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The Effects of Mobile Application for Cardiorespiratory Synchronization Training on Heart Rate Variability and Electroencephalography

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Background and Description. Cardiorespiratory synchronization training (CRST) is a biofeedback intervention that uses slow and deep diaphragmatic breathing to increase autonomic activations, decrease symptoms of physical and mental disorders, and decrease negative emotions. Diaphragmatic breathing decreases central neuron system activations, increases the theta and alpha powers, and decreases the beta power of electroencephalography (EEG). High-technology mobile applications (APPs) combined with CRST brings innovation and convenience to users in the field of clinical psychological intervention. The aims of this study were to examine the effects of mobile APP for CRST on heart rate variability (HRV) and EEG.

Method. Two hundred participants were recruited from a university and communities. Ninety-two healthy participants were screened and assigned randomly to the CRST group, relaxation training group (RT group as a sham-control group), and control (C) group. The CRST group received resonance frequency and diaphragmatic breathing training with an APP, and the RT group received muscle relaxation with normal breathing rate achieved by using an APP. The training program took 1 hour and was conducted weekly for 4 weeks. The C group did not undergo any APP training. All the participants underwent pretest and posttest measurements performed using psychological questionnaires, electrocardiography, and EEG. The raw electrocardiographic signals were transformed to HRV indexes, which included standard deviations of all normal-to-normal intervals (SDNN), low frequency (LF), high frequency (HF), total power, and maximum and minimum heart rate (HRmax–min). The EEG parameters included absolute power and relative power of delta, low/high theta, low/high alpha, and low/high beta powers at Fz, Cz, Pz, F3, F4, C3, and C4.

Results. The CRST group had significantly higher HRV indexes (including SDNN, LF, total power, and HRmax–min) than the RT and C groups; decreased relative high beta power at Pz, F4, C3, and C4; and increased absolute high alpha power at Pz. The CRST group also had a significantly higher increase in the change scores of HRV indexes (△SDNN, △LF, △total power, and △HRmax–min) than the RT and C groups, increased △absolute high alpha, and decreased △relative high beta from pretest to posttest.

Conclusion. Combining CRST with mobile APPs not only increased autonomic activations but also improved cortical activations. This program allows participants to practice everywhere and all the time and will be applied to different populations to improve autonomic dysregulation and cortical hyperarousal in the future.

References

Chan, A. S., Cheung, M.-C., Sze, S. L., Leung, W.-M., & Shi, D. (2011). Shaolin Dan Tian Breathing fosters relaxed and attentive mind: A randomized controlled neuro-electrophysiological study. *Evidence-Based Complementary and Alternative Medicine*, vol. 2011, Article ID 180704, 1–11. http://dx.doi.org/10.1155/2011/180704

Lutz, A., Greischar, L. L., Rawlings, N. B., Ricard, M., & Davidson, R. J. (2004). Long-term meditators self-induce high-amplitude gamma synchrony during mental practice. *Proceedings of the National Academy of Sciences of the United States of America, 101*(46), 16369–16373. http://dx.doi.org/10.1073/pnas.0407401101

Park, Y.-J., & Park, Y.-B. (2012). Clinical utility of paced breathing as a concentration meditation practice. *Complementary Therapies in Medicine, 20*(6), 393–399. http://dx.doi.org/10.1016 /j.ctim.2012.07.008

Prinsloo, G. E., Rauch, H. G. L., Karpul, D., & Derman, W. E. (2013). The effect of a single session of short duration heart rate variability biofeedback on EEG: A pilot study. *Applied Psychophysiology and Biofeedback, 38*(1), 45–56. http://dx.doi.org/10.1007/s10484-012-9207-0

Relationships Between Cortical Hyperarousal and Sleep Quality Among Patients Comorbid Major Depressive Disorder and Insomnia

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Background. Previous studies confirmed cortical hyperarousal at pre-sleep and sleep stages among patients with primary insomnia or major depressive disorder (MDD); few studies explored cortical hyperarousal at daytime. This study aims to investigate: (1) cortical hyperarousal at daytime among patient comorbid MDD and insomnia and (2) relationships between cortical hyperarousal and sleep quality.

Methods. Seventy-seven healthy participants and 111 patients with MDD were recruited in this study. Pittsburgh Sleep Quality Index (PSQI) was used to separated participants into healthy controls (PSQI ≤ 5), MDD with mild insomnia (5 < PSQI ≤ 11), and MDD with severe insomnia (PSQI > 11). Seven subscales of PSQI (subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction) were used to explore the relationships between sleep quality and cortical hyperarousal. Electroencephalography (EEG) was measured at Fz, Cz, and Pz for 5-min resting state with their eyes-closed during daytime via 19-channel BrainMaster equipment (BrainMaster Technologies, Inc., Bedford, OH). The peak-to-peak amplitude of EEG was analyzed and showed low beta (12–20 Hz) and high beta (21–32 Hz) as the indices of cortical hyperarousal.

Result. Significant greater high beta at Fz and Cz in MDD with mild/severe insomnia and at Pz in MDD with severe insomnia compared to healthy controls. Significant greater low beta at Fz in MDD with mild/severe insomnia and at Cz in MDD with mild insomnia compared to healthy controls. However, no significant difference in low/high beta between MDD with mild and severe insomnia. In addition, significant positive correlations between sleep efficiency with low/high beta at Fz, Cz, and Pz in MDD with severe insomnia group. Significant positive correlations between use sleeping medications with low/high beta at Fz, Cz, and Pz; and negative correlations between daytime dysfunction with high beta at Fz, Cz, and Pz in MDD with mild insomnia.

Conclusion. Patients comorbid MDD and insomnia had higher cortical hyperarousal at the midline area of brain compared to the healthy controls. Poor sleep efficiency was related to cortical hyperarousal in MDD with severe insomnia; frequency of using sleep medications and daytime dysfunction were related to cortical hyperarousal in MDD with mild insomnia.

References

Nofzinger, E. A., Price, J. C., Meltzer, C. C., Buysse, D. J., Villemagne, V. L., Miewald, J. M., ... Kupfer, D. J. (2000). Towards a neurobiology of dysfunctional arousal in depression: the relationship between beta EEG power and regional cerebral glucose metabolism during NREM sleep. *Psychiatry Research: Neuroimaging, 98*(2), 71–91. http://dx.doi.org/10.1016/S0925-4927(00)00045-7

Perlis, M. L., Merica, H., Smith, M. T., & Giles, D. E. (2001). Beta EEG activity and insomnia. *Sleep Medicine Reviews, 5*(5), 365–376. http://dx.doi.org/10.1053/smrv.2001.0151

Wołyńczyk-Gmaj, D., & Szelenberger, W. (2011). Waking EEG in primary insomnia. *Acta Neurobiologiae Experimentalis, 71*(3), 387–392.

Atypical Processing of Novel Distracters in a Visual Oddball Task in Children with Autism Spectrum Disorder: An ERP Study

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Background. Several studies have shown that children with autism spectrum disorder (ASD) show abnormalities in ERPs (Baruth, Casanova, Sears, & Sokhadze, 2010; Bomba & Pang, 2004; Kemner, van der Gaag, Verbaten, & van Engeland, 1999; Sokhadze, Baruth, Tasman, & Casanova, 2013). Children with ASD have been found to differ from typical developing (TD) children mainly with respect to the parietal P3b to targets in standard oddball tasks (Cui, Wang, Liu, & Zhang, 2017). The proposed study employed a three-stimulus visual oddball task with ERP recording and focused on

analysis of responses to both target and nontarget items. In order to better understand attentive orienting to novel signals, we studied both frontal and parietal ERP indices of information processing. The oddball task was aimed to test our hypothesis that children with autism are abnormally orienting attention to novel distracters probably due to impaired habituation to novelty. We predicted a lower selectivity in early ERPs components in response to target, frequent nontarget, and rare distracters and delayed endogenous ERP components in autism group.

Methods. We enrolled 24 children with ASD (13.4 ± 1.9 years) and 19 TD children (14.1 ± 3.05 years). The ERP test used letters "X" (target 25%), "O" (standard, 50%), and novel distracters ("v," "^," ">," and "<," 6.25% each) presented for 200 ms at approximately 1 Hz rate. Reaction time (RT), accuracy, and post-error RT were analyzed as behavioral measures, while ERPs recorded with EGI EEG system at the frontal region-of-interest (ROI) and parietal ROI.

Results. One-way ANOVA showed that children with ASD compared to the TD controls yielded group differences in response error rate (17.7 in ASD vs. 4.6% in TD, p = .043) and did not show normative post-error RT slowing (−17.3 vs. 19.5 ms, p = .028). Parietal P100 was higher to novels in ASD (3.66 vs. 2.16 uV, F = 4.5, p = .041). At the frontal ROI ASD group showed higher amplitudes of exogenous components (e.g., N100, −4.05 vs. −2.69 uV, p = .044) and higher amplitude of endogenous ERP components (e.g., P3a, 4.88 vs. 2.17 uV, p = .015) to novel distracters.

Discussion and Conclusion. These results indicate a reduced capacity for the ASD group to process distracters and orient attention to novelty. The findings are in line with our prior studies using different tasks with visual and auditory stimuli (Kiser et al., 2012; Sokhadze et al., 2009, 2012). Augmented early potentials and a delayed frontal P3a to novel stimuli suggest low selectivity in preprocessing of distracters resulting in excessive processing at the later stages at frontal regions. This may indicate a reduction in the discriminative ability of the ASD group. These results may reflect a locally overconnected network where sensory inputs evoke abnormally large ERP for unattended stimuli with signs of a reduction in the selectivity. This may incur a high load at the later stages of perceptual and cognitive processing and response selection when novel distracter stimuli are differentiated from targets. Analysis of ERP in autism may provide important biomarkers for functional diagnostics and in addition these biomarkers could be used as outcomes in interventions such as rTMS or neurofeedback.

References

Baruth, J., Casanova, M., Sears, L. & Sokhadze, E. (2010). Early-stage visual processing abnormalities in high-functioning autism spectrum disorder (ASD). *Translational Neuroscience 1*(2), 177–187. http://dx.doi.org/10.2478/v10134-010-0024-9

Bomba, M. D., & Pang, E. W. (2004). Cortical auditory evoked potentials in autism: A review. *International Journal of Psychophysiology, 53*(3), 161–169. http://dx.doi.org/10.1016/j.ijpsycho.2004.04.001

Cui, T., Wang, P. P., Liu, S., & Zhang, X. (2017). P300 amplitude and latency in autism spectrum disorder: A meta-analysis. *European Child & Adolescent Psychiatry, 26*(2), 177–190. http://dx.doi.org/10.1007/s00787-016-0880-z

Kemner, C., van der Gaag, R. J., Verbaten, M., & van Engeland, H. (1999). ERP differences among subtypes of pervasive developmental disorders. *Biological Psychiatry, 46*(6), 781–789. http://dx.doi.org/10.1016/S0006-3223(99)00003-7

Kiser, R. M., Sokhadze, G., Gross, E., El-Baz, A., Sokhadze, E., & Casanova, M. (2012). Selective attention and audiovisual integration in children with autism. Applied Psychophysiology and Biofeedback, 37, 307.

Sokhadze, E. M., Baruth, J. M, Sears, L., Sokhadze, G. E., El-Baz, A. S, Williams, E. L., … Casanova, M. F. (2012). Event-related potential study of attention regulation during illusory figure categorization task in ADHD, autism spectrum disorder, and typical children. *Journal of Neurotherapy, 16*(1), 12–31. http://dx.doi.org/10.1080 /10874208.2012.650119

Sokhadze, E. M., Baruth, J., Tasman, A., & Casanova, M. F. (2013). Event-related potential studies of cognitive processing abnormalities in autism. In M. F. Casanova, A. S. El-Baz, and J. S. Suri (Eds.), *Imaging the Brain in Autism* (pp. 61–86). New York, NY: Springer.

Sokhadze, E., Baruth, J., Tasman, A., Sears, L., Mathai, G., El-Baz, A., & Casanova, M. F. (2009). Event-related potential study of novelty processing abnormalities in autism. *Applied Psychophysiology and Biofeedback, 34*(1), 37–51. http://dx.doi.org/10.1007/s10484-009-9074-5

Emotional Changes of ALAY Neurofeedback for Patients Comorbid of Anxiety Symptoms and Major Depressive Disorder

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Background. Previous studies indicated that ALAY neurofeedback (NFB) was an effective protocol for reducing depression and increasing frontal alpha asymmetry (FAA). However, most studies were preliminary case studies of major depression disorder and do not include a control group which could compare with neurofeedback group to examine the effect of ALAY NFB. The purpose of the present study was to examine the effect of ALAY

NFB for patients comorbid of anxiety symptoms and major depression disorder (MDD).

Methods. Twenty-six patients of comorbid anxiety symptoms and MDD were assigned to the ALAY NFB group and the control group. All participants received psychological questionnaires and 5-min resting electroencephalography (EEG) with eyes-closed measurement at pretest and posttest. Beck Depression Inventory II (BDI-II) and Beck Anxiety Inventory (BAI) were administered, and 19-channel EEG was measured and analyzed by BrainAvatar (BrainMaster Technologies, Inc., Bedford, OH). A1 score [log (F4 alpha) – log (F3 alpha)] were calculated as the index of FAA. Participants in the ALAY NFB group received increased A1 score training 1 hour twice weekly for 5 weeks by BioGraph Infiniti (Thought Technology Ltd., Montreal, Quebec, Canada) with bipolar–channel at F3 and F4. Participants in the control group received pretest and posttest.

Results. No significant difference between two groups on age (t = 1.89, p = .07) and sex ($\chi 2$ = .01, p = .91) at pretest. The pair t test revealed that lower scores on anxiety (t = 2.18, p = .047) and depression (t = 3.01, p = .009) in the ALAY NFB group at posttest than that at pretest. However, no emotional change on anxiety and depression in the control group.

Conclusion. This study indicated that ALAY NFB was an effective protocol for reducing negative emotion for patients of comorbid anxiety symptoms and MDD.

References

Baehr, E., Rosenfeld, J. P., & Baehr, R. (1997). The clinical use of an alpha asymmetry protocol in the neurofeedback treatment of depression: Two case studies. *Journal of Neurotherapy, 2*(3), 10–23. http://dx.doi.org/10.1300/J184v02n03_02

Thibodeau, R., Jorgensen, R. S., & Kim, S. (2006). Depression, anxiety, and resting frontal EEG asymmetry: A meta-analytic review. *Journal of Abnormal Psychology, 115*(4), 715–729. http://dx.doi.org/10.1037/0021-843X.115.4.715

The Different Levels of Golf Players on Mu Rhythm Coherence Prior to the Golf Putt

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Background and Description. The Mu rhythm (8–13 Hz), located in the sensorimotor cortex, is related to visual processing and motor control and coordination during activation. Mu rhythm coherence would further understanding of the relationship between brain regions of the functional connections in precise action during the preparation period. Past studies have shown that experts in visual processing (occipital area), motor control and coordination (parietal area), and oral analysis (left hemisphere) showed lower brain coherence, which was consistent with the neural efficiency hypothesis. However, the neural efficiency hypothesis was regulated by the task properties and experience level. Therefore, the purpose of this study was to use Mu rhythm coherence to explore the differences of functional connection from sensorimotor area to other areas with different levels of golf players by controlling putting task difficulty. The hypothesis was that experts would show lower coherence than novices.

Methods. Sixteen experts (mean handicap = 4.44 ± 2.06), 10 amateurs (mean handicap = 32.20 ± 7.61) and 17 novices were recruited. The task difficulty depended on 50% putting successful rate of the individual performance. Sixty putts were executed and divided into six blocks, where each block contained 10 putts. The positions at F3, F4, C3, C4, T3, T4, P3, P4, O1 and O2 were assessed.

Results. When putting difficulty was set at 50% for each group, putting distance performance was experts (402.50 ± 46.55 cm) > amateurs (356.00 ± 27.16 cm) > novices (248.24 ± 43.05 cm). Under the same putting difficulty, compared to novices, experts exhibited significantly higher coherence between the sensorimotor area and parietal area, and between the sensorimotor area and left hemisphere. Also, experts and amateurs demonstrated higher coherence between the sensorimotor area and occipital area.

Conclusion. Under the same effortful difficulty task, compared to novices, experts significantly involved more resources into visual-motor integration, coordinated control, and verbal analysis to come into better putting performance. The excellent cortical functional organization experts have shaped might be flexibly adjusted according to external requirements and performance needs. In terms of space experts might recruit more related cortical regions to parallel signal processing, and in regard to time experts might activate the dominant cortical region more neurons simultaneously, increasing calculation speed, rather than being confined to a "neural efficiency" strategy for the reduction of cortical activation.

References

Babiloni, C., Del Percio, C., Iacoboni, M., Infarinato, F., Lizio, R., Marzano, N., … Eusebi, F. (2008). Golf putt outcomes are predicted by sensorimotor cerebral EEG rhythms. *The Journal of Physiology, 586*(1), 131–139. http://dx.doi.org/10.1113/jphysiol.2007.141630

Deeny, S. P., Haufler, A. J., Saffer, M., & Hatfield, B. D. (2009). Electroencephalographic coherence during visuomotor performance: A comparison of cortico-cortical communication in experts and novices. *Journal of Motor Behavior, 41*(2), 106–116. http://dx.doi.org/10.3200/JMBR.41.2.106-116

Deeny, S. P., Hillman, C. H., Janelle, C. M., & Hatfield, B. D. (2003). Cortico-cortical communication and superior performance in skilled marksmen: An EEG coherence analysis. *Journal of Sport and Exercise Psychology, 25*(2), 188–204. http://dx.doi.org/10.1123/jsep.25.2.188

Jäncke, L., Koeneke, S., Hoppe, A., Rominger, C., & Hänggi, J. (2009). The architecture of the golfer's brain. *PLoS ONE, 4*(3), e4785. http://dx.doi.org/10.1371/journal.pone.0004785

Sabate, M., Llanos, C., Enriquez, E., & Rodriguez, M. (2012). Mu rhythm, visual processing and motor control. *Clinical Neurophysiology, 123*(3), 550–557. http://dx.doi.org/10.1016/j.clinph.2011.07.034

Artifact-Controlled Neurofeedback: A Pilot Study

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Neurofeedback (NF) allows individuals to train and control their own brainwaves. It has been used to assist individuals with attention-deficit/hyperactivity disorder (ADHD) since the 1970s (Lubar & Shouse, 1976). Research supports the view that NF improves attention, although there remains a dearth of research on improvements in academic achievement. Traditionally, NF research has been conducted by clinical psychologists, psychiatrists, and other medical professionals. However, technological advances now permit NF research to be conducted in schools, thereby opening a potentially useful intervention for special educators. In one study, academic achievement in a school setting found that NF may improve scores on measures of reading comprehension (La Marca & O'Connor, 2016).

This poster session will examine the initial findings of a pilot study that examined EEG "artifact"—electrical activity generated through muscle activity that is not associated with brainwaves. The presence of artifact inserts additional signals that are detected by the EEG equipment used to train brainwaves and, therefore, may impair the efficacy of NF training (Goncharova, McFarland, Vaughan, & Wolpaw, 2003). NF training is traditionally done without any control for eye movement, eye blink, or muscle tension artifacts. However, these muscle-based events generate electrical activity that interfere with the ability to accurately read brainwaves, thus potentially diminishing the effect of NF training (Montgomery, 2001).

This poster session will examine the efficacy of NF software that automatically removes artifact and report if automatic artifact removal simplifies the tasks that highly trained special educators may utilize in schools. Study data will inform future research that examines the use of NF to improve academic performance in students with ADHD. The study hypothesized that NF training without any artifact control inhibits students' abilities to learn how to self-regulate their brainwaves, while the elimination of artifact on the fly may decrease the time needed for NF. Thus, elimination of artifact may make use of the intervention more amenable to special educators.

References

Goncharova, I. I., McFarland, D. J., Vaughan, T. M., & Wolpaw, J. R. (2003). EMG contamination of EEG: Spectral and topographical characteristics. *Clinical Neurophysiology, 114*(9), 1580–1593. http://dx.doi.org/10.1016/S1388-2457(03)00093-2

La Marca, J. P., & O'Connor, R. E. (2016). Neurofeedback as an intervention to improve reading achievement in students with attention deficit hyperactivity disorder, inattentive subtype. *NeuroRegulation, 3*(2), 55–77. http://dx.doi.org/10.15540/nr.3.2.55

Lubar, J. F., & Shouse, M. N. (1976). EEG and behavioral changes in a hyperkinetic child concurrent with training of the sensorimotor rhythm (SMR). *Biofeedback and Self-Regulation, 1*(3), 293–306. http://dx.doi.org/10.1007/bf01001170

Montgomery, D. D. (2001). Change: Detection and modification. *Applied Psychophysiology and Biofeedback, 26*(3), 215–226.

External and Internal Foci of Attention with Frontal Midline Theta

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Background. Frontal midline theta (Fm θ, 4–7 Hz) is related to top–down control and attentional resources engagement during activation. Lower Fm θ power in expertise of precise sport means less willing effort and automatic processing alike when in preparation period. Past studies have shown that internal focus of attention during motor preparation makes chocking, which is consistent with the constraints action hypothesis. However, the research in expertise of precise sport was not consistent with past studies. Therefore, the purpose of this study was to use Fm θ to examine the

constraints action hypothesis. The research question was that whether external focus of attention makes expertise more automatic processing than internal focus of attention? The hypothesis is that Fm θ power of external focus of attention (Fm E) is significantly lower than internal focus of attention (Fm I).

Methods. One expert (handicap = 0) was recruited. Both foci of attention were used in personal 50% hole-rate distance as the radius with 40 different positions. A total of 80 putts were executed and divided into four blocks, each block containing 20 putts. Fm θ was recorded and assessed at each putt.

Results. For behavior, both foci of attention were with 12 in-holes in 40 putts. For Fm θ power, external focus of attention (8.622) was larger than internal focus of attention (6.987).

Conclusion. The result of Fm θ was reverse to our study hypothesis; the reason might be that the expert necessarily redeployed attention resource at each putt at different positions with 50% putting task difficulty, especially external cues. Therefore, it led to more external attention than internal attention. Besides, the innovation of improving methodology of this study was measuring EEG and behavior information by each putt at different sites, and it increased ecological validity.

References

Arns, M., Kleinnijenhuis, M., Fallahpour, K., & Breteler, R. (2008). Golf performance enhancement and real-life neurofeedback training using personalized event-locked EEG profiles. *Journal of Neurotherapy, 11*(4), 11–18. http://dx.doi.org/10.1080/10874200802149656

Kao, S.-C., Huang, C.-J., & Hung, T.-M. (2014). Neurofeedback training reduces frontal midline theta and improves putting performance in expert golfers. *Journal of Applied Sport Psychology, 26*(3), 271–286. http://dx.doi.org/10.1080/10413200.2013.855682

Wulf, G. (2013). Attentional focus and motor learning: A review of 15 years. *International Review of Sport and Exercise Psychology, 6*(1), 77–104. http://dx.doi.org/10.1080/1750984X.2012.723728

Wulf, G., Höß, M., & Prinz, W. (1998). Instructions for motor learning: Differential effects of internal versus external focus of attention. *Journal of Motor Behavior, 30*(2), 169–179. http://dx.doi.org/10.1080/00222899809601334

Wulf, G., & Lewthwaite, R. (2016). Optimizing performance through intrinsic motivation and attention for learning: The OPTIMAL theory of motor learning. *Psychonomic Bulletin & Review, 23*(5), 1382–1414. http://dx.doi.org/10.3758/s13423-015-0999-9

Biofeedback Intervention for Anger Management: A Case Study

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Although the two are not synonymous, stress is usually tied into anger; both of which have been proven to have negative health effects. Many studies have discussed biofeedback and the effect it can have on relieving stress, as well as its effect on other health conditions (Greenspoon & Olson, 1986; Shellenberger, Turner, Green, & Cooney, 1986; Wyner, 2015). And, although the results weren't conclusive, biofeedback has been shown to be a viable method of tracking and regulating emotions such as anger (Francis, Penglis, & McDonald, 2016) and is suggested as an intervention for anger management. A United Kingdom study indicated that self-monitoring alone isn't enough to manage anger; when paired with self-intervention the results are more positive (Fernandez & Beck, 2001). One of the goals of the present case study was to attempt to target my anger so that it was at appropriate levels of frequency and intensity. The approach was to utilize biofeedback to self-monitor heart rate variability (HRV) through practicing focused breathing and using positive thoughts when I felt angry; this approach was also utilized as a maintenance strategy. This approach is based on protocols developed by HeartMath LLC. The intervention took place at home, but the measurement of frequency and intensity of the emotion took place both at home and in public. The baseline was 12 days; interventions occurred twice daily, with times of each increasing every 7 days and tracked for 4 consecutive weeks. The intervention showed a significant reduction in the number of anger events, as well as a marked decrease in the intensity of each event. The results of this case study indicate that biofeedback paired with HRV can be a successful intervention for a broad range of anger issues. The limitation is that the intervention was with a single person and self-implemented.

References

Fernandez, E., & Beck, R. (2001). Cognitive-behavioral self-intervention versus self-monitoring of anger: Effects on anger frequency, duration, and intensity. *Behavioural and Cognitive Psychotherapy, 29*(3), 345–356. http://dx.doi.org/10.1017/S1352465801003071

Francis, H. M., Penglis, K. M., & McDonald, S. (2016). Manipulation of heart rate variability can modify response to anger-inducing stimuli. *Social Neuroscience, 11*(5), 545–552. http://dx.doi.org/10.1080/17470919.2015.1115777

Greenspoon, J., & Olson, J. (1986). Stress management and biofeedback. *Clinical Biofeedback & Health: An International Journal, 9*(2), 65–80.

Shellenberger, R. D., Turner, J., Green, J., & Cooney, J. B. (1986). Health changes in a biofeedback and stress management program. *Clinical Biofeedback & Health: An International Journal, 9*(1), 23–34.
Wyner, D. R. (2015). Pilot study of a university counseling center stress management program employing mindfulness and compassion-based relaxation training with biofeedback. *Biofeedback, 43*(3), 121–128. http://dx.doi.org/10.5298/1081-5937-43.3.01

Stress Recovery and Psychophysiological Self- Awareness and Mindfulness

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Cumulative stress can negatively impact emotional and psychological states. When faced with stress, one of the first line of recommendations is to take time away and withdraw from stressors…rest.

Mindfulness practice has been increasingly recommended by many healthcare professionals. The simple nature of the practice can be easily misunderstood and understated, without the backing of empirical evidence of its benefits. Mindfulness research has shown that this practice shows improvement in attention, focus, emotion regulation, and self-awareness (Keng, Smoski, & Robins, 2011; Weinstein, Brown, & Ryan, 2009).

Researchers in the field of neurology have reported that Mindfulness Meditation training can alter regions of the brain known to coordinate stress processing and physiological stress responses (Taren et al., 2015). In field research and in real life it can be difficult to maintain a practice of mindfulness. Without daily practice the benefits of Mindfulness are reduced. Neuro/biofeedback can be used as real-time feedback to teach self-regulation and potentially be used as an aid for Mindfulness Meditation (Brandmeyer & Delorme, 2013).

Purpose. To assess the effects of self-awareness (mindfulness) on stress recovery (rest/neuro-psychophysiology).

Hypothesis. Mindfulness Meditators (M) have significant difference in psychophysiological self-awareness and emotion regulation during rest and recovery than non-Mindful Meditators(nM).

Procedure. Real-time psychophysiological methods to measure two major effects of mindfulness: self-awareness and emotion (stress) regulation in those scoring high on MindfulnessScales (Mgroup) and those scoring lower on MindfulnessScales (NMgroup). Specifically, two major components of Mindfulness will be analyzed:

- Self-awareness: through neuro/biofeedback
- Emotion regulation: neuropsycho-physiological measures of rest/stress recovery from stressors

Psychophysiological Measure (GSR, EEG, EEG; EMG, HR, Temperature) used to measure Baseline, Rest (Post-stressors)/Recovery. Script on a computer screen with the following sequence of events will be presented: 1. Baseline psychophysiology (no stressor), stressor 1 (color Stroop test), rest, stressor 2 (numbers and speed), rest, stressor 3 (timed recall), and rest period.

Self-Report Methods. Mindfulness attention awareness scale (MAAS) and Short Compassion Scale N = 15, Mindful group, n = 7; nMindful group, n = 8.

Preliminary results. Normalized HR and GSR at rest for M and nonM groups, A non-parametric test (Mann-Whitney test) was used to compare two groups, as a more flexible option because the data is likely to be skewed. This is also the reason to report median values for measures of central tendency (instead of means). Results showed that mindful people have lower GSR at rest 1 (median = 1.18) compared to non-mindful participants (median = 1.60), p = .037. Median of 1.60 indicates that a "typical" non-mindful participant has GSR at rest 60% higher than baseline. Median of 1.18 indicates 18% higher for mindful participants compared to baseline. Between the two groups we can assume a difference of 60−18 = 42%.

Participants with high mindfulness score also had lower GSR scores at rest; even though scores were higher during stressors, recovery was closer to baseline than those with lower mindfulness scores. This is a pilot study. The main study has a larger population and more results will be available.

References

Brandmeyer, T., & Delorme, A. (2013). Meditation and neurofeedback. *Frontiers in Psychology, 4*, 688. http://dx.doi.org/10.3389/fpsyg.2013.00688
Heilig, M, & Egli, M. (2006). Pharmacological treatment of alcohol dependence: Target symptoms and target mechanisms. *Pharmacology and Therapeutics 111*, 855–876. http://dx.doi.org/10.1016/j.pharmthera.2006.02.001
Keng, S.-L., Smoski, M. J., & Robins, C. J. (2011). Effects of mindfulness on psychological health: A review of empirical studies. *Clinical Psychology Review, 31*(6), 1041–1056. http://dx.doi.org/10.1016/j.cpr.2011.04.006

MacLeod, C. M. (1991). Half a century of research on the Stroop effect: An integrative review. Psychological Bulletin, 109, 163–203. http://dx.doi.org/10.1037/0033-2909.109.2.163

Taren, A. A., Gianaros, P. J., Greco, C. M., Lindsay, E. K., Fairgrieve, A., Brown, K. W., … Creswell, J. D. (2015). Mindfulness meditation training alters stress-related amygdala resting state functional connectivity: A randomized controlled trial. *Social Cognitive and Affective Neuroscience, 10*(12), 1758–1768. http://dx.doi.org/10.1093/scan/nsv066

Weinstein, N., Brown, K. W., & Ryan, R. M. (2009). A multi-method examination of the effects of mindfulness on stress attribution, coping, and emotional well-being. *Journal of Research in Personality, 43*(3), 374–385. http://dx.doi.org/10.1016/j.jrp.2008.12.008

Isochronic and Binaural Beats Affect the EEG to a Similar Degree at the Cranial Vertex

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Purpose. Brainwave entrainment (the frequency following effect) using sonic beats has long been demonstrated, but there are conflicting claims as to whether isochronic auditory beats or binaural auditory beats are more effective at entraining brainwaves. This study confirmed that brainwaves can be entrained by auditory stimuli and examined whether binaural beats or isochronic tones are more effective at entraining brainwaves at the cranial vertex.

Procedure. Sixty sessions were conducted using eight participants. An active EEG electrode was placed at the cranial vertex, with a reference electrode on the left earlobe and a ground electrode on the right earlobe. The EEG was measured for 8 min under three conditions, in random order for each subject, with a 20-min delay between conditions: (1) a control sessions of soft piano music, (2) piano music with isochronic tones at 10.88 Hz, and (3) piano music with binaural beats set for 10.88 Hz. Statistical tests were performed to assess statistical significance.

Data. Exposure to soft piano music and an auditory stimulus at 10.88 Hz increased the percentage of alpha power at the cranial vertex, compared to piano music alone ($p <= 0.05$). No differences were noted based on the order of the sound exposures. Binaural beats increased the alpha power ratio by 11.1%. Isochronic tones increased the alpha power ratio by 11.5%. Compared to control, both auditory stimuli decreased the total EEG brain power ($p <= 0.05$); the binaural beats by 20.5% and the isochronic tones by 19.3%. The auditory stimuli entrained brainwaves more effectively in subjects with lower alpha power ratios in the control session.

Conclusion. Brainwaves can be entrained to auditory stimulation. Although the absolute alpha wave power decreased with the auditory stimuli, the ratio of alpha wave to total EEG power increased. The isochronic tones were slightly more effective, but the difference was not statistically significant. More research is needed to assess how long the effect will last, and to correlate the changes to other psychological measures.

References

Evans, J. R. (Ed.). (2007). Handbook of neurofeedback: Dynamics and clinical applications. New York, NY: Haworth Medical Press.

Evans, J. R., & Abarbanel, A. (Eds.). (1999). Introduction to quantitative EEG and neurofeedback. San Diego, CA: Academic Press.

Huang, T. L., & Charyton, C. (2008). A comprehensive review of the psychological effects of brainwave entrainment. *Alternative Therapies, 14*(5). 38–50.

Comparing the Effectiveness of Recall of Traumatic Memories (RTM), Eye Movement Desensitization and Reprocessing (EMDR), and Neurofeedback (NFB) on Veterans Diagnosed with PTSD Using a 19-Channel EEG

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Many veterans return from conflict zones suffering from Posttraumatic Stress Disorder (PTSD). Current treatments provide partial symptom relief that is lengthy and ineffective (Schiller & Phelps, 2011). This research seeks to address the impact of PTSD on warriors and veterans by enhancing treatment outcomes, encouraging treatment participation and completion, and decreasing treatment expense by introducing better treatments for the intrusive and hypervigilant symptoms for PTSD. Between September 2001 and August 30, 2011, more than two million (2,333,972) American military personnel were deployed to Iraq, Afghanistan, or both (Martinez & Bingham, 2011). The prevalence of PTSD among veterans of Operation Iraq Freedom (OIF) and Operation Enduring Freedom (OEF) ranges between 13% and 17% (Tanielian & Jaycox, 2008). Between 2002 and the third quarter of fiscal 2011, 711,986 veterans used Veteran Affairs health care (Martinez & Bingham, 2011). Only 23–40% of veterans diagnosed with a mental disorder sought mental health care (Hoge et al., 2004). Low motivation to seek help for mental health care has been attributed to stigma (Hoge et al., 2004), lengthy

waiting periods for obtaining treatment, inconsistent results from currently approved treatments, the length of time in treatment, and the high rate of relapse (Gray & Liotta, 2012). In light of the need for treatment, the frustration that service members and their families experience with current treatments and increasing fiscal restraints, new treatment options are needed. This research study will compare three treatment protocols: a recognized PTSD treatment, Eye Movement Desensitization and Reprocessing (EMDR) therapy, the adapted Reconsolidation of Traumatic Memories (RTM), and Neurofeedback (NFB). EMDR, RTM, and NFB therapies are noninvasive minimal exposure-based interventions that are typically completed in 3 to 20 sessions of 60 to 90 minutes each.

This study researched veterans for noninvasive shorter term, comprehensive, and efficacious interventions. Our hypothesis is that, compared to the pretest and untreated group controls, all three neurotherapy treatments will show clinically significant posttreatment decreases in PTSD symptom scores. There will be statistically significant differences in the pre- and posttest 19-channel EEG's of the RTM, EMDR, and NFB treatment groups compared to the pretreatment waitlist control group

References

Gray, R. M., & Liotta, R. F. (2012). PTSD: Extinction, reconsolidation, and the visual-kinesthetic dissociation protocol. *Traumatology, 18*(2) 3–16. http://dx.doi.org/10.1177/1534765611431835

Hoge, C. W., Castro, C. A., Messer, S. C., McGurk, D., Cotting, D. I., & Koffman, R. L. (2004). Combat duty in Iraq and Afghanistan: Mental Health Problems, and Barriers to Care. *New England Journal of Medicine, 351*(1), 13–22. http://dx.doi.org/10.1056/NEJMoa040603

Martinez, L., & Bingham, A. (2011). U.S. Veterans: By the numbers. *ABC News*. Retrieved from http://abcnews.go.com/Politics/us-veterans-numbers/story?id=14928136 - 1

Schiller, D., & Phelps, E. A. (2011). Does reconsolidation occur in humans? *Frontiers in Behavioral Neuroscience, 5*, 24. http://dx.doi.org/10.3389/fnbeh.2011.00024

Tanielian, T., & Jaycox, L. (Eds.). (2008). *Invisible wounds of war: Psychological and cognitive injuries, their consequences, and services to assist recovery*. Santa Monica, CA: RAND Corporation. https://www.rand.org/pubs/monographs/MG720.html

The Combined Effects of Neurofeedback and Intensive Behavior Intervention on Children with Autism Spectrum Disorder

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Autism spectrum disorder (ASD) is a neurological disorder that affects the wiring of the brain, given variable cognitive impairment and language. These findings have been found thanks to the empirical studies that have been performed around pervasive developmental disorders (PDD), known as qualitative alterations of the communication and the mutual interaction of the individual. Additionally, some changes in the motor area can be included, along with the aforementioned communication and social skills. Neurofeedback, also known as EEG Biofeedback, teaches self-regulation of brain activity by normalizing dysregulated brains in establishing focus and concentration. A large number of studies have applied Neurofeedback in the treatment of ASD, and the results point to a considerable usefulness of this technique, so this study was proposed to review the applicability of Neurofeedback in a group of 30 children between 2.5 and 12 years of age with ASD and/or anxiety receive either both Neurofeedback and combined treatments. The participants received either a combined treatment or isolated treatment of Intensive Behavior Intervention (IBI), Neurofeedback (NF), or Speech and Language (SLP). NF starts with the TLC assessment and Brain mapping to determine specific needs to tailor a detailed and individualized training plan. NF sessions for participants range beginning from 10 to 40; half hour in length, depending upon the type of treatment and participant. Research results show improvements in speech, language, movement, attention, and focus. A calculated increase of accumulated skills estimated of a 30% behavior change with combined Neurofeedback and Intensive behavior intervention.

References

Diaz, J. R., Camelo, S. M., & Avendano, B. L. (2015). Use of Neurofeedback in Different Psychopathologies. *Cognitive Remediation Journal, 1*(4), 22.

EEG Data for a Significantly Improved Alzheimer's Disease Case After Photobiomodulation Treatment

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Neurofeedback (NFB) treatments often cover 10 to 40 sessions over several months. While NFB has been effective for many psychological and psychiatric conditions, significant clinical improvements are not usually observed during the early treatment sessions, and outcomes are not always predictable. An intervention that is simple for NFB practitioners to implement, produces rapid entrainment, and drastically cut short treatment time would potentially change expectations for NFB practice. Photobiomodulation (PBM) offers an intervention with these possibilities, supported by decades of research on its effect on neurological conditions (Hamblin, 2016). Latest research and development in the PBM extend expectations further by allowing the control of key parameters such pulse frequencies and nuclei targets to be controllable, opening up new solutions in personalized intervention. In addition, PBM with selected parameters are starting to produce evidence to improve Alzheimer's disease (AD) conditions. This expands the scope of NFB practice when it is partnered with PBM.

Presentation Contents. To support this argument, the presenters have been involved in recent investigations to test the hypothesis that the brain is immediately responsive to PBM, indicating rapid brain wave training. Furthermore, new scientific theories and evidence continue to build up to support PBM's efficacy for various neuropsychiatric conditions.

In the presentation, analyses of these data from four sets of studies will be discussed. They were based on home-use intervention devices directing near infrared (NIR) light at 810-nm wavelengths pulsed at either 10 Hz or 40 Hz to the hubs of the brain's default mode network. The studies analyzed with summarized results comprise:

- A case series report of five dementia patients with mild to moderately severe impairment treated over 12 weeks. It used 10-Hz pulsing devices which helped produce significant improvements measured with widely recognized cognitive scales, with no side effects (Saltmarche, Naeser, Ho, Hamblin, & Lim, 2017).
- A case report of a moderately impaired AD patient treated with a 40-Hz device and measured with electroencephalography (EEG) over 3 weeks. It presented even more significant cognitive improvement presenting more than 100% improvements in EEG measurements (Zomorrodi, Saltmarche, Loheswaran, Ho, & Lim, 2017).
- A double-blind crossover EEG observational study on PBM of 20 healthy brains. It confirms that NIR directed to the brain produces significant neuro-stimulation effects.
- New data accumulated on brain response to changes in pulse frequencies between 0 Hz to 40 Hz driven at different power. We are also able to demonstrate that changes in pulse frequencies and power evoke changes in EEG patterns in real-time, suggesting that we can rapidly modify EEG brain maps to achieve desired clinical outcomes.

Conclusions. Evidence suggest that PBM has a good argument to be a strong partner to NFB, with the potential to allow it to raise the expectation bar and opens up new solutions for NFB. It also has the potential to personalize treatments. However, to fulfill some of its potential, more work will be required to build up reference profiles related to different pulse frequencies, as well as trigger parameters.

References

Hamblin, M. R. (2016). Shining light on the head: Photobiomodulation for brain disorders. *BBA Clinical, 6*, 113–124. http://dx.doi.org/10.1016/j.bbacli.2016.09.002

Saltmarche, A. E., Naeser, M. A., Ho, K. F., Hamblin, M. R., & Lim, L. (2017). Significant Improvement in Cognition in Mild to Moderately Severe Dementia Cases Treated with Transcranial Plus Intranasal Photobiomodulation: Case Series Report. *Photomedicine and Laser Surgery, 35*(8), 432–441. http://dx.doi.org/10.1089/pho.2016.4227

Zomorrodi, R., Saltmarche, A. E., Loheswaran, G., Ho, K. F., & Lim, L. (2017). *Complementary EEG Evidence for a Significantly Improved Alzheimer's Disease Case after Photobiomodulation Treatment*. Accepted for Poster Presentation at the Alzheimer's International Conference 2017.

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