Brainwave Connections

Dedicated to communication and education in the emerging fields of neurofeedback, mental fitness, and brain modification

VOLUME 2, ISSUE 3 Summer 2006

SETH CHWAST, ARTIST AND PIONEER

Seth Chwast, who was diagnosed with autism as a very young child, lived for years in an internal world of roller coasters, haunted houses, and classical music. At age 20, Seth's mother was advised that Seth's best chance at meaningful work would be mopping and cleaning floors.

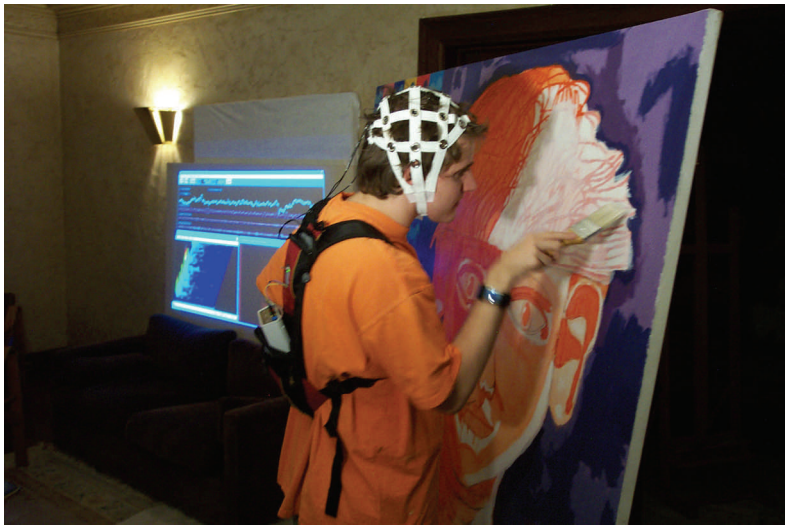
Not willing to accept that assessment of her son's future, Debra Chwast looked for alternatives. A dramatic change occurred when Seth took an oil painting class at the Cleveland Museum of Art. Seth, who rarely speaks, began describing his world in paint. It turned out that he had an innate ability to mix colors and create amazing large scale oil paintings.

Self-study portraits are now one of his recurring subjects, along with spectacular landscapes of aurora skies, mysterious forests, and horses. His work has been appreciated by collectors and recognized by art experts. Perhaps more importantly, painting has opened up a world of communication for Seth, and meaningful work as a committed artist. As part of Seth's exhibit and discussion at the 2006 Cleveland Ingenuity Festival, Tom Collura, of BrainMaster Technologies, Inc. collaborated to record Seth's brainwaves while painting, using wireless EEG technology.

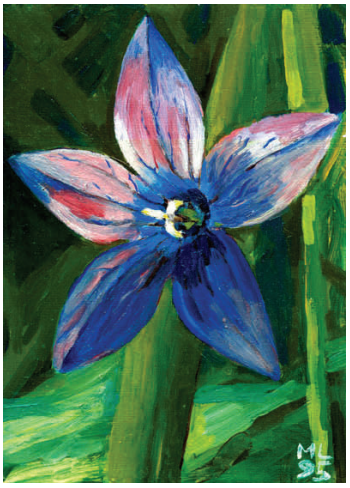
During the recording session, Seth observed his own EEG for over 2 hours, and became absorbed in his own brain activity. As this stimulated his creativity, he recited the phrase "grow your brain" as he worked on a new self-portrait.

Ingenuity attendees were able to see Seth's brainwaves in real-time and learn about Seth's astonishing ability to enter the creative zone. The discussion group included Dr. Collura and artists, producers, educators, and clinicians discussing the importance of understanding autism, and fostering creativity and acceptance of those we may inclined to think of as "outsiders."

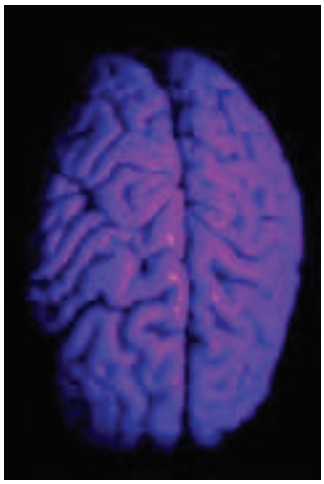
ALSO IN THIS ISSUE:



Seth Chwast "grows his brain" while combining EEG biofeedback with artistic expression



Coherence and Brain Connectivity—Their meaning and implications for neurofeedback



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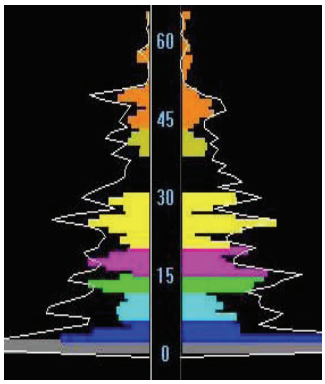


As the field of neurofeedback evolves, we define and apply new metrics that have value in understanding as well as training the brain. No topic has garnered more interest or controversy than that of coherence training. Coherence addresses the connectivity in the brain, not just the tone or level of excitation. It reflects the content of the messages in a manner that amplitude training cannot.

Classical or "pure" coherence reflects the stability of the timing between two brain sites. If the EEG peaks and valleys have a constant phase separation, they will have a high coherence. This reflects the amount of information shared between the sites.

Phase measures the actual separation between two sites. It reflects the speed of information transfer between the sites, or between the two sites and other "third party" sites. For example, the left and right occipital cortices communicate with sensory thalamic nuclei including the lateral geniculate nucleus and the superior colliculus. As a result of symmetrical thalamocortical reverberations, the occipital lobes often exhibit synchronous (symmetrical) bilateral alpha waves. So although the left and right occipital lobes do not communicate directly with each other, they share a common connection that still serves to bring them into synchrony.

Why is connectivity training important? Because it reflects the relative amount of processing that the brain is devoting to particular activities, in contrast to others. For example, if the thalamus is engaged in a reverberation with the cortex, then other mechanisms having to do with recall, processing, and other internalized operations are limited. Similarly, coherence is relevant to language, planning, and other higher brain activities. It is also of value in cases of injury or trauma, in which brain connectivity is compromised.

In addition to "pure" coherence, other metrics are of value in assessing and training brain connectivity.

The BrainMaster system includes a "similarity" metric that is related to coherence, but is sensitive to the actual phase separation of the signals, as well as to their relative size. This metric is maximized when the signals are lined up in phase, and are of similar size, and has particular value for "synchrony" training.

Another such measure is the Spectral Correlation Coefficient (SCC) implemented by David Joffe in Lexicor's BioLex software. This reflects how similar two signals are in their spectral energy signature. In other words, if in a particular frequency band, the energy distributions in the Fast Fourier Transform (FFT) have similar shape, then the SCC will be large. This was developed as a convenient way to assess how similar two signals are, without regard to their phase relationship or timing. It only looks at how they are similar in terms of the "bars" in the FFT amplitude spectrum.

Another related measure is the "comodulation" originally defined by Drs. Barry Sterman and David Kaiser, implemented in their SKIL software. This looks at a particular frequency band, and watches how the amplitudes of the energy in each band vary over time, in comparison to each other. Simply put, if the signals wax and wane together, they will have a high comodulation. Like SCC, comodulation does not look at the relative timing (phase) of the signals themselves at all, it only looks at the amplitudes of the signals.

Both SCC and comodulation have been found of clinical and research value, in that they provide important indicators of brain functioning in a variety of scenarios. For example. Dr. Kirtley Thornton has studied and trained the SCC metric in children with learning disabilities, and has created a database of normative data as well as a set of protocols useful for neurofeedback training.

David Kaiser has noted that brain connectivity has a "Goldilocks" aspect. It can be too high, or too low in any given pair of sites. Connectivity training is thus oriented toward getting connectivity "just right," hence optimized.

The Neuro-relaxation Paradigm

At its most basic level, EEG biofeedback is derived from methods that we generically describe as "relaxation" training. This is the strict definition recognized by the FDA in its labeling requirements for EEG feedback systems, and constitutes the primary claim available to providers of such equipment.

Historically, there is also a tendency to consider this as "just" relaxation training, as if it were a generic technique without specific value. I recall being told by a neurologist, when I presented the possibility of EEG training for epilepsy, that "no, it's been shown that this just produces generalized relaxation, and really isn't useful."

However, it has become clear that neurofeedback is far more than a simple way to learn to relax. Rather, it has specific effects on the brain, and can achieve much more than simple relaxation would suggest.

Thanks largely to the work of Dr. Barry Sterman, we understand that the generation of brain rhythms is a phenomenon that involves complex thalamocortical interactions, and engages whole brain mechanisms. For example, the production of the sensorimotor rhythm (SMR) is accompanied not only by relative stillness of the body, but also by the "intention not to move." This means that the nervous system is not simply keeping the body still, but that deeper brain/mind mechanisms associated with intention and planning are also being trained.

Owing to its unique access to the central nervous system, neurofeedback entails systemic regulation at the deepest level. This includes unconscious, autonomic, and related integrated somatic processes which can be re-educated and reorganized through EEG operant conditioning.

When we consider this, the value of SMR training is deepened. We are actually accessing a variable that not only reflects the current state of the body, but that actually connects with the trainee's internal state. No other technique has this component working with the deepest intentions of the mind, in a quantitative and well-defined manner.

When relaxation training occurs at the level of individual neurons and individual brain structures, the possibilities are endless. The brain contains its own drug factories and control mechanisms, and is integrated with the body at the deepest levels. Neurofeedback allows us to work with these systems in terms of their interactions, in a dynamic and profound manner.

It has been documented that neurofeedback training has measurable clinical benefits working with disorders including seizures, depression, learning disabilities and attention deficits. If neurofeedback were "mere" relaxation training, these findings would not be possible, and the potential of EEG feedback would be considerably more limited than we know it to be.

Could it be that brain disregulation is at the core of a wide range problems including ADD, insomnia, headaches, and chronic pain? Are these "mere" signs that the brain/body is starved for internal regulation and stability at a root level? If so, then neurofeedback is far more than "mere" relaxation, and the future is far brighter than we have even imagined.

When relaxation training occurs at the level of individual neurons and individual brain structures, the possibilities are endless.

Dr, Thomas F. Collura is a biomedical engineer, neurophysiologist, and educator. He has over 30 years professional experience in the areas of EEG, evoked potentials, brain mapping for epilepsy, computer systems, and neurofeedback. He has held senior staff and faculty positions with AT&T Bell Laboratories, the Cleveland Clinic, and Case Western Reserve University. He received undergraduate degrees in philosophy and biology from Brown University, and the Ph.D. in biomedical engineering from Case Western Reserve University.

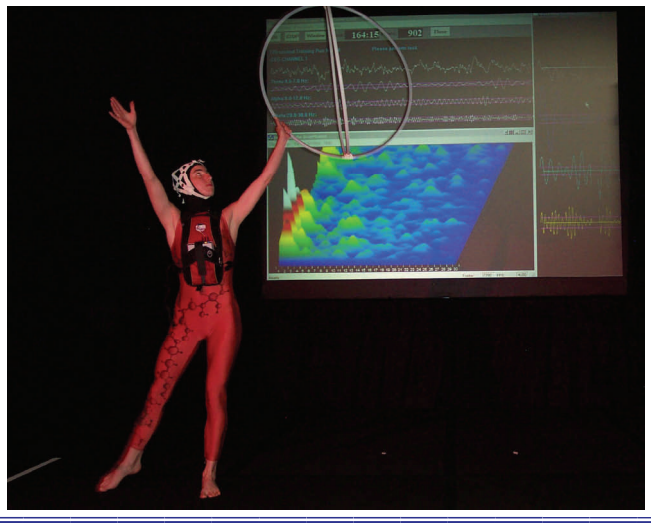
MorrisonDance and BrainMaster perform "Inside" at The Cleveland Clinic Bakken Heart/Brain Institute

Sarah Morrison of MorrisonDance and Tom Collura of BrainMaster Technologies, Inc. collaborated recently in the second public performance of Morrison's composition "INSIDE (Molecular Bodies Within)," using BrainMaster's new "Freedom" wireless EEG neurofeedback technology. This was an updated excerpt of the similar performance that was presented last year as part of the "Ingenuity Cleveland 2005" science/art festival.

This latest performance was presented at the 2006 Heart/Brain Summit at the Earl and Doris Bakken Heart/Brain Institute of the Cleveland Clinic. Performed at the HealthSpace Museum on June 16, 2006, the performance combined Morrison's original dance choreography with live EEG waveforms and graphics projected behind her. This reception and performance was combined with the presentation of a Lifetime Achievement Award to Dr. Earl Bakken, founder of Medtronic. Dr. Paul Pearsall, a psychoneuroimmunologist from the University of Hawaii, also presented a talk on "Contextual Cardiology," which was accompanied by an interpretive Hula dance conveying the connection between the heart, brain, and health. 225 physicians, researchers, and health-care leaders were in attendance at the event.

Dr. Collura introduced the performance by explaining the technology and the interpretation of the live real-time EEG displays. These were visible on a giant rear-projection screen while Ms. Morrison was still backstage. Morrison then came onstage, showed the live nature of the brainwave recordings, and demonstrated voluntary control over her internal brain state via neurofeedback.

The Freedom wireless EEG system provides a range of over 100 feet and easily penetrates objects and walls, giving Morrison exceptional freedom and flexibility in her artistic performance.



This new adaptation of INSIDE included new dance moves including gymnastic maneuvers and even a headstand, as part of the updated choreography.

Morrison also participated in live demonstrations during the pre-dinner activities, showing that her awareness and control of brain states contribute to her artistic composure and expression. Neurofeedback provides a two-way street, in which the audience appreciates the internal brain states of the performer, while the performer enjoys the benefits of neurofeedback for peak performance and creativity. Morrison's EEG showed that she was able to remain "in the zone" during the demonstrations, which yielded both interesting and engaging EEG displays, and enhanced the quality of the performance.

BrainMaster and MorrisonDance plan to continue their collaboration fusing art and science, in the pursuit of new ways of approaching the brain, mind, heart, and the "dancer within." Future projects will include EKG monitoring, heart-rate variability, and additional modalities, as part of the continuing artistic and technical development of this new and engaging art form.

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Published by: Stress Therapy Solutions, Inc.
Publishing Editor: Terri Mrklas Collura
Subscription: $50/year; Provided to all Active Affiliates of BrainMaster Technologies, Inc.
Website: www.stresstherapysolutions.com
Publication: minimum of 4 issues/year

Editorial Guidelines: Articles 250 to 2000 words, PC format ASCII or Word. Submit via email to info@stresstherapysolutions.com or send disk or hardcopy to Stress Therapy Solutions, 25825 Science Park #100, Beachwood OH 44122. FAX: 216-439-3015. Phone: 216-766-5707.

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