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The Suisun Summit 2022: Emerging Themes and Open Questions in qEEG and Neurotherapies

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Abstract

The Suisun Summit 2022 was a gathering of 70 clinicians, educators, and researchers in quantitative electroencephalography and neurofeedback. During this 5-day event, several themes emerged in talks or discussion groups: EEG/qEEG Reading Skills; Medication Effects and Pharmaco-EEG; Technological Advancements; Emerging Concerns; and Growing Community Prestige through Research. Participants were asked to summarize what they believed to be the most important messages from the event to share with colleagues who were not in attendance, resulting in this review. A unifying concept for all the themes was a desire for higher quality, standardized EEG/qEEG education that provides depth as well as breadth. Models of clinical care that encourage open communication with prescribers and functional medicine specialists were strongly emphasized. Abstracts from all presentations are attached in Addendum B.

Keywords: EEG; qEEG; neurofeedback; education; conference review; best practices

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Introduction

The Suisun Summit was a gathering of nearly 70 clinicians, educators, and researchers in quantitative electroencephalography (qEEG) and neurofeedback on October 12–16, 2022, in Suisun City, California. For most, this was the first in-person professional conference they attended since before the COVID pandemic. Twelve presentations and group discussions were organized as a 5-day, single-track event, that was flawlessly executed by Mary Tracy. Many participants commented that it was the best conference they have ever attended, both for the quality of the presentations and the inclusive sense of comradery they experienced.

International Society for Neuroregulation and Research (ISNR) President Mark Jones is on a mission that his term at the helm be known for reinvigorating the "R stands for research" into the identity of ISNR. He and Ron Swatzyna set a tone for the event on the first day with an encouraging discussion on developing support for clinicians to design research projects and gather data in their private practices. The final discussion, led by Rogene Eichler West, organized attendees to co-author this conference review so that they might gain some experience with the process of publishing in a peer-reviewed journal.

The group first identified common cross-cutting themes and then were asked to remark on: (a) the current state of knowledge; (b) the new material that was introduced during the Summit that other professionals in the field should know about; and (c) the open questions that were driving the future of the field. Multiple themes emerged: qEEG Reading Skills; Medication Effects and Pharmaco-EEG; Technological Advancement; Growing Community Prestige through Research; and Emerging Concerns. From here, smaller groups were formed with each responsible for writing a summary of each theme. Each group had the opportunity to offer feedback on the sections submitted by the other groups.

The reminder of this paper explores those themes in greater detail. The paper closes with some comments on the history of the event, born out of two workshops in 2019, as well as the origin of the Onto Innovations Study Group, many of whose members were in attendance.

QEEG Reading Skills

An emphasis on improving qEEG reading skills using visual inspection as the first step in the interpretation of neuropsychiatric symptoms in the brain is a challenge of continuous refinement. There are various pitfalls to avoid and many subtleties that require exposure to many EEGs for reliable interpretation. This summit was not intended to be a didactic for a qEEG exam, nor was it a tutorial on abnormal waveforms. Instead, EEG reading skills were emphasized in the context of case reviews. Jay Gunkelman presented talks on "Unexpected Epileptiform Content in the EEG" and "PTSD Biomarkers with ERP and EEG." Tiff Thompson delivered the presentation on "Pediatrics and Developmental Trauma in the Brain." Angelika Sadar discussed important reading skills during her moderated discussion of "Medications and EEG Correlates," as did Ron Swatzyna and Jay Gunkelman, who presented on "Pharmaco-EEG and Phenotypes: The Interface between Neurology, Psychiatry, and Neuromodulation."

The Challenges to Becoming Competent in Reading Raw EEG

Philosophically, and from a practical standpoint, what unites most participants at this event is the fundamental assumption that interpreting a qEEG requires the ability to read and interpret the raw EEG first before processing it with higher order statistics (i.e., Fast Fourier Transforms, comparison with normative databases, and displays of head maps). Processed algorithms are averaged over all epochs in a recording, which means that important but less frequently occurring features, such as isolated epileptiform discharges, may not show up in the final analysis. Understanding how filters can alter waveform morphology could explain the appearance of multiple peaks in the power spectrum. Furthermore, it is not always possible to remove all sources of artifacts; therefore, one needs training to develop confidence in determining that the higher order statistics and brain maps are a true reflection of the raw EEG features and have not been influenced by artifacts or skewed by frequencies outside of their range, such as alpha loading into theta or beta bands, since the brain maps have fixed frequencies. For instance, slow alpha loading into the theta band results in a high theta beta ratio, and leptokurtic alpha appears as hypercoherence in that single frequency.

Our competence as clinicians and outcomes for our clients improve significantly when we commit ourselves to acquiring these skills. For example, the

pattern of waxing, waning, and intermittent coherence of frontal alpha suggests issues with vigilance and perhaps chronic poor sleep quality. A qEEG clinician trained in reading raw EEG data will have a better sense of whether a complaint of attention issues might first be addressed through improved sleep hygiene. Dropping into stage 2 sleep before 300 seconds (technically known as “mean sleep latency time”) necessitates a referral for sleep monitoring as untreated sleep apnea can be life-threatening and can explain many presenting symptoms that could improve with better quality sleep. And certainly, a neurofeedback session on someone who is unable to maintain vigilance is of dubious value.

Opportunities to become competent in seeing these patterns, developing skills in interpreting EEG data using different montages that verify the focal localization and identification of abnormal EEG features, and awareness of the multitude of clinical interpretations, especially in the realm of mental health, are difficult to find in this burgeoning field. This is why we emphasize the attainment of a higher standard of EEG skills by encouraging students to become Board Certified in qEEG.

Formal Training of Neurologists and Psychiatrists in Reading Raw EEG

Formal training in reading EEG is typically restricted to neurologists and some psychiatrists. However, even in this population, 43.2% of neurology residencies do not include dedicated EEG rotations. A residency that does contain an EEG rotation only provides 6 weeks of EEG training, and 74% of neurology trainees will receive no further EEG training beyond this residency (Weber et al., 2016). Beyond this, more highly specialized training requires an additional 1 or 2 years in an epilepsy or sleep medicine fellowship and a board exam after completing a 4-year neurology residency after medical school. These specialists may further specialize in pediatrics and neonatal populations.

Even though medical professionals and qEEG analysts like us are looking at the same data, medical specialists do not learn clinical correlates associated with mental health, and we as qEEG analysts do not have the specialty training to make definitive calls for medical referrals. How can we be certain that appropriate help for our clients is not lost in the space between our scopes of practice? There are two steps we can take to move forward: (a) we can continue to develop learning opportunities for standardized and structured training in EEG reading skills and interpretation for mental health practitioners; (b) we can seek to build bridges between the communities so that appropriate communication can be facilitated, and cross-referrals can be made.

Nonmedical qEEG Certification and the Importance of Ongoing Education

Currently the standard in nonmedical EEG is a qEEG certification as a Diplomate or Technologist through the International qEEG Certification Board (IQEEGCB). Passing the qEEG Board exam is intended to demonstrate one’s general knowledge of electrophysiological processes, instrumentation features, and clinical correlates of EEG and qEEG findings. In addition, the ability to confidently record, artifact, and process the EEG using various technologies for clinical interpretation is one gold standard for attaining certification. However, even with these credentials, it may take years of practice and the examination of thousands of EEGs with mentoring from an expert to become a competent qEEG Analyst. The IQEEGCB requirement for writing five qEEG reports, and 10 hours of mentoring by a qEEG Diplomate is not enough. It is for this reason that opportunities for ongoing education such as weekly grand rounds or presentations that emphasize EEG reading skills are held in such high regard by the attendees of this event.

The Power of Case Studies

Jay Gunkelman, who was the featured expert in EEG and qEEG at the Summit, is technically an EEG technician, not a clinician. His profound influence and deep commitment to the education of this community emphasizes the importance of intensive training and experience over titles. Jay’s method of instruction is centered on case studies. He presented an example where a 55-year-old female, in otherwise good health, developed trouble with word finding and lost the ability to sing. While reviewing her EEG with a clinical colleague, he pointed out sharp slow transients emanating from the temporal area. Jay understood that this waveform, particularly at this location, suggested deleterious vascular changes, perhaps in the aortic arch, left brachial or left carotid artery. The clinician then pushed for a referral for further testing in the form of a magnetic resonance angiography (MRA), which specifically evaluates the condition of blood vessels. The MRA revealed an aneurysm, which resulted in proper medical intervention, likely saving this person’s life.

That story has an amazingly happy ending. It illustrates the power of raw EEG interpretation in the hands of those properly trained, and in partnership

with a clinician whose scope of practice allows further medically based investigation.

In another case study, we learned of a client whose family intervened in a scheduled neurosurgery procedure of a family member in favor of trying neurofeedback training. This young woman was diagnosed with a seizure disorder and was given the option of surgery as a last resort. Fortunately, the family became aware of the potential of neurofeedback to stabilize the dysregulated pattern. Gunkelman and his team worked with the neurologist to offer an alternative treatment, and this young woman is now living a seizure-free life without having to undergo neurosurgery.

Examples of Clinical Correlates That Are the Product of Raw EEG Interpretation

Throughout the various talks, several other correlates were discussed, along with how their presence indicated the most efficacious treatment selection:

- Beta spindles can indicate several issues from anxiety to insomnia to inflammatory processes to benzodiazepine or amphetamine intoxication, with distribution, amplitude, and frequency contributing to the interpretation (Swatzyna et al., 2015).
- Paroxysmal activity is present in between 20% and 60% of clients with attention-deficit/hyperactivity disorder (ADHD) and autism spectrum disorder (ASD), which need to be stabilized before other interventions are pursued (Swatzyna et al., 2015).
- Phenotype classification may reveal physiological issues that need to be addressed before engaging in other neurotherapies. For example, low power EEGs (less than ± 25 mV) should first be assessed for metabolic insufficiencies, infections or toxicities, or traumatic brain injuries.

Tiff Thompson, a specialist in neonatal and pediatric EEG and trained as a registered EEG tech as well as a licensed clinical psychologist, presented on “Pediatrics and Developmental Trauma in the Brain.” Her talk stood out because of the use of a timeline to introduce the developmental evolution of EEG markers, neurobiology, and behaviors from birth to adolescence. This approach was both complementary to clinical case studies and integrative of the emergence of expected waveforms. It also took the form of a longitudinal case study, featuring her own children!

Mastering EEG Tools

There are a great many analytic tools available, each with its strengths and weaknesses. A practitioner must know how to choose the correct tool for each kind of analysis. “You are only as good as your data and your ability to quantitatively process that data” (Gunkelman, 2014). For example, the “correct” montage is the one that allows you to verify the signal source in a particular way. The Linked Ears montage is the derivation used to create databases, so this montage needs to be used when referencing a normative database. This montage can be contaminated with ear lead and temporal artifacts, however, which creates the appearance of elevated coherence. Neurologists use bipolar montages to best localize the origin of a particular waveform (Nunez & Srinivasan, 2006).

EEG Reading Skills and Neurofeedback

EEG reading skills directly impact one’s ability to assess appropriate neurofeedback software to accurately target the marker of greatest concern. A “hot-spot-ologist” might try to train down a beta peak at 20 Hz, only to be training down a 10 Hz alpha with a notched appearance, because of filter settings. Focal slowing, for example, might not be adequately trained using standard band and reward settings if the occurrence is relatively infrequent. Excess frontal beta or peak alpha frequencies above 12 Hz can indicate dysregulation but may also indicate markers of the drive and motivation of peak performers. Training the clients to turn this ability on and off at will is far more powerful than squashing excess frontal beta because their *z*-score is an outlier.

Medication Effects and Pharmaco-EEG

Two of the presentations were explicitly about the impact of medications on EEG or, conversely, the use of EEG to better select medications. Angelika Sadar moderated a group discussion on “Medications and EEG Correlates”; Ron Swatzyna and Jay Gunkelman presented a talk on “Pharmaco-EEG and Phenotypes: The Interface between Neurology, Psychiatry, and Neuromodulation.”

Influence of and Selection of Drugs From Raw Data

The discussion with Angelika Sadar reinforced the importance of learning to disambiguate medication-related features in the raw data on the EEG from those generated by the brain for more accurate interpretation, as it is unethical for qEEG analysts to instruct a client to taper off medications before collecting a qEEG unless they are also the prescribing MD. While some medications can be

expected to have the same effect on all brains, such as diffuse presentation of beta associated with benzodiazepines or amphetamines, other drugs will exert their effect based on a baseline of overarousal or underarousal. This knowledge is useful when selecting an applied psychophysiological protocol appropriate to the underlying brain patterns rather than their chemically shifted state.

Jay Gunkelman cited two studies (Arns et al., 2008; Loo et al., 2016) where the EEG phenotype model was instrumental in an improved success rate when selecting ADHD medications. He gave examples where the choice of the medication for psychotic illness, bipolar disorder, epileptiform activity, or posttraumatic stress disorder (PTSD) was best selected by the presence of beta spindles, global/focal slowings, and/or paroxysms, rather than the primary symptoms or Diagnostic and Statistical Manual (DSM) diagnostic labels. These recommendations fall under the rubric of "Personalized Medicine" based on phenotypic biomarkers and must be facilitated by qEEG analysts in conjunction with the prescribing physician or other professionals. It is noteworthy to mention that the general medical use of genotypic and phenotypic biomarkers to better select treatment for an individual is predicted to become a $500 billion market by 2027 (Mehra, 2022). Success in oncology, cardiology, and neurology will likely influence the pursuit in other fields, such as mental health. Journals such as *Clinical EEG and Neuroscience* have taken notice, devoting an upcoming special issue based on work in this area presented at this year's International Pharmaco-EEG Society Annual Meeting.

Ron Swatzyna strongly agreed with these observations. In reviewing thousands of EEGs from his own clients with mental health diagnoses, he identified four main neurobiomarkers that account for most medication failure: encephalopathy, focal slowing, beta spindles, and transient discharges. One or more of these neurobiomarkers were identified in all refractory cases. Swatzyna et al. (2014) found that multiple neurobiomarkers were associated with more psychopathology, diagnoses, and medication prescribed.

There is a growing enthusiasm in the qEEG community that replacing the traditional DSM and International Classification of Diseases (ICD) diagnostic criteria that psychiatrists rely on for medication prescriptions with EEG biomarkers would result in improved outcomes. In February, World Psychiatry (Leichsenring et al., 2022) published a review and meta-analytic evaluation of recent meta-analyses highlighting the limited gain for both psychotherapies and pharmacotherapies over placebo or treatment as usual (TAU). The highest impact psychiatric journal is suggesting that a paradigm shift is required to achieve further progress. Now is our time to provide research supporting the use of EEG and qEEG for medication selection especially in refractory cases.

Partnering with Prescribers

One of the main frustrations for mental health practitioners trained in qEEG is clearing the way for open and respectful communication with prescribers, enabling information to be shared within the boundaries of an individual's licensure and training.

As qEEG clinicians, unless we are the prescribing professional, we would be creating legal liability for ourselves and may do harm to our patients or clients if we encouraged or even agreed with a patient to taper off medications before a qEEG or because of the findings in a qEEG. We must therefore refer the patient or client to their prescribing professional or have a conversation with the said person before any medication changes are made under the authorization of the prescribing professional.

The question arose whether members of this community had an *ethical* responsibility to bring this information to a prescriber if a client's EEG appeared to be subject to increasing instability due to a choice of medication. For example, some medications exacerbate seizure discharges or even trigger outright seizures in some patients who have isolated epileptiform discharges (IEDs) in their brains, which can only be detected with an EEG. Psychiatrists have no way of knowing about the presence of silent discharges in the brain and therefore might appreciate that information to make an informed decision regarding medication choice. This situation becomes more complicated as several neurobiomarkers, such as positive identification of IEDs, can only legally be reported by a neurologist, who will rarely get involved unless there is clear evidence of epileptiform morphology in the EEG or a report of an outright seizure.

Participants developed a list of ideas to help improve the communication process between providers:

1) Providing the prescriber with a list of peer-reviewed research articles to back up the EEG findings. How can our professional organizations help provide an up-to-date portal of this kind of information, so that each individual clinician

need not have to continuously update their own corpus of new research in this area?
2) Networking with client's prescribing practitioners by offering a professional courtesy assessment to the practitioner or their clinical team. Offering to tell them about their own brain will engender some personal interest and help them to develop confidence in your clinical skills.
3) Creating a one-page informational sheet to be used as a handout to introduce prescribers to EEG-guided medication selection. Can one of our professional organizations produce an authoritative version that can be used by the entire community?

Successfully collaborating with prescribers to build an effective and knowledgeable team is essential to the continuity of care for clients. For qEEG practitioners who are not licensed as psychiatrists, it is important to work with a knowledgeable, licensed prescriber. One way to network with local psychiatrists is to join any regional listserv of mental health professionals. There are often group meetups for providers soliciting referrals. One suggestion was to consider hosting a meetup and to post it on the listserv.

Psychiatrists have a basic understanding of the EEG, though they don't often get as much EEG training in school as many would like. Those who have received training most certainly would not have had exposure to the application of EEG to medication selection, as this is a relatively new specialty. It is recommended that qEEG analysts develop a relationship with a prescribing professional. As the relationship grows, it is important to make this relationship a reciprocal one: the psychiatrist will have his or her own informed reasoning for choosing a medication. The group recommended sharing what we know and learning how the prescribing professional formulates a decision. Collaboration is encouraged.

Technological Advancements

Three talks introduced new technologies in the form of algorithms or new hardware. Peter Gast and Michael Villanueva gave a joint presentation entitled "Art of Dimension" where they demonstrated motivations for alternative representations of data for improved insight and analysis. Rogene Eichler West presented an introduction to a kind of analysis that has become pervasive in many fields, machine learning, in her talk, "Machine Learning Algorithms for the Identification of Signals in the Noise." Finally, attendees received a demonstration of the latest innovations in wearable EEG during Seung Wan Kan and Daekeun Kim's talk, "Vision of New Decade: Building a digital mental care platform with qEEG brain mapping and neuromodulation." For those new to the field, Dave Siever reviewed the power of audio-visual entrainment during his talk, "Physiology and Clinical Applications of Audio-Visual Entrainment Technology" (Siever & Collura, 2017).

The Art of Dimension

Gast (also known by the name Makoto Miyakoshi) is a researcher and programmer who plays an active advisory role in the EEGLAB community. At the start of his presentation, Gast set the tone for his talk using a video of the "Ambiguous Cylinder Illusion," a popular YouTube video and winner of the 2016 Best Illusion of The Year Contest. The message was that our perception of data is dependent on how it is displayed. For example, a common practice in clinical EEG is to collapse the time dimension and represent the data as power spectral density averages. Although this method of reducing dimensionality makes the ensuing information simpler and quicker to view, it also can create false impressions about the nature of the EEG and the salient information contained therein.

The importance of the transient and intermittent features of EEG was illustrated by a second analogy, first by playing an audio clip of a popular Beatles song normally and then by compressing the entire song into a couple of seconds; averaging EEG power from a multiminute recording into a single image is similarly reductive. Gast demonstrated an alternative way of viewing the data known as a peak-power frequency ribbon analysis, a graphical representation that reveals a low-dimensional representation of stationary power distribution in the time domain. Visually, this appeared as a shorthand for viewing the whole length of a multiminute EEG recording while simultaneously retaining important temporal features.

Michael Villanueva, a clinical psychologist and neurofeedback practitioner brought the concepts introduced by Gast into a practical clinical framework. Most EEG analysis software relies on spectral averages to create comparisons with normative databases. But given the transient nature of EEG, as demonstrated in the audio analogy, we may grow dissatisfied with the lack of any temporal resolution in such comparisons. Furthermore, although *p*-values associated with differences in spectral power density between an individual and the database may help identify areas of interest,

significance (*p*-values) may not be relevant given the intended application of neurofeedback.

As a more appropriate method for comparison of either pre–post or individual-database EEG time series data, Villanueva proposed the application of Cohen's D, or the standardized mean difference. Villanueva announced the future release of a "d-Matrix" toolbox within EEGLAB, created by Gast, that can apply the Cohen's *d* effect size calculation to a set of EEG time series. This comparison allows for the retention of the time dimension and "provides a beautiful spatial overview of cortical power levels," giving a unique window into the hitherto unseen effects engendered by neurofeedback.

An Introduction to Machine Learning

Rogene Eichler West is a research scientist, former clinician, and qEEG-diplomate, who provided a broad-reaching introduction to machine learning and its potential applications for EEG. She pointed out that machine learning approaches have begun to surpass the use of standard statistics in discovering and classifying high-dimensional relationships in data features. Because of this ubiquity, it will become important for clinicians to learn to skeptically read the machine learning literature rather than to accept the conclusions at face value.

Machine learning comprises a variety of computational approaches to data that vary in their complexity, data requirements, computing power consumption, and use-case considerations. Machine learning algorithms are divided into supervised learning, for which examples must be provided to learn from, and unsupervised learning, where the data is clustered based on some distance measure. The simplest of these methods, such as simple linear regressions and decision trees are already intuitively used by most people.

The use of more advanced methods hold promise for identifying yet-unknown features or correlates of EEG signals, but also present unique challenges. One such challenge is the time-consuming step of generating labeled data for supervised algorithms by humans with expertise in the domain of relevant knowledge. A second challenge is to develop strategies for handling imbalanced datasets, which frequently occur in clinical data where the number of normal examples to learn from outnumber the clinically significant ones. A third challenge is to develop a feature space to differentiate salient classes.

Early machine learning applications, such as neural networks, were motivated by an idealized model of how collections of neurons worked together to solve problems. Consequently, language developed such that terms like neurons, synaptic weights, channels, and epochs hold a different meaning for data scientists than EEG clinicians and researchers—and this can cause confusion.

Examples were given for how to critically read a study. For example, a valid result should have a separation between training data, cross-validation data, and testing data, lest performance measures such as accuracy are reported as inappropriately high.

Machine learning algorithms are available for development in major programming languages and on platforms such as EEGLAB, as are a growing number of open-access EEG data collections, such as TDBRAIN released by Martijn Arns' BrainClinic's Foundation.

The Next Generation of iMediSync's Digital Mental Care Platform

Seung Wan Kan and Daekeun Kim provided their vision for the next 10 years of iMediSync and a summary of the company's history since its founding in 2012. Their goal was to create an integrated and user-friendly EEG system so that more health professionals could make use of EEG data in their clinical practice. iMediSync has since developed an age-and-sex-matched qEEG normative database, iSyncBrain, which is available as a paid service for processing EEG data from many standard EEG devices. The iSyncBrain processing software can rapidly and automatically artifact the data using an AI-based algorithm and then compile the results into a downloadable report. iMediSync has also developed a machine learning algorithm for the detection of cognitive impairment, along the spectrum of Alzheimer's disease disorders.

Participants had the opportunity to try their new integrated EEG helmet called iSyncWave. This helmet integrates high-impedance dry sensors, an EEG amplifier, NIR-LEDs for photobiomodulation, and a wireless communication module so that data can be recorded directly to a Samsung tablet and then uploaded to the iSyncBrain server for processing. The collection software automates the recording of 2 min of eyes open and then 2 min of eyes-closed data. While several devices are currently available on the market to deliver transcranial photobiomodulation (tPBM), the iMediSync team proposes to turn the integration of

EEG and tPBM into a viable telemedicine diagnostic and personalized therapeutic device for mild cognitive decline (MCI) and dementia.

iMediSync hopes to expand the scope of their AI-based EEG analysis tools and to bring their vertically integrated EEG solutions to diverse health professionals. They reported working with medical boards to document their processes to be considered for insurance billing.

Emerging Concerns

The impact of environmental factors on brain health, such as electromagnetic radiation (EMF) and toxins in the air, water, and food, is of growing concern to a great number of attendees. There is a realization that more attention must be paid to helping clients identify and avoid exposure to these factors. However, most clinicians felt that they needed to be better educated on this topic themselves. Two talks highlighted issues to consider. Neurologist and Pediatric Epileptologist Rusty Turner spoke to the harm that our radio-enabled world is silently causing in his talk, "EMR: The Most Unrecognized Influence on EEG." Chiropractic neurologist and former professor of neurochemistry Michael Pierce then presented on the biochemistry underlying several neurodegenerative processes in his talk, "Toxic, Metabolic and EMF Effects on EEG and the Brain."

Toxins All Around

Dr. Turner illustrated the longstanding, yet unrecognized, adverse effects of artificial environmental electromagnetic radiation (EMR) on all life, specifically human life, and the value that careful EEG review has in demonstrating external effects of environmental EMR. Exponentially increasing EMR exposure of humans worldwide is essentially unrecognized despite its pervasive, albeit invisible, presence throughout the world. Clues arise in careful review of the EEG data being collected every day by clinicians in our field. This EMR exposure consists of increasing use of wireless networks, cell phones and towers, etc. and is demonstrated from a multitude of publications over the past 60 years. Adverse effects are also seen on genetic and reproductive health and especially on the developing nervous system. The developing nervous system is more susceptible to EMR, and neurodevelopmental anomalies and seizures or epilepsy are increasingly associated with such exposures—both pre- and postnatally. They are also manifested throughout the lifespan as is being increasingly seen in mental ill-health disorders worldwide.

Turner recommended all providers of healthcare, including those of us in the neuroregulation or neuromodulation field follow the Precautionary Principle (*taking preventative action in the face of uncertain and/or conflicting scientific evidence*) given the substantial literature involving human or animal studies and worldwide deployment of wireless technology. Evidence exists that worldwide, pervasive, increasing EMR exposure results in progressive manifestation of seizures or epilepsy, disorders of the developing nervous system, sleep, and mental health disorders, as well as systemic disorders involving the cardiovascular and GI systems.

Dr. Pierce voiced similar concerns about the toxic environment in which we find ourselves immersed. He was joined by Jay Gunkelman in sharing anecdotes concerning the lack of protections offered by the regulatory process, and he further raised concerns with regulatory peer review citing a body of work by John Ioannidis. While encouraging referrals when alarming features in an EEG are observed, he emphasized that most indications of toxins or metabolic disorders in EEG are more subtle and not in a one-to-one correlation with specific insults due to biochemical individuality and underlying endophenotypes.

Pierce enumerated a plethora of environmental stressors such as chronic exposure to heavy metals, molds, industrial solvents, and agrichemicals. He pointed out unexpected sources of exposure, as well as the deleterious synergistic impact at the blood-brain barrier when chemical and EMR exposures are combined. The clinical implications are often observed as forms of insulin resistance, lectin intolerance, thyroid conditions, adrenal or sex hormone imbalances, inflammation and oxidative stress, alterations in methylation pathways, and anemias. He emphasized the utility of comprehensive history collection and lab testing as well as the efficacy of detoxification through supplementation and therapeutic diets.

Questions Directing a Course of Action

In the follow-up discussions, many echoed the need to form the same kinds of partnerships with functional medicine specialists as with medication prescribers. However, what differs with emerging concerns is that by their very definition, the clinical path forward for diagnosis and treatment is not well defined.

- How do we handle potential diagnostic findings in our qEEG recordings that are affecting the

brain and may be due to causative factors that are clearly not well defined (e.g., EMF exposure)? All too often, these findings and symptoms are medically dismissed by a client's general practitioner or specialist.
- How and to whom do we refer in such cases? What is the process of proper referral and tracking? Who coordinates overall care? When is it time for second opinions? How do we improve patient education beyond simple referrals?
- How do we resolve difference between patient goals and clinician priorities in EMF and toxic or environmental cases, where the problems may not be recognized as orthodox diagnoses or treatments, despite measurable contribution to EEG changes?
- How do we prioritize issues, symptoms, and mechanisms of injury when so much is unknown regarding continuing environmental threats to the patient?
- There is often no standard of care for environmental exposures despite recognizing their long-term impact on brain function. How do we approach the relative quality of evidence in our cases? How do we report these outcome measures in case study data?
- How do we relate EEG findings to symptoms or lab findings when they are stand-alone indicators of dysfunction? Can EEG findings be integrated into a comprehensive brain diagnosis that has room to include emerging environmental factors?

A New Normal for How the Body Keeps the Score

As environmental toxins exponentially accumulate, changes are happening in the landscape of disease that we appear to be accepting as "normal." Insidiously, this change is happening sufficiently slowly and invisibly that it is perceived to be unremarkable. Despite the concern for an impact on brain health being called out at this year's meeting of the American Neurological Association (Lakhani, 2022), traditional assessments and interventions remain insufficient to help our patients and clients identify causes and implement solutions to regain their health.

EEG practitioners are often on the front lines of working with persons suffering from an environmental exposure because the symptoms often have a mental health component such as depression, anxiety, or brain fog. While we come from a variety of disciplines to study brain dysregulation and promote healing, there is an overwhelming convergence in the stories we share about the health challenges of our clients and the studies we share with each other validating our observations (Ventriglio et al., 2021).

When van der Kolk (1994) first reminded us that the body keeps the score, his intention was to bring our attention to the ways that dysregulation lives on invisibly in the body after a trauma. We are waking up to the observation that that scoreboard also reflects a game played against the very air we breathe and water we drink. While knowledge of a trauma provided us with a therapeutic direction to try to even the score, our community is somewhat lost in the ability to offer recommendations to these new environmental threats. This is especially true in that most mental health clinicians have no training in the ability to recognize, or even screen for, underlying metabolic and toxic impacts on mental health. Even if we suspect an underlying issue, we find ourselves isolated from a network of providers with whom we might work to find the root cause. As a first step, we propose working more closely with the functional medicine community to develop standard screenings from which we might refer and coordinate care.

Standardized Intakes and a Model of Client Care

It is important for the neurofeedback community to create a standard system for screening the most common physical issues that need to be addressed as a referral, prior to neurofeedback treatment. For example, most experienced practitioners understand to refer out a client with untreated thyroid issues, sleep apnea, mold poisoning, toxic exposure, or inflammation due to undiagnosed causes prior to beginning neurofeedback. Yet, this knowledge is not part of our standardized training, and what constitutes a thorough clinical and medical history widely varies. It is also useful for greater training on physical symptoms and health issues to probe when a particular EEG pattern is observed, such as low power EEG indicating toxic or metabolic issues and beta spindling possibly indicating inflammation.

This system of intake and screening should be supported by models of client care that include what types of medical professionals to refer to for various physical issues and the proper process for initiating these referrals. This intake should include chronological health histories, developmental milestones, review of organ systems, metabolic symptom questionnaires, and questions related to infections and potential toxic exposures. Such a model should address when and how to obtain second opinions or consultation for routine laboratory assessments and who is responsible for

overseeing this process to facilitate the highest quality of care.

The resulting system needs to be easy and supportive for clients. Already, new clients are subjected to an increasing number of questions and assessment forms to become established at a practice. Complicated histories place a burden on the client's capacity to express the most urgent priorities in an uncomplicated form. Since the outbreak of the COVID-19 pandemic, and with the growing impact of environmental toxins, patients are presenting with more complex symptoms and histories. Many patients are already feeling lost and unsupported by healthcare practitioners.

Clients who are already overwhelmed may also find it difficult to prioritize the order of potential environmental threats to eliminate or the order in which to pursue health interventions. Expectations should be set so that they understand that attempts to address their symptoms may require a degree of trial and error. An effective model of care might offer a decision tree with suggested priorities so that the interventions most likely to yield success are tried first.

Finally, there is a pressing need to develop and institute pertinent education for clients to help them understand the symptoms associated with various medical issues and the appropriate process to follow in navigating their care. While education already exists regarding conventional health practices, such as diet and exercise and the effects of recreational drug use that are foundational to good neurofeedback treatment outcomes, there is also a huge amount of conflicting information that causes confusion and limits compliance. Unambiguous, authoritative, age-appropriate, and readily available education modules might be developed by experts in relevant disciplines within our community and made available through professional organizations.

The Standard of Care: Partnerships With Complementary and Alternative Medicine

Standards of care in both physical medicine and in mental health practice lie at the nexus between state regulatory boards and professional association consensus statements. A growing demand for science-based and brain-based measures of mental health and brain tissue physiology is placing pressure on private therapists to integrate complementary and alternative medicine (CAM) reports and methods into their care. Some of these methods are within their scope of practice and some of them are outside their scope, requiring interdisciplinary communication and integration with multiple disciplines. A basic science understanding of these mechanisms is demanded by patient populations and families, and communication skills across disciplines are required more and more. Political forces and captured regulatory agencies add more complexity to the pressures on mental health clinicians as they serve patients and seek root causes. Many of the modes of physiologic and metabolic brain investigation are science-based but have not yet developed validation, yet clients seek them with great interest, and some doctors discharge patients for the infraction of using CAM services. As clinical science marches forward, there is a structural gap that will always exist between early development and validation of methods, within which lie both risky and unproven methods and at the same time contain what will become known as some of the safest, most sustainable, and effective methods ever discovered. A balanced approach to this unknown gap is required without either discarding promising methods or accepting methods without critical thinking. New clinical ideas must be given a clinical chance to blossom and financial perverse incentives must be transparent while these studies are produced.

Since normal brain function depends on normal neuronal metabolism, which is related to systemic homeostasis of metabolites, such as glucose, electrolytes, amino acids, and ammonia (Lin, 2005) we recommend a more comprehensive laboratory panel which may include CBC, comprehensive metabolic panel, fasting glucose, HbA1C, iron, ferritin, TIBC, B12, MMA, folate, homocysteine, CRP, fibrinogen, magnesium, thyroid panel, TGF-1, heavy metal panels (serum and urine), and other infectious and/or autoimmune markers that are relevant for each patient. If a healthcare provider does not have the scope of practice to order laboratory tests, it is recommended that they should collaborate with a health professional who can provide these services.

Growing Community Prestige Through Research

Ron Swatzyna and Mark Jones discussed ways to increase research on neurofeedback by gathering data from clinician's private practices and collaborating in sharing data in ways that create substantial multisite analyses. Swatzyna described ways he has amassed a large database of patients through his own practice, including EEG analysis and biomarkers, medications, and diagnoses. He has published on Pharmaco-EEG topics and

continues to promote research through an institutional review board (IRB) he helped create (through the local Sigma Xi chapter at Rice University and the Texas Medical Center). Jones shared his vision as the current president of the International Society for NeuroRegulation and Research (ISNR) for “the R in ISNR,” a collaborative citizen-science approach to sharing data from across multiple practices and agencies to create an open-source database in which participants can upload their respective data sets and do analysis via queries of the online database, possibly housed at the university where he teaches. Swatzyna and Jones facilitated discussion on the various nuances of research designs, IRB requirements, and eventually establishing standardized assessments and protocols related to specific syndromes to facilitate robust statistical analysis.

Generating further research will significantly contribute to our understanding of mental health disorders, and the unfolding understanding of individualized neurobiomarkers is key to improving pharmacotherapy outcomes. Ron Swatzyna stressed the need and benefits of partnering with editors that are versed in qEEG and neurofeedback and who are open to cross-publishing in journals such as the *World Psychiatry Journal* such that both communities are being exposed to cross-cutting discoveries.

While many participants expressed a desire to become involved with research, many expressed a sense of being overwhelmed by how to get started. Ours is a heterogeneous community, and just as our backgrounds and licenses differ, so do our experiences participating in research. Many participants have never designed an experiment, performed (or evaluated) a statistical analysis, or published research. As with many of the other themes above, many expressed a desire for additional educational opportunities.

History of the Suisun Summit

The Suisun Summit was born out of two events that took place in 2019. The first was the "Back to Basics" workshop that was held in Suisun at the Hampton Inn from Feb 6–10, 2019, featuring Jay Gunkelman’s teachings on reading and interpreting the raw EEG. In the summer of 2018, it had become apparent that Jay’s health would no longer allow him to travel to professional meetings. Mary Tracy and Brian Judd suggested to Jay that a conference be organized near his home, and he was thrilled to accept the offer. They invited 20 people who were interested in the visual interpretation of the EEG with higher order processing using WinEEG. Tracy sincerely wanted people to begin hearing Gunkelman teach in person at the most fundamental level. She believed that the international EEG community would benefit from refocusing on the interpretation of the raw EEG instead of relying on brain mapping alone to tell the story. Linda Walker and Gunkelman co-taught this 5-day event. This very successful workshop spawned another workshop, Onto Innovations, at the same location in October of 2019, which Cindy Reynolds and Candia Smith facilitated. Other presenters at this meeting included our dear, late friend Harry Kerasidis, as well as Michael Villanueva and his colleague Clement Lee.

Another colleague who we lost in July of 2021, Joe Castellano, attended this second event and took the name to begin the online Onto Innovations Study Group. The group received Gunkelman's BSI (Brain Science International) collection of papers and talks, which, in addition to the classic textbook, *Niedermeyer’s Encephalography*, became the basis for biweekly meetings (Schomer & da Silva, 2011). Topics evolved to include content beyond these resources, but with a continued focus on the intersection between neuroscience and mental health. Membership required making a good faith effort to attend as many sessions as possible to support presentations by one’s colleagues, but also that members commit to making their own presentation to the group annually. Group members felt the loss of Castellano deeply and are grateful to Dave Siever and Mary Tracy for picking up the reins to keep the group moving forward.

The Suisun Summit was originally intended to be an opportunity for members of the Onto Innovations Study Group, who had grown close through their biweekly online meetings during the pandemic, to finally meet without a computer screen between them. Word of mouth grew such that the number of participants soon hit the limit of the seating capacity of the largest event venue in Suisun City.

A delightful and comradery-building aspect of this meeting was that there were opportunities to get to know colleagues through their artistic gifts. Participants enjoys musical offerings by Dave Siever, Rusty Turner, Tony Jackson, and Rebekah Walker.

The Suisun Summit will take place again in 2023. While the number of in-person attendees must

remained capped at 70, the new planning committee will arrange to livestream the event.

Conclusion

Several themes emerged in talks directly or in discussion groups at the Suisun Summit 2022: qEEG Reading Skills; Medication Effects and Pharmaco-EEG; Technological Advancement; Emerging Concerns; and Growing Community Prestige Through Research. Participants were asked to summarize what they believed to be the most important messages from the event to share with colleagues who were not in attendance, resulting in this review. Cross-cutting all the themes was a desire for higher quality, standardized education that provides depth as well as breadth, and models for clinical care that provided closer relationships between qEEG analysts, medication prescribers, and functional medicine specialists.

We are uniquely poised as a profession of qEEG analysts to offer services to the public that are not available with any other medical or nonmedical practitioner. For example, our ability to identify and locate isolated interictal discharges in the brain during routine EEG screening for seemingly unrelated presenting issues allows us to make referrals to neurologists or epileptologists for proper medical diagnosis and perhaps medication management. Indeed, the biomarkers and EEG features that are correlated with numerous physical (e.g., cerebral ischemia, traumatic brain injury [TBI], stroke, etc.) and neuropsychiatric (e.g., migraine headaches, ADHD, affective dysregulation, ASD, etc.) problems are routinely identified in our processing of the EEG and we can develop training protocols or neuromodulatory treatment to address these symptoms.

In many ways, our dependence on maps and their automated interpretation have already taken away much of our power as clinicians, leaving us in the role of technicians when it comes to the potential power of qEEG in our practices (see addendum “Neidermeyer’s Lament.”). Future developments in the application of AI algorithms which can correlate EEG and qEEG patterns, symptom questionnaires and laboratory biomarkers have the potential of becoming a more sensitive and specific method for identifying these disorders. Yet as clinicians, we need a greater degree of standardized training to possess knowledge of these indicators for ourselves, to verify and corroborate the findings.

United in our respect across the professions and our sense of comradery, achieving our common goal of restoring and promoting brain health, we call upon each other and our professional organizations to inspire the development of higher quality standardized education in qEEG reading skills, the development of an authoritative compendium of clinical correlates for mental health and emerging concerns, and models for clinical care that provided closer relationships to prescribers and functional medicine specialists.

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Addendum A

Niedermeyer's Lament: Toward a Fundamental Understanding of the EEG

A Note on the Examination of Contemporary Practices of EEG Acquisition, Processing, and the Neuropsychiatric Interpretation of Brain Activity

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"*A certain malaise has inched its way into the hearts of thousands of electroencephalographers who have started to feel the grip of stagnation … the feeling of doing pragmatically useful work with an ill-understood method has been depressing to many workers in the field ... A more real danger, perhaps, is presented by the poorly trained colleagues who are tarnishing the image of EEG ... In these times of challenge, a review of the state-of-affairs in EEG seems to be appropriate."* Ernst Niedermeyer, Spring, 1981.

Ernst Niedermeyer wrote these words in a preface to his tome on the basic principles, clinical applications, and related fields of electroencephalography. Although written in 1981, these excerpts from *Niedermeyer's Electroencephalography* are as fresh and salient to our current state of affairs in EEG as they were in the era that he composed them. Today, rapidly expanding technological advances and automated algorithms for higher order statistical processing of EEG, along with the easily produced, spectacular neuroimaging displays are replacing the considerations of the raw EEG that are at the basis of these transformations. Well-intentioned students and professionals who are excited about the prospects of a career in EEG assessment and neurofeedback are becoming fully armed with EEG software platforms that promise an easy solution to the detection of dysregulation in the brain, replacing the otherwise difficult and tedious undertaking of a basic education in electroencephalographic principles. There is a clear danger in putting this technology into the hands of licensed clinicians and researchers who are undereducated in the identification of meaningful electroencephalographic features and the functional association of raw EEG findings to psychiatric and behavioral symptoms. Intelligent and curious students who expect that higher-order software programs for EEG processing alone will rescue them from the arduous task of truly understanding how to both detect and interpret basic EEG morphology and features will become quickly disillusioned when they realize that they do not know how to interpret the results, no matter how spectacular the displays.

To further complicate this picture, the market is being flooded with low-cost gadgetry that claims to reliably record EEG and facilitate neurofeedback training without any user access to the specifications, quality, or reliability of these devices. The global connected health and wellness devices market was estimated to be $123.2 billion in 2015 and is expected to reach $612.0 billion by 2024 (Byrom et al., 2018). Especially in this time of global pandemic, neurofeedback practitioners are desperate to employ remote training using inexpensive EEG technology that has not been rigorously tested or undergone clinical trials. There exists a large gap, some would say a veritable chasm, between classically trained electroencephalographers and contemporary consumers of novel EEG systems who have little understanding or appreciation of the origin, meaning, and functional significance of the EEG. Even medically trained neurologists, who typically have about 6 months of training in EEG interpretation, generally use visual examination of the EEG solely for the identification of epileptic features. Epileptologists and electroencephalographers have at least 1.5 years of specialized training in the identification of abnormal features in the EEG as they pertain to seizure disorders, but, like neurologists, they are unlikely to refer patients to neurofeedback specialists as there is little understanding in the medical community of the benefit of neurofeedback for training cortical networks in epileptic disorders. In fact, there is a vast literature on both the analysis of raw EEG and the neuropsychiatric correlates of EEG phenomena, as well as the clinical application to neurofeedback and neuromodulatory training that is still virtually unknown in the medical establishment.

A part of Niedermeyer's lament about the underutilization of EEG addressed the phenomenal "progress of the new methods of structural diagnosis." EEG has been relegated to an antiquated status as more expensive imaging methods like MRI, CT, PET, and SPECT scans took precedence in the medical analysis of brain health beginning in 1977. The problem with this is that imaging methods reveal structural detail in the brain *but have no bearing on functional relationships of brain networks*, which can be beautifully elucidated with EEG analysis with good temporal resolution. This leaves the EEG, which is a superior tool in describing the functional significance of psychiatric symptoms, to an underutilized realm that is poorly understood by the practitioners who could benefit from it the most.

Indeed, there is no real occupational classification for the individual who has mastered traditional electroencephalographic assessment as it applies to the interpretation of functional localization of patient symptoms and behaviors in the brain. They are not “neurophysiologists,” nor “psychophysiologists.” Neither are they purely electroencephalographers. A more precise terminology for the work and skill base of the EEG technician who interprets psychiatric symptoms with a fundamental understanding of the EEG would be “neuropsychiatric or neuropsychological electroencephalographer” (personal communication, Jay Gunkelman August 2020). This occupational classification, used in a professional context, has yet to be introduced to those who practice EEG interpretation or who use EEG as a foundation for developing neurofeedback and neuromodulatory protocols for optimizing brain function.

The purpose of this note is to bring attention to the “pragmatically useful work” of raw EEG interpretation as a foundational and practical platform for examining the validity and application of modern EEG technology to the clinical interpretation of neurological and psychiatric phenomena. It is time to explore the possibility of introducing and training individuals in the extended neuroscience community in the occupation of “neuropsychiatric electroencephalography,” beginning with a rigorous educational foundation in the instrumentation and electronics that support EEG recordings, as well as raw EEG interpretation. Without this foundation, the necessary tools for the interpretation of the research and clinical literature in the field are questionable, and the meaning derived from such explorations will only further muddy the waters of this “pragmatically useful work.”

Addendum B

Abstracts - Suisun Summit 2022

Suisun Summit 2022, October 12–16, Suisun, California

Expect the Unexpected: Epilepsy and the Foundation of Neurofeedback

Jay Gunkelman

In the beginning of the field of neurofeedback (NF) there were those doing “state-based” EEG training like Joe Kamiya and Elmer Green, and those doing “clinical” work with epilepsy associated largely with Barry Sterman or Nils Birbaumer. ADHD and other applications came later, but the scientific proof level work in epilepsy was quite impressive even in the mid-1970s.

I would dare to suggest that despite the efficacy proofs, the bulk of the NF practitioners today do not work with epilepsy as a primary indication for clinical work—at least not knowingly. However, approximately 25% of those with ADHD and from 60% of those with ASD have “unexpected” epileptiform discharges or paroxysms, meaning there are clients with these patterns who need our help. There are many thousands of clients with intractable epilepsy and thousands more with unexpected epileptiform discharges.

A recent series of severe intractable epileptic cases will be used to illustrate the life-changing nature of applying NF to these cases. Very current publications on the efficacy of treating psychiatric clients who have epileptiform activity, but no seizure history will be shared, as will publications challenging the standard of practice in psychiatry in treating these clients without reviewing the EEG.

A plea from a mother whose daughter was successfully treated for intractable epilepsy asking the field to provide access to far more practitioners who are willing to accept these cases will be shared.

Support for Clinicians to Design Research Projects and Gather Data in Their Private Practices

Moderators: *Ron Swatzyna and Mark Jones*

Clinical research is valuable and necessary. Innovative therapeutic approaches need proof of concept studies which are vital for our field to grow. However, there is a dearth of case studies and clinical research in general, despite noteworthy findings. This presentation lays the groundwork for making your center a clinical research facility. We start with explaining how to collect and categorize data, writing and publishing case studies, building a research team, securing an institution review board (IRB) approval, data mining, and publishing clinical research. The “old guard” is graying so now is the time to highlight your work, publish your findings, and help our field grow.

Medications and EEG Correlates

Moderator: *Angelika Sadar*
Panel: *Ron Swatzyna, Jay Gunkelman, and Robert ‘Rusty’ Turner*

It is not uncommon that a person seeking an EEG is taking one or more prescribed medications, and maybe taking various nonprescribed substances (including vitamins, supplements, and self-prescribed) as well. For the purposes of this discussion, we will refer to all natural and unnatural products that affect the EEG as substances. As practitioners, we are faced with discussing how substances may affect the EEG, but we may not be licensed to make recommendations. Following the data acquisition, we are faced with discussing the impact of the substances on the readings obtained. Then, we are faced with considering how the ensuing neurofeedback (and other interventions) may impact the effect of the substances. With the knowledge of our panel of experts who can address the impact of substances on the EEG, we will discuss the broader topics related to best practices for working with patients who are utilizing substances of any kind.

Art of Dimension

Michael Villanueva and Peter Gast

In this joint presentation, Michael (Clinical Psychologist) and Peter (EEG researcher/programmer), distill a fundamental "takeaway" from their 7-year-long corroboration while sharing the resulting new analytic tools. Peter

will discuss the relationship between dimension reduction and data analysis. Criticizing the widespread overreliance on power spectral density analysis, he will propose two alternative analyses designed to overcome its limitations. The first method, called the peak-power frequency ribbon analysis, is a spectrogram sorted by instantaneous frequencies. The ribbon analysis reveals a low-dimensional representation of stationary power distribution in the time domain. The second method designed to test pre–post EEG data is called the d-Matrix. The d-Matrix implements Cohen's *d* obtained from before–after comparisons visualized in a channel-by-frequency matrix. Starting with the ribbon analysis, Michael will demonstrate how sorting by frequencies gives the clinician a radically different temporal visualization into fluctuations of the alpha band and their relationship to clients' symptomatology. Next, he will compare pre–post EEG data using WinEEG software and then use the same data to demonstrate the d-Matrix (within an EEGLAB environment). Neurofeedback practitioners seek to alter specific frequency ranges by channel location; thus, significance (*p* value) is the least relevant, while effect size is the most pertinent to the client. The d-Matrix provides a beautiful spatial overview of cortical power levels, giving a unique window into the hitherto unseen effects engendered by neurofeedback. In sum, our proposed methods can facilitate an efficient, statistically rigorous neurofeedback clinical practice.

EMR: The Most Unrecognized Influence on EEG

Rusty Turner

The premise for this presentation will be mechanistic, focusing on documented problems related to wireless communications radiation and HEV-blue light from screens, with EEG and qEEG data presented:

(1) cause morphologic changes in erythrocytes including echinocyte and rouleaux formation that can contribute to hypercoagulation
(2) impair microcirculation and reduce erythrocyte and hemoglobin levels exacerbating hypoxia
(3) amplify immune system dysfunction, including immunosuppression, autoimmunity, and hyperinflammation
(4) increase cellular oxidative stress and the production of free radicals resulting in vascular injury and organ damage
(5) increase intracellular Ca2+ essential for viral entry, replication, and release, in addition to promoting proinflammatory pathways; and
(6) worsen neurologic and developmental disorders, heart arrhythmias and cardiac disorders.

Pharmaco-EEG and Phenotypes: The Interface Between Neurology, Psychiatry and Neuromodulation

Ron Swatzyna and Jay Gunkelman

No Abstract Available

Physiology and Clinical Application of Audio-Visual Entrainment Technology

Dave Siever

Since the discovery of photic driving by Adrian and Matthews in 1934, much has been discovered about the benefits of brainwave entrainment (BWE) or audio-visual entrainment (AVE), as it is commonly known today. The brain responds extremely well to stimulation. However, the concept of AVE implies a frequency-following response, where the frequency of the brain synchronizes to the frequency of stimulation. While this is true, frequency-following is the least of what AVE is about.

AVE increases cerebral blood flow, stimulates beneficial neurotransmitters, has profound calming effects on the mind and body, induces a calming meditative mind state, is very effective for teaching heart rate variability (HRV) in highly anxious persons who fail HRV biofeedback training, increases brain lactate and ATP, triggers protective heat-shock protein, excites microglia, improves neuronal efficiency, and excites noninflammatory cytokines, which, in turn, promote microglial phagocytic states, such as IL-6 and IL-4, and increased expression of microglial chemokines, such as M-CSF and MIG.

There have been dozens of AVE devices marketed over the decades, but most do not consider scientifically derived stimulation methods and frequencies used. As a result, AVE has, to some degree, fallen into a New Age type of category. The truth of it is that AVE has strong empirical evidence as to its efficacy in physiological effects and clinical applications.

Research on the effectiveness of AVE in promoting relaxation, cognition, and hypnotic induction, treating ADD, PMS, SAD, PTSD, migraine headache, chronic pain, anxiety, depression, episodic memory, cognitive decline in seniors, and potential for treating early-onset Alzheimer's disease is now available. Recent discoveries have shown AVE to be a powerful means of recovery from traumatic brain injuries (TBI) of a newly identified type, termed thalamocortical disconnect (TCD). The TCD type of TBI is quite common and characterized by general anxiety, obsessive-compulsiveness, and severe insomnia.

Machine Learning Algorithms for the Identification of Signals in the Noise

Rogene Eichler West

Classifying collections of EEG subtypes, such as phenotypes, or identifying particular waveforms, such as a spike and wave, are typically performed visually by an expert. In some research endeavors, it is not clear what characteristics are the most important to look for when labeling each dataset as belonging to a particular clinical group. In situations such as long-term monitoring, it is tedious for a neurologist to observe the data in real time to catch an elusive marker, and therefore this manual process is prone to error. In both of these scenarios, it would be useful to have a software tool perform with similar levels of sensitivity and specificity as an expert. Machine learning approaches on EEG data are beginning to meet this performance criteria. In this talk, the underlying principles behind machine learning algorithms will be presented. Concepts to be explored include supervised versus unsupervised learning; gradient descent and clustering; underfitting and overfitting; evaluating performance; and dealing with small datasets. The goal of this talk is to familiarize clinical professionals with machine learning concepts that they may encounter in the literature, so that they might have confidence when interpreting the conclusions of such studies**.**

Toxic, Metabolic and EMF Effects on EEG and the Brain

Michael Pierce

This 45-min discussion is a brief survey of the known brainwave changes seen in toxicity, metabolic disorders, and EMF studies with correlation to common exposures. While there is not generally a one-to-one correlation from specific brainwaves or paroxysms to discrete exposures, there are common or global patterns that emerge across a broad range of chemical and electrical exposures, and EMF exposures facilitate barrier disruptions and transfer of metals. Regional brain tissue metabolic vulnerabilities to substances and hypoxia are also surveyed. Significant brainwave findings indicate clinical and lab correlations for specific diagnostic follow up. Discussion of typical cases and citations are included.

Pediatrics and Developmental Trauma in the Brain

Tiff Thompson

No Abstract Available

Vision of New Decade: Building a Digital Mental Health Care Platform With qEEG Brain Mapping and Neuromodulation

Seung Wan Kan and Daekeun Kim

In the last three decades, neurofeedback has evolved from experience-based to quantitative EEG (qEEG)-guided practices that have been applied to various neuropsychiatric disorders. Despite their potential values, neither neurofeedback nor qEEG brain mapping are recognized by conventional medical specialists as legitimate methods for functionally analyzing the brain. During the recent COVID pandemic period, digital healthcare and digital therapeutics attracted attention, especially for mental health purposes. iMediSync Inc. has the vision of contributing to global mental health care and wellness and the evolution of human consciousness using integrative AI mental health care platform services. We have developed four innovative solutions in the qEEG and neuromodulation areas.

First, iMediSync has developed the only sex- and age-matched qEEG normative DB which was initiated at Seoul National University in 2012. Sex differences can affect EEG variance according to development and aging, but there has been no qEEG normative DB differentiating biological sex before iSyncBrain.

Second, there has been a barrier for clinical practitioners to apply qEEG to ordinary practice, as most conventional qEEG analysis software requires manual processing, which takes time and requires experience and knowledge. So, we developed iSyncBrain, a user-friendly, AI-powered, automated EEG signal processing system using SaaS (software as a service).

Third, to expand the application of qEEG to more than functional brain mapping and endophenotyping, and to identify qEEG features as digital biomarkers for the diagnosis of specific mental disorders, we developed qEEG-specialized AI/ML technology and created a qEEG-based algorithm for differential detection of either Alzheimer-induced or non-Alzheimer-induced amnestic mild cognitive impairment (aMCI) from normal aging.

Fourth, brainwave measurement with conventional wet-type EEG sensor systems is not user-friendly and EEG acquisitions cannot easily be accomplished in real-world situations such as school, sports, or military camps. We developed iSyncWave, a wireless, wearable EEG helmet with 19 dry sensors and NIR-LED stimulators, which can both measure EEG and provide neuromodulation. It demonstrates high signal quality and interconnects with the iSyncBrain software platform.

By integrating these four core technologies, iMediSync is opening a new era of qEEG-centered digital mental health care platforms which will support data-driven mental care services either online or offline.

PTSD Biomarkers with ERP and EEG

Jay Gunkelman

Trauma leaves a lasting “mark” in the brain’s function, whether from developmental issues with attachment or changes later in life. This talk will show the relationship between the ERP and EEG findings seen in trauma, with a special focus on the eyes-open and closed EEG features involved. A discussion of the underlying mechanisms for these findings will be presented.

The Suisun Summit 2022: Emerging Themes and Open Questions in qEEG and Neurotherapies

Moderator: *Rogene Eichler West*

The purpose of this session is to organize interested participants towards the co-authorship of a journal article summarizing the themes and questions covered during the summit. We will begin by whiteboarding the most important topics to include. We will then break into small groups to add details to particular sections. We will then come together as a group again to determine homework assignments and deadlines for submitting a final production. We will aim for submission to the journal *NeuroRegulation*. Authorship requires submitting two to three paragraphs towards the completed document. If you have never published before, get your first publication credit just for writing up what you learned this week with your friends.