to sleep and deal with stress and anxiety (Barratt & Davis, 2015). For some people, the sensation of ASMR is also associated with a condition called misophonia, which can be defined as high sensitivity or aversion towards sound, especially human sounds like eating, coughing, and breathing. In such cases, ASMR videos are distressing, unpleasant, and uncomfortable (McErlean & Banissy, 2018). This could be the reason for the decrease in joy and love and thankfulness. Thus, these studies point towards the heterogeneity in the phenomenon of ASMR, which shows massively different and mixed reactions.

From Table 5, the increase in relaxation states of disengagement, mental quiet, at ease and peace and decrease in stress states of worry and negative emotion in individuals who watched the neutral video can be explained by the evidence from previous studies which indicated that visual imagery of nature increases relaxation, which turned out to be one of the limitations of the present study. The neutral video used in the present study was comprised of photographic pictures and short videos of nature. Research has shown that even exposure to photographic pictures of nature, compared to pictures of urban environments, has positive effects on emotional states and cognitive performance (Hartmann & Apaolaza-Ibáñez, 2010). The findings suggest that even short-term visits to nature areas have positive effects on perceived stress relief compared to build-up environments. There is also increasing interest in studying whether nature may help prevent illnesses mediated by psychological processes, such as stress, and curing stress-related diseases, such as burnout and depression. Research stretching over several decades has shown the overall preference for natural scenery consistently instead of artificial environments (Calvin et al., 1972). The attraction toward nature is widely considered a significant aspect of human behavior. Numerous studies have demonstrated humans' preference for environments with natural elements over those that are predominantly built (Cackowski & Nasar, 2003; Kaplan & Kaplan, 1989; Lamb et al., 1994).

The study results have shown a significant difference in four relaxation states (sleepiness, joy, love and thankfulness, and prayerfulness; Table 6). Graphical representation of this difference is plotted in Figure 1. This indicates that the changes that happened in these relaxation states of both groups are exclusively the result of video exposure. Participants in the experimental group who watched the ASMR video experienced a higher relaxation state of sleepiness, which affirms previous self-reported studies and indicates the advantage of ASMR videos over other videos to induce sleep and thereby relaxation. From this study, it can be stated that ASMR videos have their highest impact on sleepiness than any other relaxation states.

Aligning with the result of this study, a study by Barratt and Davis (2015) stated that 82% of its participants use ASMR videos to induce sleep, and 70% added that it helps to cope with stress. ASMR triggers combined with binaural beat have the advantages of inducing brainwave entrainment and psychological stability (Lee et al., 2019). The results of multiple studies, along with this study, strongly indicate that ASMR has a high impact in inducing sleep; it can help treat patients suffering from sleep disorders like insomnia. It is also helpful in reducing stress by reducing worries, indicating that it can be used as a relaxation technique.

One of the significant limitations of this study was the absence of a scale in measuring ASMR at the time of this study and a way to distinguish or screen ASMR-sensitive and nonsensitive individuals. Since ASMR is a relatively new phenomenon, a shortage in studies and transparency in the whole phenomenon makes it more challenging to interpret meanings and support the research findings. The study would also have to be replicated with a larger sample. Another limitation is that even though the neutral video was developed to produce no effect, there were significant changes in the control group's relaxation states and stress states after watching the neutral video. Another limitation is that since the study was wholly quantitative and used established standard scales, the participants were not screened for common beverages like coffee, which is also a stimulant.

Since this field of study is novel, multiple domains are still unexplored. This study stated the impact of ASMR in inducing sleep; one of the possible extensions of this study can be done on the EEG study of sleep induced by ASMR, and in the future more studies could be carried out to develop possible interventions using ASMR, especially to cope and deal with insomnia.

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Author Declaration

The authors declare no conflicts of interest with respect to the research, authorship, and publication of this article. There is no financial interest or benefit that has arisen from this research.

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NeuroRegulation

How a Chronic Headache Condition Became Resolved with One Session of Breathing and Posture Coaching

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Abstract

This case example reports how a 32-year-old female student with chronic headaches since age 18 became headache-free after one session of breathing and posture coaching. She self-medicated and took between 2 and 10 Excedrin tablets per week. The class coaching session focused on shifting her habitual thoracic breathing to slower lower abdominal diaphragmatic breathing and posture retraining. While working at the computer, she used an app installed on her computer that provided visual and auditory feedback each time she slouched. She used the app 2–6 hours per day for 2 weeks, and each time in response to the slouching feedback she sat up erect and breathed slower and lower. After the first coaching session and for the following 14 weeks, she has been headache-free and not used any medications. After implementing breathing and posture changes, she also reported significant reduction in shoulder pain, back pain, depression, anxiety, and improvement in motivation. We recommend that when college students report headaches, anxiety, and gastrointestinal distress that they are first offered self-mastery interventions.

Keywords: headache; breathing; posture; awareness; electromyography

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Introduction

Many students report experiencing anxiety, Zoom fatigue, neck and shoulder tension, abdominal discomfort, vision problems, and headaches, and the incidence has increased over the last few years as students spent more and more time in front of screens (Ahmed et al., 2021; Bauer et al., 2021; Charles et al., 2021; Kuehn, 2021; Peper et al., 2021). In many cases, the cause is more functional than structural, with headache pathogenesis indicating the linkage between bad posture, breathing, and headache (Elizagaray-Garcia et al., 2020; Schulman, 2002). Without awareness, students look down at their screens, maintain low-level muscle tension, and breathe shallowly, predominantly in their chests. When students become aware of these dysfunctional patterns and implement behavioral stress management skills as part of a semester-long class, they report a reduction in symptoms including irritable bowel syndrome, acid reflux, or anxiety (Peper et al., 2017a; Peper et al, 2016a). Sometimes, a single coaching session can be enough to improve health. This case report describes how a student with chronic headaches resolved her chronic headache in a coaching session.

The student was a 32-year-old woman who suffered from headaches which she self-labeled as migraines generally two or three times per week and took between 2 and 10 Excedrin tablets per week. As Excedrin contains 65 mg of caffeine as well as 250 mg acetaminophen and 250 mg of aspirin, the chronic headaches may have been partially caused by caffeine withdrawal which would get resolved by taking more Excedrin (Greben et al., 1980). Acetaminophen may also be harmful to liver function (Bauer et al., 2021). She reported that headaches first began when she was 18, after using digital devices which encouraged her to slouch as she looked down. Although she describes herself as healthy, she reports having high anxiety and experiencing occasional depression.

The Behavioral Coaching Intervention

At the beginning of the class, the student approached the instructor and said that she was not feeling well and had a severe headache. As she was talking, the instructor noticed that she was breathing in her chest without any abdominal movement, her shoulders were held tight, her posture was slightly slouched, and her hands were cold. She was unaware of what was happening in her body. The instructor offered to guide her through some practices that she might find useful to reduce her headaches.

Working Hypothesis. The headaches most likely were tension headaches and not migraines. They may be the result of neck and shoulder tension which is maintained during chest breathing and the slouched head forward body posture. If she could change her posture, relax her neck and shoulders, and breathe diaphragmatically so that the lower abdomen widens during inhalation, most likely her shoulder and neck tension would decrease. Therefore, by changing posture from a slouched to upright position combined with slower diaphragmatic breathing, the muscle tension would be reduced and the headaches would decrease.

Breathing and Posture Changes

With verbal and tactile coaching, she learned slower diaphragmatic breathing, where she gently and slowly exhaled by making a sound of *psssssssst* (exhaling through pursed lips), which tends to activate transverse and oblique abdominal muscles as well as tighten the pelvic floor muscles so that her lower abdomen would slightly come in at the end of the exhalation (Peper et al., 2016b). The inhalation occurred by allowing the lower abdomen and pelvic floor to relax so that the abdomen would expand in 360 degrees[1]. This expansion of the abdomen allowed the air to flow in effortlessly without lifting her chest. Part of the purpose for breathing this way is that many people unknowingly tighten the pelvic floor muscle and lower abdominal wall as a protective pattern when they curl slightly forward in a protective position. This position also tends to contract the muscles of the neck and shoulders.

To allow breathing to occur effortlessly, she would need to sit upright so that the abdomen had space to expand during inhalation (Peper et al., 2020). In addition, the clothing around her waist would need to be loosened to allow her abdomen to enlarge and expand in 360 degrees (MacHose & Peper, 1991). For numerous participants, it is challenging to allow the abdomen to expand as they are self-conscious about their abdomen getting bigger or as an unconscious learned response to avoid pain after having had abdominal surgery (Peper et al., 2015).

The upright position allowed her to sit tall and erect, in which the back of head reaches upward towards the ceiling while relaxing and feeling gravity pulling her shoulders downward, at the same time relaxing her hips and legs. While practicing the slower breathing in the relaxed upright position, she was asked to sense or imagine feeling a flow down and through her arms and out her hands as she exhaled. After a few minutes, she felt her headache reduce in intensity and also noticed that her hands had slightly warmed. After this short coaching intervention, she went back to her seat and continued to practice the relaxed effortless breathing while sitting upright and allowing her shoulders to melt downward.

Demonstration of Muscle Tension While Feeling Relaxed

During the same class session, she volunteered to have her trapezius muscle monitored with electromyography (EMG). Even though she felt relaxed, the EMG indicated that her muscles were not relaxed. With a few minutes of EMG feedback exploration, she discovered that she could relax her shoulder muscles by feeling them being heavy and melting.

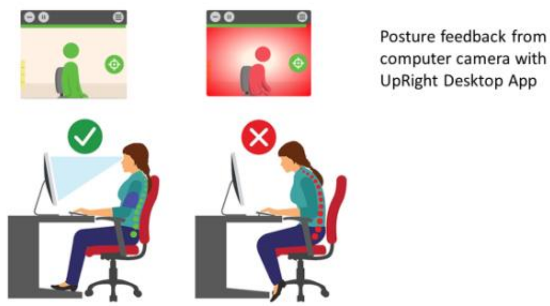
Home Practice with a Posture App

As part of the class home laboratory assignment, she was assigned a self-study for 2 weeks with a posture feedback app, Dario Desktop. The app uses the computer or laptop camera to monitor posture. When the person slouches, the app provides visual feedback in a small window on the computer screen and/or an auditory signal as shown in Figure 1.

The steps in this self-study were first to monitor her symptoms for 3 days and then install the posture feedback application on her laptop to provide feedback whenever she slouched. The posture feedback reminded her to practice better posture everyday while working on her computer and integrated short breaks of stretching and standing when using the computer for an extended period of time.

[1] She could easily allow her abdomen to expand, as she never had abdominal injury or surgery and was not self-conscious of letting her waist widen (Peper et al., 2015).

Figure 1. Posture Feedback to Signal to Participant that the Person Is Slouching.

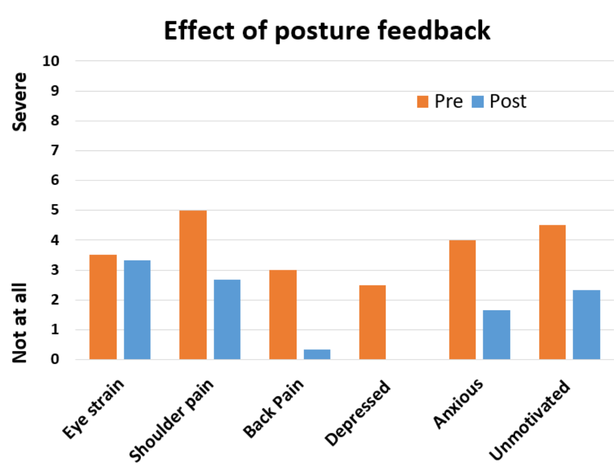


Each time the feedback signal indicated she slouched, she would sit up and change her posture, breathe lower and slower and relax her shoulders. She also monitored what factors triggered the slouching. Additionally, she added daily reminders to her phone to remind her of her posture and added reminders to stretch and stand after each hour of studying. After 2 weeks she recorded her symptoms for 3 days for the post-assessment.

Results

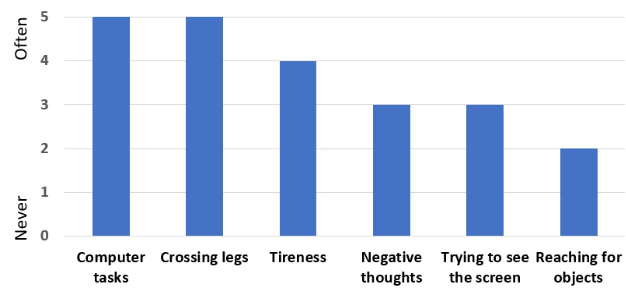
The chronic headache condition which had been present for 14 years disappeared, and she has not used any medication since the first day of class. At the 14 week follow-up she continues to be headache free. In addition, she reported after 2 weeks that her shoulder discomfort and pain, back discomfort and pain, depression, anxiety, and lack of motivation decreased as shown in Figure 2.

Figure 2. Changes in Symptoms After Implementing Posture Feedback for 2 Weeks.



She used the upright app every time she opened her laptop at home, as often as 3–5 times per day (roughly 2–6 hours). In addition, when she felt the beginning of discomfort or thought she should take medication, she would adjust her posture and breathe. While using the app, she identified numerous factors that were associated with slouching, as shown in Figure 3.

Figure 3. Behaviors Associated with Slouching.



Discussion

Using posture feedback as a tool at home to remind the person to practice sitting tall and relaxing the shoulders, while practicing slower diaphragmatic breathing, eliminated a chronic headache condition. The posture feedback also improved mood, resulting in less depression and anxiety. The decrease in depression, anxiety, and lack of motivation may be the direct result of posture change—since a slouched position allows easier access to hopeless, helpless, and powerless thought and in the upright position the subject felt increased energy and easier access to empowering and positive thoughts (Peper et al., 2017b; Tsai et al., 2016; Veenstra et al., 2017; Wilson & Peper, 2004). Most likely the success occurred because the participant actually implemented the changes in her behavior. As she noted, “Although it was distracting to be reminded all the time about my posture, it did decrease my neck pain. With the pain reduction, I was able to sit at the computer longer and felt more motivated.”

The combination of slower lower abdominal breathing with the upright posture reversed her protective/defensive body position which often tightens the muscle in the lower abdomen and pelvic floor and the shoulders and neck (pressing your knees together and curling your shoulder forward). The upright posture creates position of empowerment and trust by which the lower abdomen can expand. In addition, the upright posture allows easier access to positive thoughts and reduces recall of hopeless, powerless, or defeated memories. It is also possible that caffeine withdrawal was a cofactor in evoking headaches (Küçer, 2010). By eliminating the medication, she also eliminated the triggering of the caffeine withdrawal headaches.

This case example suggests that before medications are prescribed, health care providers may want to teach simple behavioral techniques which the student can implement during the day instead of prescribing medication. Yet, in most cases, students report that the usual medical treatment provided is medication. We recommend that when college students report headaches, anxiety, and gastrointestinal distress that they are first offered self-mastery interventions (Peper et al., 2016a). Useful interventions may include slower and lower diaphragmatic breathing, erect upright posture, stress management, cognitive behavior therapy, and health-promoting lifestyles modifications such as regular sleep, exercise, and healthier diet.

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Proceedings of the 2021 ISNR Annual Conference (Virtual): Keynote and Plenary Presentations

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KEYNOTE PRESENTATIONS

Music-Based Interventions for Cognitive and Brain Health

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Music is an art form that is found in every culture and at every stage in life. While there is much anecdotal evidence supporting the therapeutic effects of making and listening to music, the science of music for cognitive and brain health is still in its infancy. I will describe recent studies from my lab on music and the brain, especially focusing on music-based interventions for reducing stress and loneliness and for improving working memory. Results point to the role of the brain's dopaminergic reward system in mediating the beneficial effects of music. I will conclude with some evidence-based recommendations for adopting music as a lifestyle factor to stay cognitively and neurologically healthy in old age. Music therapy is an evidence-based practice, but the needs and constraints of various stakeholders pose challenges towards providing the highest standards of evidence for each clinical application. First, what is the best path from clinical need to multisite, widely adopted intervention for a given disease or disorder? Secondly, how can we inform policy makers that what we do matters for public health––what evidence do we have, and what evidence do we need? I will review the multiple forms of evidence for music-based interventions in the context of neurological disorders, from large-scale randomized controlled trials (RCT) to smaller-scale experimental studies, and make the case that evidence at multiple levels continues to be necessary for informing the selection of active ingredients of interest in effective musical interventions. I will review some of the existing literature on music-based interventions for neurodegenerative disorders, with particular focus on neural structures and networks that are targeted by specific therapies for disorders including Alzheimer's disease, Parkinson's disease, and aphasia. This is followed by a focused discussion of principles that are gleaned from studies in cognitive and clinical neuroscience, which may inform the active ingredients of music-based interventions. Therapies that are driven by a deeper understanding of the musical elements that target specific disease mechanisms are more likely to succeed and to increase the chances of widespread adoption. I will conclude with some recommendations for future research.

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Functional Neuromarkers for Psychiatry and Neurology: Applications for Diagnosis and Treatment

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The paper describes a recently emerged Human Brain Index (HBI) methodology of extracting functional neuromarkers from spontaneous resting-state EEG, from multichannel event-related potentials (ERPs; by definition, ERPs are scalp recorded voltage fluctuations that are time-locked to an event, sensory or motor) and application of this methodology in clinical practice. The methodology includes methods of independent component analysis (ICA) for artifact correcting, methods of blind sources separation (ICA, a joint diagonalization of covariance matrixes, PARAFAC, etc.) for extracting latent (hidden) components from resting-state EEG and from group event-related potentials, methods for constructing normative (a thousand of healthy subjects) and patient (thousands of patients with psychiatric and neurological conditions) databases, methods for comparing the extracted individual parameters with the normative data, as well methods for pre–post comparison. Functional association of the latent components in the cued go/no-go task with operations of cognitive control such as working memory, context updating, conflict detection and monitoring, and action inhibition are discussed. In addition, the functional meaning of the common ERP waves (N1, N170, P3a, P3b, N2 NOGO, P3 NOGO), their heterogeneity, and age dynamics is reviewed. The high level of specificity and sensitivity for defining dysfunctions in ADHD, schizophrenia, ASD, and OCD is described. The paper also presents the ways of application of the methodology for predicting clinical outcome in response to pharmacological medication (ADHD medication by Ritalin as an example), for constructing protocols of neurofeedback, transcranial direct current stimulation (tDCS), and transcranial magnetic stimulation (TMS) in clinical population. A review of the recent studies is presented. The author will share his 15 years of experience (including hardware and software requirements, educational courses, supervision, etc.) of applying the HBI methodology in clinical practice. An example of a report based on HBI methodology with analysis of spontaneous EEG, event-related potentials, and recommendations for neurotherapy will be given to attendees.

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Neurofeedback and Body Psychotherapy

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This presentation will focus on a comprehensive treatment approach of neurofeedback and body psychotherapy (NFB) with individuals who experienced primarily transgenerational trauma of third and fourth generation of Holocaust survivors by review of case studies and exploration of the framework of NFB.

What is Body Psychotherapy (BP)? BP is a field in psychology and psychotherapy that evolved over the last 100 years. Progress in neuroscience, medicine, psychology, and trauma work created waves of insight which are now further underpinning the empirical understanding of BP, as an integrated approach that brings mind, emotion, body, and spirit into deeper connection and reawakening individual well-being. Biodynamic BP (BBP), a modality of BP, is a humanistic approach that supports the processes of natural movement toward health (salutogenesis) by using body awareness, emotional expression, verbal understanding, and attuned touch. It involves a dynamic assessment process that can provide a framework to integrate neurofeedback (NF) into the psychotherapeutic process.

Transgenerational trauma in descendants of Holocaust survivors. The Holocaust and its aftermath still have a fundamental impact on the mind, body, and soul of many descendants of Holocaust survivors. More than half a century ago the most unthinkable and unimaginable horror happened, and the descendants, generations of Holocaust survivors, are left to deal with one of the most devastating, brutal, and dehumanizing experiences in human history. We are confronted by a complex traumatic phenomenon that has multiple facets, including national, political, sociological, and relational, as well as psychological and biological effects which became part of descendants' lives and of the embodied psyche. The shadow of the Holocaust impacts the development of self-identities, the deep sense of selves and the capacity to express affective states. Normal sensations like pain and pleasure as well as emotions such as anger, playfulness, grief, and love were suppressed and led to the creation of a relational crypt that contains traumatic experiences.

Implementation of NFB in the treatment process. During BBP sessions we explore past traumatic responses at different developmental levels, as well as the treatment implications of these findings. Traumatic memories are often dissociated and may be inaccessible to verbal recall or processing. Therefore, one of BBP working hypotheses is the essential need for emotional and physiological self-regulation at a subcortical level outside of awareness.

This key hypothesis enables integration of NF with BBP enhancing the psychotherapeutic process. For example, in a BBP session, I may support integration of sensory input with motoric output to enable effective movement in perceived life-threatening situations or find an internal framework which enables self- regulation of hyperarousal state on a bodily level. In both situations, when the individual can be in hyperarousal or hypoarousal states, I found it useful to integrate NF training into the BBP session; that is, NFB.

Takeaway message. BP interventions led by DA could easily be integrated into NF sessions. The use of NFB can provide multiple benefits, including enhancing self-organization and self-regulation. NFB can enhance the capacity for interoceptive awareness and facilitate processing in individuals who suffer transgenerational trauma.

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Hyperbaric Oxygen Therapy for Neuropathology: The Effect on Combat Associated PTSD

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Clinical studies present convincing evidence that hyperbaric oxygen therapy (HBOT) might be the coveted neurotherapeutic method for brain repair. HBOT is a treatment in which oxygen-enriched air (up to 100%) is administrated to patients in a chamber where the pressure is elevated above one atmosphere absolute (1ATA which is the ambient atmospheric pressure). It is becoming widely acknowledged that the combined action of hyperoxia and hyperbaric pressure leads to significant improvement in tissue oxygenation, targets oxygen and pressure-sensitive genes, improves mitochondrial metabolism and induces anti-apoptotic and anti-inflammatory effects. Special focus has been given recently to the effect of HBOT on neuropathology. The talk will reflect on the multifaceted role of HBOT in neurotherapeutics, in light of recent evidence for HBOT efficacy in conditions such as poststroke, traumatic brain injury (TBI), and fibromyalgia.

The second part of the talk will elucidate the rationale and accumulating evidence regarding HBOT's effect on posttraumatic stress disorder (PTSD). Though PTSD has been described many years ago, no cure is available and about half of the individuals meet the criteria for PTSD even after different combinations of treatments. It is known today that the syndrome is characterized by long-term structural and functional brain changes. The severity of the brain changes correlates with the severity of the symptoms and its resistance to the current available treatments. The neuroplasticity induced by HBOT targets those brain changes and thus brings new therapeutic strategy in the arsenal used for the unfortunate who suffer from this chronic debilitating disorder.

The treatment course, the effect of clinical symptoms and structural and functional brain changes will be discussed, together with potential challenges and future plans.

PLENARY SESSION PRESENTATIONS

Neurorehabilitation Program Using Biophoto/Electromagnetic Stimulation Wearable

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Twenty-four clients, 10–86 years old, volunteered for this study. Participants previously diagnosed and treated by their own physicians or psychologists for a variety of conditions such as attention-deficit/hyperactivity disorder (ADHD), learning disorders, fibromyalgia and other pain syndromes, sleep disorders, poststroke, postconcussion syndrome, asthma, chronic obstructive pulmonary disorder (COPD), and memory dysfunctions. Before the study commenced, a battery of subjective tests (DSM-5, Amen ADD questionnaires) were completed and medical history collected. Prior to the beginning of the study, clients were evaluated cognitively with the Integrated Visual and Auditory (IVA-QS) continuous performance test. In most cases, parents, spouses, or close family members completed biweekly evaluations to monitor specific changes in the client's overall health condition and progress. After each session, participants completed a questionnaire. Neurostimulation sessions were offered three times per week, half an hour each session, for 20–40 consecutive sessions. The cognitive functions were reevaluated with the same IVA-QS battery, as used at the start of the study, after 20 and after 40 consecutive sessions of neurostimulation. Majority of the participants benefited from the neurostimulation program obtaining remarkable physical, emotional, and cognitive improvements. Objectively, the IVA-QS showed significant and continuous improvements. No negative side effects have been reported from this training.

Conclusion. The Neurodynamic Activator™, as a unique standalone brain trainer, was shown to be a useful device that benefited all the participants. The benefits obtained and reported at the end of the study continued to be sustained 18 months and longer, after the completion of the biophotostimulation. Other light or biophotostimulation methods will be compared and discussed. We had to adapt to this special isolated life during the pandemic time that we experienced for a year. The importance of integrating the biophotostimulation devices in brain training without any negative consequences will be a part of our discussion.

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Pilot Data on LORETA Neurofeedback for Improving Psychological and Neuroendocrine Status During Incarceration for Substance Abuse-related Offenders

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***Introduction*.** The data presented in this study are early results from a larger study investigating the effects of LORETA neurofeedback at precuneus for improving psychological status in inmates in the Michigan Newaygo County Jail for substance abuse-related offenses (Cannon et al., 2009, 2014). It has been proposed that one in five incarcerations are drug-related offenses. Notably the rate of recidivism for drug and alcohol offenders is 25% within 3 years of release, and it is estimated that one half of all incarcerated individuals would meet criteria for a substance use disorder (Chandler et al., 2009).

***Methods*.** This early data consists of nine participants (four female) with mean age 34.88, *SD* = 10.98. Participants completed initial screening and informed consent prior to inclusion. Participants were administered the personality assessment inventory (PAI) and self-perception/experiential schemata assessments pretraining and completed 5-min eyes-closed (ECB) and eyes-opened (EOB) baselines with EEG education and training prior to beginning the LNFB protocol. Sessions were conducted five times per week across 20 consecutive weekdays. Each session consisted of six 5-min training rounds and required approximately 50 minutes to complete. The PAI was administered at session 19 for pre–post comparison. A repeated measures ANOVA was conducted for PAI scores, and paired contrasts were conducted on EEG spectral data and LORETA current sources.

***Results*.** There were significant overall effects for reductions in nearly all scales on the PAI with the repeated measures ANOVA with Greenhouse-Geiser correction with $F(1.30) = 60.99$, $p < .000$, with partial eta squared = .67. The mean difference between scores was 5.16, $SE = .665$, $p = .000$. The LORETA contrasts showed several significant differences between pre and post EOB in delta $t(8) = 5.48$, $p = .005$; theta $t(8) = 3.41$, $p = .009$; alpha 1 $t(8) = 2.20$, $p = .054$; alpha 2 $t(8) = 1.22$, $p = .257$; beta 1 $t(8) = 3.44$, p = .008; beta 2 t (8) = 2.74, p = .025; and beta 3 $t(8) = 3.00$, $p = .017$. Brain areas showing significant differences included Brodmann Areas 20, 21, 22, 32, and 36.

***Discussion*.** The current pilot data is from a larger study implementing LORETA neurofeedback training program in the local jail at Newaygo County, Michigan, to facilitate greater adaptability to nonusing patterns of behavior and internal dialogue, reduction of psychological distress, and normalization of neuroendocrine measures (cortisol) to ultimately lessen recidivism rates and improve the likelihood of continuing services upon release from the jail.

There have been research indicating treatment models during incarceration have offered some level of efficacy (Peters et al., 2017) with initial treatment and longer-term monitoring. These type of studies and active interventions in county jails may aid in the reduction of recidivism as well as decrease the rates of overdose-related deaths shortly after release (Becker et al., 2020; Davis et al., 2020; Kim & Yang, 2020; Oluwoye et al., 2020; Rushovich et al., 2020).

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Psychoneuroendocrinology of Aging: Implications for Neuroregulation

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Considering that life expectancy has increased over the last few years and that age is the main risk factor for the incidence of neurocognitive disorder (NCD), the characterization of the neurobiological substrates that constitute normal cognitive aging has become increasingly relevant, as well as the underpinnings of pathological cognitive aging. Aging is a multidimensional process, that results from the interaction of multiple factors along a person's lifespan. Hence, a better understanding of how these different factors interact with each other may lead to earlier detection and, thus, treatment of NCD. Since health is the result from the interaction from biopsychosocial mechanisms, the phenotyping of neuroendocrine profiles among the aging population might shed some light on the nature of cognitive aging (Epel et al., 2007).

As people age, the activity of several neuroendocrine axes changes, which is both a result of the aging process per se and the multiple life experiences of each particular individual. Studies have particularly focused on the hypothalamic-pituitary-adrenal (HPA) axis and it has been long known that aging results in a downregulation of glucocorticoid receptors in the brain (Sapolsky et al., 1986; Mizoguchi et al., 2009). This leads to a diminished efficiency of the negative feedback regulation of the HPA axis (Otte et al., 2005) which, in turn, affects cognitive function (Elgh et al., 2006). Moreover, the age-related changes in HPA activity have also been related to dendritic atrophy and synaptic loss (Cerqueira et al., 2005) as well as a decrease in hippocampal volume (Huang et al., 2009).

The present work reviews the aforementioned evidence in terms of its utility for neuroregulation research. Since the assessment of the efficacy of certain type of neurotherapy is typically carried out by means of behavioral (clinical) outcomes, the inclusion of biomarkers could lead us to a better understanding of the mechanisms involved in the observed clinical change.

With these in mind we have characterized two populations of healthy older adults, which are defined with respect to their resting EEG. I will present the evidence that we have gathered so far in terms of how neuroendocrine activity modulates brain function (Villada et al., 2020) as well as the exploration using event-related potentials during cognitive tasks.

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Advances in Photobiomodulation Using a Closed-Loop Design

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In the time since the initial designs for integrating pulsed near-infrared (pNIR) light with EEG biofeedback were developed, there have been advances in both EEG and pNIR technology. This presentation will evaluate how applying closed-loop principles to the communication paradigm between brain and light source have increased the potential for more nuanced clinical neuromodulation paradigms.

The basis for this talk will be the dynamics involved when directly integrating pulsed near-infrared light into neurofeedback designs which modulate the delivery of the pulsed NIR based on changes in selected EEG metrics. Used as an adjunctive intervention, photobiomodulation devices have historically been standalone methods, delivering pre-set pulses for selected amounts of time in a separate context from neurofeedback.

One example of this technology is the Vielight Neuro headset. The first instrument of its kind, the VieLight is a transcranial-intranasal near infrared light (NIR) photobiomodulation device, delivering pulsed NIR with light emitting diodes (LEDs) at a wavelength of 810 nm, which has been documented as the infrared wavelength with the highest skin penetration profile (Rojas & Gonzalez-Lima, 2013). Delivering the near-infrared light in pulses, instead of as a continuous exposure, addresses concerns regarding thermal effects on biological tissue (Ando et al., 2011).

Making the Vielight stimulation contingent on EEG behavior creates a framework in which the pulsed light becomes an explicit feedback element, an entirely novel application pairing its documented enhancement of BDNF and synaptogenesis (Hennessy & Hamblin, 2017) with unique patented live *Z*-score neurofeedback designs focusing heavily on supporting neural connectivity (Collura, 2008).

These feedback designs incorporate the Vielight device to deliver NIR at 810 nm, pulsed at rates determined by the clinical analysis of individual qEEG results of each subject within the context of current literature on photobiomodulation. The exposure to these pulses is directly modified by shifts in preselected EEG metrics, with paradigms based on changes in power and connectivity in monitored neurophysiological locations compared to a set of database norms.

Early findings in the literature indicate photobiomodulation has significant clinical potential in the treatment of a number of brain-based disorders, including, but not limited to, traumatic brain injury (Henderson, 2016), Alzheimer's and Parkinson's (Johnstone et al., 2015), improving executive function (Barrett & Gonzalez-Lima, 2013), memory, stroke, and developmental disorders (Hamblin, 2016), and depression (Cassano et al., 2015). A meta-analysis of articles examining the link between photobiomodulation and biological processes such as metabolism, inflammation, oxidative stress, and neurogenesis suggest these processes are potentially effective targets for photobiomodulation to treat depression and brain injury. It also suggests there is preliminary clinical evidence suggesting the efficacy of photobiomodulation in treating major depressive disorder, comorbid anxiety disorders, and suicidal ideation (Cassano et al., 2016).

Updated versions of the Vielight Neuro headset line offer more complex photobiomodulation design options, and this presentation will examine the clinical relevance of more advanced frequency-based and locational targeting. Collected data with pre and post qEEG analysis will be presented, and the practical significance of including photobiomodulation as an element of feedback within the neurofeedback paradigm itself will be discussed.

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Integrating Neurofeedback into Trauma Therapy: Insights from a Qualitative Study

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Trauma has been found to have a significant impact on the brain. This is particularly true when trauma occurs during developmental years (Thomason & Marusak, 2017). Due to the increasing body of research demonstrating these impacts, neuroscience-informed approaches have been encouraged when working with trauma survivors in a mental health context. One approach that more directly addresses the functioning of the brain is neurofeedback. Some studies have found evidence for neurofeedback as an effective treatment for symptoms related to trauma (e.g., Frick et al., 2018; van der Kolk et al., 2016). As a result, some trauma therapists have decided to integrate neurofeedback into their practices. The process of integrating neurofeedback into trauma therapy presents several challenges, including learning to use the necessary technology, gaining an understanding of brain anatomy and functions, and introducing neurofeedback into the therapeutic relationship (Weiner, 2016).

Therapists who choose to add neurofeedback to their practice typically lack a background of extensive education in brain science and technology, and therefore there can be a steep learning curve (Hamlin, 2018; Weiner, 2016). In addition to requiring additional education, integrating neurofeedback into trauma therapy creates a shift in the therapeutic relationship. Fisher (2014), a psychotherapist specializing in trauma who integrated neurofeedback into her therapy practice, wrote about the process of introducing this modality into her work with clients. Other than Fisher's (2014) guidance on how to introduce clients to neurofeedback, there is minimal literature on the process of integrating neurofeedback into trauma therapy. Some other neurofeedback providers have written about the integration of neurofeedback into clinical practice (e.g., Hamlin, 2018; Weiner, 2016), but these do not address the specific challenges that come with treating trauma survivors.

This 60-min standing presentation focuses on results from a qualitative phenomenological study on trauma therapists' experiences with integrating neurofeedback into therapy for complex or developmental trauma. The study focused on practical and relational aspects of integration. This presentation aims to provide participants with background information on the use of neurofeedback in the treatment of trauma and provide insights into the process of integrating with a focus on relational aspects. At the time of this proposal the analysis process of the study is still in progress, but it will be completed by the end of May 2021. In order to gain a deeper understanding of participants' experiences, the proposed research design used interpretative phenomenological analysis (IPA; Smith, 1996). Data were collected using a demographic survey and semi-structured interviews, and analysis was conducted using IPA.

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Demystifying Independent Component Analysis (ICA)

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In an easy-to-digest manner for those who are less mathematically inclined, independent component analysis (ICA) is increasingly gaining popularity in the EEG-processing community, yet not many industry professionals truly understand what the analysis is doing "under the hood." This has led to a multitude of debates on whether or not ICA should be utilized for the EEG at all (Friston, 1998). This talk aims to provide concrete information about the theory and usage of ICA with respect to the EEG. To begin, this talk will go over the basic matrix equation that ICA algorithms attempt to solve: S = WX (where S is the matrix of independent components, W is the "Mixing matrix," and X is the raw EEG; Langlois et al, 2010). Then the talk will discuss the five key assumptions that provide the foundation of ICA and discuss whether the EEG is a suitable subject for independent component analysis under these assumptions (Debener et al., 2010). The five assumptions are as follows: (1) statistical independence between each source, (2) the mixing matrix must be square and full rank, (3) no external noise, (4) data must be centered, and (5) source signals must not be gaussian. The gaussian assumption is difficult to truly prove when it comes to an EEG, so we will discuss why that is and how ICA can still be implemented (Onton & Makeig, 2006). After understanding the general ICA assumptions, we will compare the unique underlying procedures and assumptions of the three most widely used ICA algorithms in the field: Infomax, fast-ICA, and AMICA (Palmer et al., 2011). These comparisons will be accompanied by ICA examples created in EEGLAB, ISync, and WinEEG. To conclude, the presentation will go over some important clinical considerations for those who want to implement ICA, such as the amount of data required for a good recording, how to maximize the accuracy of your results, and when ICA may fail.

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Normal EEG

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In neurotherapy we often look for abnormalities in brain function that are related to our clients' struggles. Concurrently, there has been a trend in our field for a long time to rely on maps to make assessments; however, it is imperative as practitioners that we learn to look at the EEG to verify the features we see in the maps. It is common to refer to features like excess frontal theta, alpha asymmetry, or spindling beta at the vertex as features in clinical populations, but what defines normal EEG? Niedermeyer himself said "a chapter on normal EEG is more difficult to organize than it might seem." This talk will provide a synthesis from relevant sections from Niedermeyer's chapter on normal EEG in Adults and Elderly and connect the dots to other key texts in our field. This "back to basics" overview will help solidify the neurotherapist's foundation in assessing 19-channel EEG. A solid understanding of normal EEG is a crucial skill for a neurotherapist to develop their treatment plans, develop their protocols, and to make better decisions on when an EEG needs to be reviewed by a neurologist or referred out entirely. The presentation will start by discussing the common brainwaves and explore topics such as amplitude, functions, reactivity, morphology, generators, coherence, and Brodmann Areas, as they all relate to normal EEG. It will also provide examples of each in 19-channel EEG recordings. We will then discuss and identify normal variants within an EEG such as Mu, the sensorimotor rhythm (SMR), Lambda, K-complexes, positive occipital sharp transients (POSTS), vertex sharp waves, and sleep spindles. After an overview of the various frequencies that one might find in a normal EEG, the presentation will introduce vigilance modeling and briefly touch on its implications for neurotherapy. This final section will cover sleep architecture, with specific 19-channel EEG examples to represent each of the various stages of sleep.

This overview of commonly accepted facts and concepts is intended for anyone who needs to be able to identify key features in normal EEG: whether they are a new neurotherapist, someone preparing for their qEEG exam, or a more experienced professional in the field.

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Nurturing Awareness: Neurofeedback and Psychedelic Therapies

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Neurophenomenological studies are increasingly exploring the brain mechanisms through which psychedelic substances exert their mind-altering effects. A provocative question is whether such knowledge might be harnessed as a means of self-inducing altered states of consciousness by nonpharmacological means; for example, through the combination of meditation practices and EEG neurofeedback. Ros et al., (2013) demonstrated that down-regulation of the amplitude of EEG alpha oscillations recorded from midline posterior cortex (Pz electrode) is possible in healthy volunteers via neurofeeedback, with correlated effects observed for fMRI in the precuneus as well as with the experience of mind-wandering. Recently, DMT literature related to cortical travelling waves further highlights the importance of the alpha decreases and increased signal diversity, also known as entropy as indicative of the psychedelic state (Alamia et al., 2020).

Emphasis will be placed on how neuro and biofeedback technologies can help highlight, assess and support the various states of awareness that underlie the positive outcomes associated with meditative practices and psychedelic therapies. By reframing neurofeedback modalities as tools to encourage "state awareness," there is great potential to combine neurofeedback with the emerging psychedelic renaissance. Psychedelics are "state" shifting medicines; therefore, the use of neurofeedback inspired therapies within the psychedelic framework can help both therapist and client better acquaint themselves with the human capacity to state shift. Meditation and psychedelic inspired neurofeedback modalities offer a direct experience of how attention alters states, which can offer support toward preparing individuals for the psychedelic experiences, by helping to reduce the preoccupation often associated with challenging psychedelic experiences, while simultaneously increasing a state experience of embodied allowing, associated with an increase in long-term therapeutic change. We will discuss how neurofeedback therapies are well poised to offer a method to support the integration of psychedelic sessions, as the afterglow state can sometimes become dimmed and lost if not rehearsed and therefore maintained via state therapy support.

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Treating COVID-19 with Photobiomodulation – Short-term Recovery and Long-Haul NeuroRegulation

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Considerable global effort has been directed towards vaccination to control the spread of COVID-19. While there is significant success in these preventative efforts, there is still a need to consider options to improve the outcomes of those who have been infected. This presentation discusses photobiomodulation (PBM) as such an option.

PBM is increasingly used by neurofeedback practitioners as an adjunct to the established brain training practices. Hence it is worth examining its prospect for treating the largest health crisis in a century.

PBM is a modality involving the delivery of certain light to modulate the body and brain. Its mechanisms and related evidence are credible bases for this modality to help treat patients with COVID-19 and other viral infections.

Literature have shown that PBM is antiviral (Liu et al., 2003), anti-inflammatory (Hamblin, 2017), and accelerates the healing of lesions and sepsis (Costa et al., 2017), all are important factors in COVID-19 morbidity. These properties are supported by reports of rapid recovery in several severe hospitalization cases (Sohailifar et al., 2020). These are just a few cases, but the positive outcomes warrant randomized controlled trials (RCTs) for widely acceptable validation.

In this respect, we have been conducting a pivotal RCT involving 280 subjects to determine whether PBM can shorten the time to recovery in confirmed severe COVID-19. The device used allows the subjects treat themselves at home. At the time of writing, the RCT is yet to be completed but successful results upon completion will propose PBM as a viable treatment for COVID-19. Of further significance, it is an alternative for the population that seek a nonpharmaceutical treatment.

An interim analysis of the RCT at the 73 (out of 280) subject mark has concluded that the study is not futile with the recommendation that it should continue until completion.

Furthermore, at this time, the attention on the pandemic is shifting towards the long-term debilitating sequelae of chronic fatigue, depression, posttraumatic stress disorder (PTSD) on the survivors, who are commonly known as “long haulers.” Literature suggests that PBM has the underlying bases for neuroregulation to potentially address these.

This presentation will present the underlying mechanisms of PBM that can lead to an effective treatment for COVID-19 and other coronavirus infections, and how the thoughtful selection of parameters can enhance the efficacy. It will also present an analysis of available clinical evidence, if available at the time of the presentation. The potential of PBM to treat long haulers will also be discussed; particularly chronic fatigue syndrome, which is common in this cohort.

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The State of NeuroMeditation: Historical Perspectives, Current Research, and Future Directions

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From the earliest days of neurofeedback, clinicians have been using this technology to enhance states of meditation and improve mental health. In general, these early approaches focused on increasing the amplitude of alpha/theta. These strategies were used to guide the meditator into deeper states of consciousness, enhance creativity, and reduce anxiety. Eventually, these protocols were advanced and expanded into alpha/theta protocols, which have been used successfully to treat addictions and PTSD.

In the past 20 years, researchers have dramatically increased our understanding of brainwave states in relation to both meditation and mental health concerns. This knowledge has been used to create new, more complex neuromeditation approaches for specific meditation styles including focus, mindfulness, and open heart practices. In addition, there is increasing evidence that each of these approaches has a different impact on specific mental health concerns which has led to a comprehensive approach to neuromeditation for mental health.

In this program, we will explore the history of combining neurofeedback with meditation, following this work to the most current applications. We will examine current research in the field, including recent studies demonstrating the feasibility of neurofeedback for meditation training. The first such study used real-time fMRI data to examine the subjective experience of meditators when a specific brain region was active versus quiet. Follow up studies have demonstrated that EEG neurofeedback can also be used to effectively indicate internal states related to meditation and that these signals can be controlled by both novice and experienced meditators to direct the meditation experience. More recent studies have demonstrated that even a brief training in neuromeditation can lead to improved cognitive functioning.

Beyond the most recent research in this area, this talk will provide a glimpse into the ways that neuromeditation is being used as a treatment intervention for ADHD, anxiety, depression, and PTSD.

We will conclude with an exploration of the future of neuromeditation, including applications for elevated states of consciousness, advances in software and hardware, and the combination of EEG NeuroMeditation with other technologies, such as AVE and vibroacoustics.

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QEEG and LORETA Monitoring of Repetitive Transcranial Magnetic Stimulation for Medication Resistant Depression

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Repetitive transcranial magnetic stimulation (rTMS) is an effective treatment for medication resistant depression (Boes et al., 2018; Trapp et al., 2020). Numerous studies have investigated the neurophysiological, neuroanatomical, and functional connectivity effects relative to rTMS (Bailey et al., 2019; Ge et al., 2020; Keuper et al., 2018; Noda et al., 2017; Song et al., 2019; Wu et al., 2020). The typical target for rTMS is the left dorsolateral prefrontal cortex (DLPFC) with effects seen in cortical thickness in rostral anterior cingulate cortex (rACC) (Boes et al., 2018; Trapp et al., 2020). Data evaluating EEG sources with low-resolution electromagnetic tomography (LORETA) are scarce. Thus, the current study aims to evaluate changes in functional connectivity of EEG frequency bands, with special emphasis on theta power in the prefrontal cortices as a result of rTMS (Esposito et al., 2020). This explorative study consists of four males between the age of 21 and 76, mean 52, *SD* = 23.84. All had diagnosis of major depressive disorder (MDD) and met requirements for rTMS program using Neurostar (Malvern, PA). TMS sessions were carried out daily for 30 consecutive weekdays. All clients completed 20 or more sessions of LORETA neurofeedback concurrently with rTMS or immediately following rTMS sessions. In three of the clients, qEEG mapping was performed daily during the TMS sessions. Clients completed several assessments or screening instruments over the course of sessions of and the personality assessment inventory (PAI). Significant changes were seen in theta and alpha power between areas 24, 6, 10, and 33 in both theta and alpha current source density. Interestingly, one of the more significant differences across rTMS was a reduction in theta power shown both in topographical EEG measures and current source distributions. These theta excesses can in theory be thought of power distribution and energy consumption errors related to dysfunctional integrative loops that do not permit novel learning concerning the self and its positive and rewarding characteristics. Theoretical considerations will be discussed with emphasis on comorbid anxiety disorders and additive programmatic mechanisms to sustain rTMS/neurofeedback effects over time.

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Infraslow Neurofeedback Update

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At the beginning of its development, infraslow bipolar neurofeedback (ISF) was implemented as a one-channel intervention that required three electrodes. Over the last 15 years ISF has blossomed to include a 19-channel sLORETA version and garnered several publications including a recent randomized, double blind, placebo-controlled study published in the Journal Nature. This study, produced by Dr. Dirk De Ridder's neuromodulation lab at the University of Otago, has led to the study of ISF neurofeedack's application in chronic pain and affective disorders. Both studies have published preliminary articles related to their forthcoming results in our Journal, NeuroRegulation, in the last year. Palva and Palva (2012), referred to the infraslow frequencies as the "superstructure" of the brain interacting with and regulating both the integration within and decoupling between concurrently active neuronal networks. The burgeoning research combined with clinical outcomes has challenged our traditional understanding of the mechanisms of psychopathology. We have begun to recognize the large contribution of the autonomic nervous system (ANS) generally to psychopathology and the efficacy of directing infraslow neurofeedback at the cortical hubs of sympathetic and parasympathetic response. In a recent publication ISF bipolar training impacted measurements of autonomic response while SMR training did not (Balt et al., 2020). Balt's results are a confirmation of the association of infraslow frequencies with parasympathetic response first demonstrated by Aladjalova (1957). The application of infraslow sLORETA training to autonomic targets has proved clinically useful with addictions, pain, affective disorders, and tinnitus. In all of the preceding disorders, ISF sLORETA protocols target the dorsal anterior cingulate gyrus (dACC) or the posterior cingulate gyrus (PCC) singularly or within a behavioral network. The goal is to reduce sympathoexcitatory drive or increase parasympathetic response or vice versa, restoring autonomic regulation. Within this ANS centric rubric, the triple network theory plays a leading role. Effective self-regulation occurs through the identification of salient stimuli and the smooth recruitment of the appropriate behavioral network to process it. If the shift from one large behavioral network to another is not achieved within a well-regulated ANS and behavior is chronically driven by mismatched autonomic response, then psychopathology is the likely result.

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COVID-19: Effects on Brain, Behavior, and QEEG Correlates

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As of December 2020, 69.1 million have been reported infected and 1.57 million deaths have resulted from COVID-19. Without question, the primary focus of the resulting pandemic has been to reduce the risk or death and the rapid contagion of the disease. Given that it has been recognized that this and other viruses do indeed enter the brain (Desfordes et al., 2020; Zubair et al., 2020), studies are now being turned to understand possible residual effects on behavior and brain function. There are several routes in which the virus can influence brain function resulting in delayed demyelinating processes (Zanin et al., 2020) and general neuroinflammatory processes effecting frontal lobes and brainstem structures (De Santis, 2020; Dubé et al., 2018; Gandhi et al., 2020). Initial structural neuroimaging studies have evidenced generalized encephalopathies and damage particularly to medial temporal regions (Kramer et al., 2020; Paterson et al., 2020). As might be expected, patients requiring more intensive care have more diverse anomalous findings in MRI studies (Kandemirli et al., 2020). Six months following discharge from hospitalization, studies are reporting that as many as over 30% of patients are experiencing decline in cognitive functioning and that over 20% of patients experience significant mood regulation problems (Huang et al., 2021). Functional neuroimaging studies have corroborated structural findings in noting dysfunction in the frontal regions (Cani et al., 2020). EEG studies have also noted frontal regions increased delta corresponding to these findings (Pasini et al., 2020). COVID-19 patients with resultant seizures, focal areas have been identified in the temporal, frontotemporal, and central-parietal regions (Narula et al., 2020). In an effort to develop a database of qEEG correlates resulting from COVID infection, the authors are contributing EEG data with qEEG and sLORETA analyses that can potentially provide a method differentiating residual effects that can be attributable to COVID-19. Preliminary cases studies comparing pre to post COVID-19 exposure evidence increased delta and theta absolute power in bilateral frontal poles, fronto-temporal regions and central-parietal regions and increased volumetric deviations in the frontal and temporal regions by sLORETA analyses with concomitant changes in aspects of cognition and mood regulation. Current vaccines being used to prevent more serious effects of the COVID-19 and potential variants can stimulate the immune system to trigger cytokine storms in some individuals and can trigger neuroinflammatory effects on the brain. Pre- and postvaccination non-COVID-positive subjects will be discussed. These early findings speak to the importance of using qEEG to provide biomarkers for individuals who may have cytokine storms by any of number of challenges to the immune system.

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Integrating Neurofeedback and Mindfulness Techniques in Sports Psychology for Enhancement of Athletic Performance

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For athletes competing in all levels of sport, focus and the ability to regulate emotions, cognitions, and physical responses are important skills to achieving personal goals, enhancing performance and overall success. Athletes and their coaches are incorporating the use of sports psychologists and counselors on a regular basis as a means of reducing mental barriers to performance as well as learning skills to intensify sports performance during competition. The development of a strong mindset and resilient attitude will give an athlete the edge during the moments of competition where they are physically pushed to their limit. The use of neurofeedback in training and in the therapeutic process is being researched as an effective means increasing efficiency in sports performance (Mirifar et al., 2017). The ability to incorporate new thinking patterns, in addition to increasing awareness of the mind–body connection, can help an athlete advance their training level at record paces. There is increasing awareness of the benefits and effectiveness of neurofeedback as a treatment option for athletes, however its use has not reached the full potential within the field (Strack et al., 2011). Combining neurofeedback with other techniques such as mindfulness can greatly increase performance of individual athletes by increasing neurocognitive processing and efficiency (Crivelli et al., 2019). The development of specific protocols which can strengthen mindset, assist in the reduction of ineffective cognitive patterns, and increase an athlete's composure during challenging training weeks as well as competition is part of a current opportunity in this area of study and practice. This workshop provides an overview of the current literature and discusses implications for additional research into the integration of the fields of neuroregulation and sports sciences. This workshop will also include discussion of how the research of neurofeedback and mindfulness can be evaluated and incorporated into active treatment plans for practical application for individuals as well as teams.

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Impact of Neurofeedback on Executive Functions of Children and Adults with Developmental Trauma: Results of Two Randomized Control Studies

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This presentation focuses on results from two pioneers' random control studies that showed that 24 sessions of neurofeedback training (NFT) sessions improved executive functioning in adults and children with developmental trauma.

Developmental trauma (DT) is arguably one of the costliest public health challenges in the USA. DT is a chronic early childhood exposure to neglect and abuse by a caregiver. It has been shown to have a long-lasting, pervasive impact on mental, physical, and neural development, including problems with executive functioning, attention, impulse control, and self-regulation. These deficits not only interfere with adequate daily functioning but also interfere with the ability to benefit from treatments.

These two randomized control studies consisted of 49 adults and 37 children ages 6–13, with developmental trauma. The participants were randomly divided into two groups, active NFT (adults n = 26; children: n = 20) and waiting list (WL), adults n = 23; children n = 17). The NFT group received 24 NFT sessions twice a week (T4-P4). Executive functioning was assessed by BRIEF (Behavior Rating Inventory of Executive Function), a commonly used assessment of executive functions and self-regulation. It was conducted at four time points over the course of training: (1) baseline; (2) midpoint, after 12 NFT sessions for the NFT group or after 6 weeks for the WL group; (3) post-NFT for the NFT group or after 12 weeks for the WL group; (4) follow-up, 1 month post-NFT for the active NFT group or after 16 weeks for the WL group.

For the adults, NFT training showed significant improvement in all the subscales of BRIEF with the exception of emotional control (baseline to 1-month follow-up). Similarly, for the children, NFT training showed significant improvement in all the subscales of BRIEF with the exception of metacognition subscale on (baseline to post-NFT). However, for the children, there was a regression between post-NFT and 1-month follow-up assessments. These results indicate that NFT is a promising technique to improve executive functioning of individuals with developmental trauma who are struggling in their daily functioning and benefit from treatment.

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Correlations Between Quantitative EEG Volumetric Analysis and Computerized Cognitive Testing Shortly After Sport Concussion Injury in High School Athletes, Part 2

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We previously reported statistically significant correlations between performance on a computerized neurocognitive test battery and whole brain deregulation seen on sLORETA quantitative EEG analysis. With advances in software analysis capability, we are now able to report significant region-specific and task-specific correlations between the cognitive test performance and lateralized hemispheric regions of interest. We previously reported two correlational relationships: (1) negative correlations in which increasing deregulation on the EEG was associated with poorer performance on the cognitive tasks, and (2) positive correlations in which increasing deregulation on the EEG was associated with better performance on the cognitive tasks. The latter is interpreted as compensatory changes in brain physiology and was entirely confined to the alpha frequency band.

***Methods*.** Standard electroencephalograms (EEGs) were recorded in 70 high school athletes (20 males) shortly after concussion injury using sLORETA imaging compared to a normative database (NYU/BrainDx). Peak *Z*-score variation (PZV), and % volume of grey matter activity that fell outside $Z = -2.5$ to 2.5 (PIGMV for increased activity, PRGMV for reduced) were calculated for each of five EEG frequency bands. The data for hemispheric and midline regions of interest were compared for correlations to computerized neurocognitive and symptom assessment (XLNTbrain) also performed shortly after concussion injury.

***Results*.** (1) Task-specific or region-specific correlations were present with the more refined hemispheric regions of interest demonstrating lateralized functional activation depending on task. (2) Even when the stimuli of the cognitive test were controlled, there were different hemispheric regions of interest correlations based on changes of task demands. (3) Compensatory relationships were seen primarily in the alpha band, with a small proportion occurring in the neighboring bands of low beta and theta.

***Conclusions*.** This study demonstrates more refined correlations between performance on computerized neurocognitive tasks and hemispheric regions of interest changes in quantitative sLORETA EEG analysis shortly after concussion injury in high school athletes. This new data analysis confirms the previously reported compensatory relationships between deregulated alpha activity and cognitive performance. These findings may have potential impact on protocol design for neurofeedback after concussion injury.

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Clinical Applications of 10-Channel qEEG Analysis: The Goldilocks Array

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Clinicians who specialize in EEG feedback services can sometimes feel as if they have to choose between economy, efficacy, and convenience when it comes to selecting equipment and deciding on analytical software. QEEG analysis programs often require 19-channel EEG recordings, which can mean more expensive amplifiers to collect the necessary data and more expensive software to generate the quantitative analyses. Simpler EEG analysis procedures based on only one or two channels of EEG are often more economical, but some practitioners worry they may be missing important information that could make their neuromodulation program planning more effective (Collura, 2008).

In the last 15 years, advances in both EEG software and EEG hardware have offered the opportunity to compare and contrast the clinical efficacy of simpler analysis and feedback approaches with the more complex EEG feedback designs based on denser electrode arrays. The emergence of sLORETA-based feedback brought with it a new interest in amplifiers with a minimum of 19 active EEG channels, the number of surface sites required to reliably execute sLORETA source localization (Pascual-Marqui, 2002). These new possibilities generated discussion among clinicians attempting to determine whether more electrodes on the head meant more effective feedback, or if including too many data elements in a feedback paradigm resulted in training tasks which were too complex and tiring for the typical client.

This presentation will discuss the clinical utility of both the quantitative analytics derived from a static 10-channel electrode configuration and the implications for neuromodulation designs based on the intentionally selected 10–20 locations (Delorme & Makeig, 2004). The purpose of exploring the clinical relevance of a 10-channel array is to provide an option for practitioners which is more economical and convenient, while still capable of executing robust neurofeedback training. Not too big, not too small, but "just right": a Goldilocks solution.

During this session, qEEG reports based on 10-channel EEG collections will be presented, and protocol designs which capitalize on the neuroanatomy reflected in frontal, sensory motor and parietal regions will be introduced and discussed (Wolbers et al., 2007). The electrode configuration of F3, F3, C3, Cz, C4, T3, T4, P3, Pz, and P4 presents specific opportunities for executive function network support, sensorimotor integration, and increasing state flexibility in ways which improve complex attention and help regulate disorders of arousal and hypervigilance (Papousek & Schulter, 2002).

One of the strengths of multivariate percentage-based *z*-score feedback is the ability to build protocols based on explicit connectivity metrics and to select targeted frequency bands and locations to further customize the training program (Gracefire, 2016). In this presentation, we will examine how the Goldilocks configuration taps into the cortical circuits on which the brain relies to prioritize effective resource recruitment and allocation, and review case presentations with pre and post data from individuals who were trained with the Goldilocks array.

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A Possibility of qEEG-Centered Mental Healthcare Platform as a Mainstream Practice in Mental Health

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Despite the fact that EEG is a clinically valuable signal for various brain-related disorders, EEG has been underutilized in mental health practices due to labor-intensive denoising process and the required expertise for the denoising, complex signal processing to get sensor or source level features, and lack of biomarker relevant for various clinical process. But, the recently developed iSyncBrain platform provides an efficient automated process targeted to various clinical circumstances, even for telemedicine. The platform on the cloud comprised of AI-guided EEG denoising process (Kang et al., 2018) trained through 1800 normative EEG data collected during last 7 years, sex classified healthy normative qEEG database, standardized qEEG feature extraction process from adaptive mixture ICA (AMICA) dipole source information to sLORETA-based ROI connectivity, normative library and group statistics for researchers (Kim et al., 2018; D. Lee et al., 2018; Min et al., 2020), and a series of qEEG discriminant biomarker has been implemented, such as early screening of Alzheimer dementia, prognosis of coma patients, and brain age for development disorder (Han et al., 2021; Shim & Shin, 2020; Thapa et al., 2020). Biomarkers for stroke rehabilitation, Parkinson's disease, and early screening and intervention prediction for depression are under development (Baik et al., 2021; Lee et al., 2018, 2020; Min et al., 2020). In this lecture, a typical development process of machine learning model will be introduced using aMCI biomarker, a cloud-based AI algorithm using 19-channel resting-state EEG for early detection of prodromal stage of Alzheimer's dementia. As an example, in the aMCI biomarker, the first qEEG discriminant functions on iSyncBrain platform, iSyncBrain iSB-M1 engine removes the noise signals and extracts various EEG features, which would be put into trained machine learning (ML) algorithms, then the probability score is calculated from 0 to 100. The scoring system consists of sequentially combined different ML algorithms, Alzheimer model, MCI model, and amyloidopathy model. The clinical test with 429 participants, which is divided to two groups, aMCI and normal, finally shows 93.2% of sensitivity and 90.2 specificity. Furthermore, possibilities of the methodology of the biomarker development could be a catalyst for utilizing qEEG in various clinical circumstances in the mental health area including neurology, psychiatry, and psychology will be announced (Maestú et al., 2019). QEEG experts in ISNR community can collaborate together to disseminate qEEG-guided mental health methodology from a modeling of various mental diseases to an educational support to new comer in this field.

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Good Vibrations

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This presentation is an EEG Spectral analysis of passive listening to Native American Flute pentatonic scales, plus a review of audioanalgesia healing literature. In the last 20 years, this area of science has exploded with research related to the effect of sound and music on brain functions (Trimble & Hesdorffer , 2017; Pantev et al., 1998; Peretz & Zatorre, 2005; Zatorre et al., 2007). Noninvasive procedures have allowed science to observe the areas of the brain which are activated by music and has shown that music activates more areas of the brain than nearly any other stimuli. At the same time, quantum physics has explored the theory that everything is made of vibrations. The theory suggests that solid matter is really an illusion and that everything vibrates or "resonates" at a particular frequency, including human cells (McTaggart, 2001).

Some consider music a gateway to the awakening of the spiritual because, again, frequency is an activator of the brain (Kunkkullaya, 2020). This is one of the reasons chanting and toning have traditionally been used in every major religion of the world to enhance prayerful, meditative, super-aware states of mind. When a person is in a relaxed state, beta-endorphins are produced, which promote healing. When this state is brought on by exposure to music, the result is called *audioanalgesia*. Music's healing effects are described as three-fold: emotional, spiritual, and physical (Cvetkovic & Cosic, 2011).

Music comprises pitch, timbre, vibrato, intensity, beat tracking, tempo or velocity, contour or intonation, rhythm variation or timing, and melody and harmonic features—all of which can drive and entrain neural, respiratory, and cardiac activity (Goss & Miller, 2014; Miller & Goss, 2014, 2015).

This presentation explores the interface of captured brain activity and the implied emotional/spiritual realm of "healing" as defined by the metaphysical literature. Metaphysical healing is not necessarily curing; it is an aspect of the spirit, while curing is an alteration of the body. One can experience healing without curing, but some research suggests that curing rarely occurs without prior healing. This presentation examines the results of participants passive listening to different octaves of solo Native American pentatonic flute music, including (a) a comparison between a "baseline" period of silent relaxation and brain response to flute music, (b) a comparison between the first half and the second half of the five-minute period of flute listening, and (c) a comparison between the periods of listening to lower-pitched flute compared to higher-pitched flute. The presentation will also provide live examples of shifts in brain wave patterns suggested for (a) preoperation calming protocols, (b) postoperation protocols to promote alertness, (c) pain relief relaxation progression, and (d) near death music recommendations.

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Pilot Data Examining Induction of Suboxone and Monitoring with Quantitative EEG and LORETA methods

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***Introduction*.** Quantitative electroencephalograph (qEEG) and low-resolution electromagnetic brain tomography (LORETA) methods are undervalued and underused for determining the effects of medications on the brain, especially concerning substance use disorders (Cannon et al., 2008; Sokhadze et al., 2008) and medication-assisted therapies (MAT). Debate continues about MAT with drugs such as suboxone despite positive reports of outcomes and overdose reductions (Chang & Raynor, 2021; Demetrovics et al., 2009; Elarabi et al., 2019; Finch et al., 2007; Furst, 2013; Towns et al., 2020; Velander, 2018). This study examines the electrocortical effects of suboxone during induction and 7 days of monitoring daily use.

***Methods*.** The current data from a larger study consists of three females with SUD with mean age 32.33, *SD* = 13.31 (range 21 – 47). Five-minute eyes-opened baseline EEG were collected prior to induction of suboxone using sublingual administration. The EEG was collected using the Truscan Acquisition System (Deymed Diagnostics) with 19 channels and linked ear reference. EEG were sampled at 256 cps. Data were recorded for 15 min during induction procedures and contrasted to the Lifespan normative database (Applied Neuroscience) and pre baseline. Daily EEG baselines were collected for 1 week and monitored for change.

***Results*.** Induction itself did not produce significant changes in the topographical EEG or LORETA current source distributions. In two of the clients, dose dependent elevations were seen in both measures. As the dose was adjusted so did the decrease in amplitude in EEG and CSD levels. Symptoms for these amplitude excesses include lethargy, somnolence, giddy and odd behaviors that resolved upon dose adjustment. The greatest increases occurred in theta and beta frequency domains with one individual showing increases in all frequency domains. Coherence and asymmetry measures were reduced in two of the three individuals. LORETA increases occurred in theta and beta involving Brodmann areas 13, 38, 42, 21, and 20.

***Discussion*.** The methods of qEEG and LORETA electrical neuroimaging may provide an important tool to aid in monitoring MAT for individuals with SUD. The opiate crisis has increased the need for holistic approaches with measurable outcomes to aid in the recovery for SUD, as well as decrease the likelihood of death. The data suggest that changes in the EEG and cortical volume related to suboxone use can be determined and monitored to aid in administering dose specificity. Further research and data are ongoing and with larger sample sizes generalizable EEG and LORETA CSD patterns may become more evident. EEG and LORETA have been shown as reliable across time (Cannon et al., 2012) and therefore can provide an important tool to further evaluate MAT changes and characteristic amplitude, connectivity and current source density patterns associated with substances of abuse.

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The Use of ERP/EEG Guided tACS/tRNS Neurostimulation Methods in Clinical Practice

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Over the past 20 years the use of qEEG brain mapping has been used to develop neurofeedback treatment strategies. The typical acquisition of the EEG involves eyes open and closed recordings where the subject is not engaged in any activity. Sixty seconds of artifact free data is selected and quantified into specific frequency bands and displayed on surface head maps. The data is also analyzed in 3D LORETA solutions so as to determine the spatial location of the EEG source. The combination of these methods is typically used to generate neurofeedback protocols and has been shown to be effective in regulating the brain to a limited degree.

The evolution of computational neuroscience methods has added the use of machine learning methods that can generate independent components that have very high temporal resolution and source location capabilities that better identify actual neural activity. These methods have been applied to event related potential go/no-go paradigms that record EEG when the subject is engaged in an active task versus the standard idling tasks typically recorded. The data obtained in ERP testing can show reaction time, neurological latency and desynchronization or absence of cross frequency coupling across electrode sites. This data, combined with the typical eyes open and closed EEG is sensitive enough to reveal specific deregulations that are highly correlated to behavioral and neurological conditions. This advanced form of analysis can better guide the clinician in developing treatment plans for the use of neurotherapy techniques.

In this presentation Dr. Dogris will show how advanced computational neuroscience methods involving ERP and qEEG data was utilized to develop specific treatment plans. Dr. Dogris will also discuss his evolving hypothesis regarding the combined use of random noise and tACS neurostimulation methods. Dr. Dogris will show ERP and qEEG data that demonstrates the impact of random noise (pink and brown), tACS and pEMF neurostimulation techniques.

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NeuroRegulation

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Using Standardized Weighted Low-Resolution Electromagnetic Tomography (swLORETA) to Analyze the Deep Brain Activity for Healthy Adults and Patients with Major Depressive Disorder

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Background. The differences in brain activity between patients with major depressive disorder (MDD) and healthy adults have been confirmed by functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and electroencephalography (EEG), especially at the prefrontal lobe, posterior cingulate cortex (PCC). However, the high cost of fMRI and PET and poor time resolution limited the clinical application. Recently, researchers used high time resolution of standardized weighted low-resolution electromagnetic tomography (swLORETA) to refer to deep brain activity. This study aimed to convert EEG raw signals into swLORETA and explore the differences in deep brain activity between patients with MDD and healthy adults.

Method. BrainMaster equipment with a 19-channel EEG cap was used to collect resting EEG data with eyes closed for 5 min. NeuroGuide software was used to remove the EEG artifacts, and swLORETA software was used to analyze the 12700 voxels of current source density (CSD) for 114 patients with MDD comorbid with anxiety symptoms and 134 healthy adults. The deep brain activity at the frontal lobe and PCC in different frequency bands were analyzed for delta, theta, alpha, and beta.

Results. There were higher activities at prefrontal lobe (dorsal medial prefrontal cortex [dmPFC], ventral medial prefrontal cortex [vmPFC], dorsal lateral prefrontal cortex [dlPFC], ventral lateral prefrontal cortex [vlPFC], orbital frontal cortex [OFC]) and PCC were found in MDD patients compared with healthy adults, especially for lower delta and theta, and higher beta, beta3, and high-beta.

Conclusion. This study indicated that brain hyperactivity at the right prefrontal lobe (dlPFC and vmPFC) and PCC in patients with MDD comorbid with anxiety symptoms, and the dlPFC and PCC were also related to emotion-regulation in MDD. Inhibited high-beta activity or rewarded delta and theta activities at the right frontal lobe and PCC may be a possible neurofeedback protocol for patients with MDD in the future study.

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Frontal EEG Indices of Attentional Bias and Involuntary Orienting to Pictorial Drug-related Cues in Cocaine Addiction

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***Background*.** Preoccupation with drug and drug-related items is a typical characteristic of addicted individuals. Several research studies provided support for the hypothesis about the alteration of attention processes in chronic addicts (Hester et al., 2006; Robinson & Berridge, 2001), so-called attentional bias (Franken, 2003), when drug-related cues attain greater salience and motivational significance (Cox et al., 2006). Cue reactivity refers to a phenomenon in which individuals with a history of drug dependence exhibit verbal, physiological, and behavioral responses to cues associated with their preferred substance of abuse (Carter & Tiffany, 1999). One of the cognitive components of cue reactivity in substance abusers is the preferential allocation of attentional resources for items related to drug use (Lubman et al., 2000).

***Methods*.** This study explored frontal event-related potentials (ERP) and induced 40 Hz-centered gamma oscillation power to investigate differences associated with responses to attended and unattended drug-related cues in a three-category oddball task using neutral, drug-, and stress-related pictorial stimuli (from the IAPS and matched cocaine images). The study was conducted on 14 individuals with cocaine use disorder (CUD, mean age 44.2 years, 6 females) and 9 age- and gender-matched control (CNT, 36.7 years, 4 females) subjects. A 128-channel EGI-Phillips EEG system was used to record ERP and single trial induced gamma oscillations (30–40 Hz) during the visual three-category oddball task with three categories (neutral, drug, stress) of affective pictures, when one of the categories was used as a target (attended stimuli, 25%) requiring motor response, while images of other categories including drug images served as unattended nontarget rare (25%) distracters.

***Results and Discussion*.** Most profound group differences in reactivity to attended and unattended drug-related stimuli were found in the amplitude and latency of frontal P3a and in the relative power of induced (280–380 ms poststimulus) 40 Hz-centered gamma oscillations. At the frontal regions-of-interests (ROI, left, midline, right; three EEG sites per ROI) amplitude of P3a ERP component was higher to unattended drug cues in the cocaine use disorder group as compared to controls (e.g., mean across all ROIs 3.55 uV in CUD vs. 1.85 uV in controls, $F = 8.58$, $p < .01$) and latency was prolonged. Differences in amplitude and latency of P3a in response to attended target drug cues were not significant. Prefrontal induced gamma oscillations showed similar pattern of excessive reactivity to unattended drug cues in CUD (at FPz, $F = 55.64$, $p < .001$) but not to attended targets. Above described changes of depended variables are indicative of involuntary orienting of attention to highly salient drug-related cues even when subjects are not instructed to attend to nor to respond to them. In the prior studies we reported about usefulness of application of ERP and evoked oscillation measures as biomarkers of substance use and as neurofeedback treatment outcomes (Horrell et al., 2010; Sokhadze et al., 2008).

***Conclusions*.** We propose that the employed EEG/ERP cue reactivity variables could be used as valuable functional outcome measures in cocaine drug users undergoing behavioral treatment.

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Evaluations of Algorithmic Models for Estimations of Current Source Destiny and Electrophysiological Substrates According to LORETA and swLORETA Analyses

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This research examines the mathematical algorithms utilized for electroencephalographic source imaging (ESI) and current source localization. Electrodynamic processes that are evaluated according to source localization analyses and are derived from electroencephalographic assessments are based on the inverse problem. The inverse problem does not have a unique solution as infinite interactions between neuronal generators may yield the same derivation of scalp potentials. Source localization is subject to significant estimation errors of current source density and dipolar sources. The underdetermination of the system influences the significant estimation errors that can arise from small changes in the data related to the three-dimensional montage utilized to derive the estimations of the position and direction of potential electrophysiological generators for the lead field matrix. Common mathematical algorithms proposed to solve the inverse problem include low-resolution electromagnetic tomography (LORETA), standardized weighted low-resolution electromagnetic tomography (swLORETA), minimum norm estimate, and the weighted minimum norm estimate. Statistical evaluations of electrophysiological signals can be applied to evaluate neurocognitive behavior as linear or nonlinear functions. This research specifically evaluates the algorithmic models utilized for source localization according to LORETA and swLORETA analyses. Thus, the proposed models will be based upon linear estimations of cortical and subcortical activity that are etiologically relevant to electrodynamic processes. Because arithmetic models that incorporate priors into estimations of source distribution include the Bayesian framework and penalty function, this research examines the calculus related to estimations of source localization according to these models. The penalty function incorporates unknown source dynamics, the number of sensors utilized in the electrophysiological recording, number of samples across time, and a weighted factor. This algorithm utilizes a least squares regression model to estimate the penalty term as a quadratic function. Estimations of EEG sources according to parametric Bayesian models utilize spatial and neural constraints, evaluations of the current, and physical principles related to wave dispersion to derive estimations of localization. The parametric Bayesian model assumes Gaussian distributions and accounts for random fluctuations of sensor and source space. These mathematical models are also included due to the ability to transform one into the other while maintaining the integrity of their core structures.

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Psychophysiological Indices of Attentional Bias Towards Drug-related Pictures in Visual Cue Reactivity Test in Individuals with Opiate Use Disorder Enrolled in Buprenorphine-Maintenance Program

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***Background*.** Opioid use disorder (OUD) is a major public health problem in the United States that is expected to continue to increase (Blau, 2017; Hadland et al., 2018; O'Donnell et al., 2017). Maintenance treatment with buprenorphine in medication-assisted treatment (MAT) has been associated with reductions in opiate use in individuals with OUD. However, despite low physical symptoms of withdrawal, buprenorphine-treated opioid-dependent patients still demonstrate vulnerability to relapse (Hyman, 2005; Robinson & Berridge, 2001). Craving and attentional bias towards drug-related items may contribute to the high rates of noncompliance and relapse in OUD individuals undergoing MAT. The cue-reactivity paradigm (Carter & Tiffany, 1999) has been among the most prominent methods for investigating drug craving and psychophysiological responses to drug cues.

***Purpose*.** We propose that craving and excessive reactivity to drug-related cues could be considered the core mechanisms underlying relapse risk. Comparing central and autonomic nervous systems activity profiles and correlates of craving, drug-cue responsiveness, and more general emotional processes may provide more knowledge towards the comprehension of the interaction between craving, affect-related states, motivational processes, and clinical outcomes of OUD patients enrolled in MAT.

***Methods*.** In a pilot study were recruited 10 participants from outpatient individuals being treated with MAT for opioid addiction. Drug screens were conducted using saliva drug test and eligibility was confirmed by clinical and behavioral evaluations. Pictorial cue reactivity test was conducted using exposure to emotionally neutral pictures from the International Affective Picture System (IAPS; Lang et al., 2001) and drug-related images matching IAPS—pictures by color, size and background. The study used blocked design of presentation (16 images per block, 3 s per image) and each block was followed by subjective rating of craving. Responses were recorded with Nexus-10 psychophysiological monitor with BioTrace+ software (Mind Media, BV, The Netherlands). Photoplethysmogram (PPG), pneumogram, and electrodermal activity were acquired to measure skin conductance level (SCL), time domain heart rate variability (HRV) measures (RMSSD, SDNN), and respiration rate and amplitude. EEG was recorded from four frontal sites referenced to linked earlobes.

***Results*.** Analysis of the frontal EEG conducted to assess power of slow (theta, alpha) and fast (high beta, gamma) rhythms in neutral and drug blocks showed higher relative power of gamma (35–45 Hz), along with trends to lower power of theta activity and higher alpha-to-theta ratio in response to drug cues. Autonomic responses to drug cues were featured by increased SCL, higher frequency and lower amplitude of respiration, and increased RMSSD and SDNN measures of HRV with the tendency to phasic heart rate deceleration. This psychophysiological response profile can be considered as indicative of increased attention.

***Conclusions*.** Psychophysiological indices of heightened arousal and attention to drug cues were found to be useful objective measures to complement subjective reports of craving. Craving, cue-reactivity, attentional biases are important clinical precipitants of relapse in and their measures may serve as useful objective outcomes of behavioral therapies. Furthermore, they could be used for guiding better targeted behavioral interventions.

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Navigating Virtual Neurofeedback Treatment During COVID-19: A Retrospective Analysis

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Neurofeedback, or electroencephalography (EEG) biofeedback, is a therapeutic approach that integrates a client's brainwave activity to enhance and empower their specific, individualized growth through self-regulation (Demos, 2005). This modality continues to be applied to decreasing or alleviating symptoms associated with a variety of mental health concerns, including anxiety and posttraumatic stress disorder (PTSD; Gregory et al., 2020; Mennella et al., 2017; Romero et al., 2020). Traditionally, clinicians conduct neurofeedback services in person. Physical presence allows clinicians the ability to assist with certain tasks like correct electrode placement as well as mitigate any questions or technical issues that arise.

On January 30, 2020, the World Health Organization declared a public health emergency in response to the viral COVID-19 outbreak. Shortly after, the United States acknowledged a national emergency (9994Executive Office of the President, 2020), causing many colleges and universities to swiftly transition solely to online platforms (Murphy et al., 2020). Because of this unprecedented transition to virtual learning, collegiate programs that offer or require student internships as course credit were tasked with developing creative alternatives.

The counseling department at the University of Texas at San Antonio offers students the unique opportunity to complete an introductory-level and two advanced practicum neurofeedback courses, intentionally designed to fulfill most requirements for certification through the Biofeedback Certification International Alliance. Each course contains a hands-on component, ranging from weekly class labs to conducting no-cost neurofeedback sessions with clients from the community. With the transition to virtual learning regarding the pandemic, these specific classes were challenged with discovering avenues that continued to provide kinesthetic learning for students. Fortunately, through collaboration and donations from practitioners and organizations, the department's neurofeedback program offered virtual, distance neurofeedback services to clients that adhered to ethical guidelines postulated by the American Counseling Association (American Counseling Association, 2014). Neurofeedback equipment and laptop computers outfitted with BioExplorer software were distributed to each participant, while clinicians were able to access and operate client computers from the leisure of their homes.

If accepted, the poster presentation will illustrate a retrospective analysis of results and demographics gathered from the client's (N = 17) twice-weekly virtual sessions during the summer academic term of 2020. Those served stated having negative symptoms associated with either anxiety, PTSD, or attention-deficit/hyperactive disorder. Individualized treatment protocols were developed using preliminary theta/beta power ratio data collected before scheduled neurofeedback sessions commenced (Hernández et al., 2016; van Son et al., 2020). Presenters will also discuss the unique advantages and limitations relating to providing virtual, online neurofeedback services.

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Neurofeedback and Trauma

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Traumatic events do not discriminate and can occur to anyone. The aftermath of the trauma impacts not only the victim but family, friends, coworkers, and their community as well. The numbers are staggering with the PTSD Alliance (2018) reporting that over 13 million or 5% of Americans suffer from PTSD during any moment in time, while the yearly prevalence was reported to be 3.6%. The financial costs of anxiety disorders, including PTSD, amount to well over $42 billion with many of these dollars being spent on repetitive healthcare visits due to inaccurate diagnoses (PTSD Alliance, 2018).

This qualitative systematic literature review will focus on the current research on quantitative electroencephalography (qEEG), neurofeedback assessment and neurofeedback training with individuals who have experienced psychological trauma. The analysis of the literature surrounding neurofeedback assessment and training will also address the feasibility of identifying the area or areas of the brain impacted by psychological trauma, as well as the magnitude of the impact. Finally, it will attempt to identify areas of the brain that may benefit from training if they were altered by trauma. The overarching goal of the study is to determine if using neurofeedback assessment and training can aid in reducing the time and costs involved in establishing an accurate diagnosis, and ultimately, returning the individual to an increased level of functioning.

The statement of the problem section will identify the high cost of trauma for the individual, family, and society. The purpose of the study is to analyze the literature on neurofeedback assessment and training with individuals who have experienced psychological trauma, identify the psychological impact on the brain, and the manner in which neurofeedback assessment and training may accurately diagnose trauma, facilitate early treatment and decrease the cost of trauma to all involved. The theoretical framework of adaptive information processing theory will provide the lens through which the existing research and findings of the study will be viewed.

Finally, the significance of this qualitative systematic literature review, as well as limitations and delimitations are identified. Key words utilized include neurofeedback, EEG biofeedback, psychological trauma, posttraumatic stress disorder, PTSD, acute stress disorder, electroencephalography, EEG, quantitative EEG, QEEG, brain map, brain computer interface.

Participants were adult individuals with a history of trauma ranging from single incident trauma to chronic and developmental trauma. Findings are revealed and implications for the profession and field are noted.

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Improving Mental Health Through *Z*-score LORETA Neurofeedback During a Pandemic

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During the COVID-19 pandemic, the general population's mental health has been decreasing around the world. This creates a high need to find efficacious methods to improve mental health. Pharmacotherapy can lead to side effects and its effect subsides when the treatment is withdrawn. The field of neurofeedback, or EEG biofeedback, is over 50 years old. It has proven its efficacy in a wide range of psychological and cognitive symptoms. LORETA *Z*-score neurofeedback training (LZNFB) is a relatively new advancement in this field and, as such, there is a limited body of evidence investigating its efficacy. The aim of this study is to evaluate its effect in an uncontrolled clinical setting.

***Participants*.** Thirty-one adult clients (21 men, 10 women, mean age M = 31.63, SD = 9.5) with mental health complaints filled in the Brief Symptom Inventory (BSI-53) before and after their neurofeedback therapy. Nine clients also responded to a follow-up questionnaire 3 months later.

***Method*.** All clients started with an intake and qEEG assessment on which their LZNFB protocol was based. All qEEG analyses and protocols were executed and designed by one lead clinician. Before the first training session patients filled out the BSI-53 in order to determine symptoms related to the physiological profile. Each LZNFB session lasted between 30 and 40 minutes. A training protocol was used for at least five sessions before possibly altering it. The training protocol was designed to target a known neural network, that has a significant role in the client's symptomatology. Since this study was made in a clinical setting and received no funding, each client did a number of sessions that was estimated to be the best compromise between clinical efficacy and the possibilities of their financial situation. After their last session, they filled the BSI-53 again. A follow-up BSI-53 measurement was requested 12 weeks after the last session.

***Results*.** The participants did 16 sessions on average (M = 16.16, SD = 6.11). On average, the BSI-53 scores after neurofeedback (M = 46.16, SE = 5.77) were lower than before neurofeedback (M = 71.71, SE = 6.01). This difference, 25.55, BCa 95% CI [17.43, 33.67], was significant, $t(30) = 6.42$, $p < .001$, and represented a medium to large effect size of d = .76. Three months after the last session, the scores were still lower than before neurofeedback (M = 42.11, SE = 10.31), which was also significant $t(8) = 4.54$, $p = .002$, and represented a large effect size of d = .84. Three out of 31 (9.6%) participants were classified as nonresponders (less than 5% change in scores). The only noticeable side effect was fatigue, which subsided within a day after each session.

***Conclusion*.** LZNFB shows promise to improve pandemic-related and unrelated mental health conditions, with a high response rate, potentially long-term health outcomes and side effects limited to a short-lived fatigue. Because of the clinical, uncontrolled design of the study, mitigating factors were difficult to exclude. For example, nine participants changed their psychoactive medication habits during their neurofeedback sessions. Controlled studies are needed in order to replicate effect sizes and confirm the significance of these results.

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Comparing the EEG Patterns Between Patients with Major Depressive Disorder and Healthy Adults Through a Normalized Database in Taiwan

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Background. Brain hyperactivity has been confirmed as a trait marker in patients with major depressive disorder (MDD). Several quantitative electroencephalography (qEEG) databases are available in the United States, patients' EEG data were compared with the qEEG database and transformed into the *z*-score. However, Taiwan has not yet established a qEEG database in healthy populations. This study aimed to collect and develop the qEEG database of healthy adults and compared the qEEG patterns between patients with MDD and healthy adults.

Method. This study was based on the EEG collection and development of the qEEG database. All of participants received Beck Depression Inventory-II and Beck Anxiety Inventory. The 19-channel EEG raw signals were recorded for 5 min resting with eyes closed. NeuroGuide software was used to analyze 184 healthy adults, divided into 10-year age groups from 20 to 70, and calculated the mean and standard deviation of each age group. The statistical analysis was converted 146 raw EEG data from patients with MDD into the *z*-scores.

Results. (1) Patients with MDD revealed higher absolute high-beta at prefrontal lobe (F3/F4), parietal lobe (P3/P4), and midline (Fz/Cz/Pz) compared with the healthy adults. (2) The average *z*-score in high-beta and the absolute value of *z*-score in high-beta were both greater than 1 at prefrontal lobe (F3/F4), parietal lobe (P3/P4), and midline (Fz/Cz/Pz) in patients with MDD. (3) There were positive correlations between depression and the absolute high-beta of *z*-score at F3, P3, P4, Cz, Pz; as well as positive correlations between anxiety and the absolute high-beta of *z*-score at F4, P3, P4, Pz.

Conclusion. The brain hyperactivity was confirmed in the high-beta frequency band in patients with MDD. Moreover, the average *z*-score was greater than 1, and the *z*-score of high-beta was correlated with depression and anxiety. This study indicated that the *z*-score can be used as a reference standard for qEEG in patients with MDD.

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