Neurofeedback for
ASD AND ADHD

Thomas F. Collura, Ph.D., MSMHC, QEEG-D, BCN, LPC
The Brain Enrichment Center and BrainMaster Technologies, Inc.,
Bedford, OH

Association for Applied Psychophysiology and Biofeedback
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This talk will describe some current developments in a neuroscience-based model of decision-making that incorporates both logic and emotions as key components. The interaction of cognitive processes such as pattern recognition, prediction, and choosing, in combination with positive and negative emotional responses, produce the dynamic responses that underlie individual feeling and behavior, as a personal style. This is relevant to ASD and ADHD, which can be understood in terms of this operational model.
Summary

• The control of attention is fundamentally a decision-making process. It is affected by patterns of reward and punishment, as well as goal-seeking. The latter can include novelty, security, pleasure, sense of superiority, or need for attention, to mention only a few. Attention is also strongly influenced by mood, in that the brain will tend to focus attention on factors that provide some measure of either a positive/safe/approach decision, a negative/danger/avoid decision, or, more generally, a combination thereof.
Electroencephalography (EEG) is a technique by which the brain’s electrical activity is recorded by the use of sensors placed on the scalp, and sensitive amplifiers. The EEG was first recorded by the German psychiatrist Hans Berger in 1932, and has become an accepted clinical tool for neurologists and psychiatrists. Generally, EEG is analyzed by visually inspecting the waveforms, often using a variety of montages. Neurologists are able to identify abnormalities including epilepsy, head injuries, stroke, and other disease conditions using the EEG. A clinical EEG practitioner in the medical profession must be a neurologist or psychiatrist, and complete an additional 2 year residency and board certification, to be eligible to read and interpret conventional EEG’s.
Quantitative EEG (QEEG) is a technique in which EEG recordings are computer analyzed to produce metrics (e.g. amplitude or power, ratios, coherence, phase, etc) used to guide decision-making and therapeutic planning. QEEG can also be used to monitor and assess treatment progress. QEEG data typically consist of raw numbers, z-scores, and/or topographic or connectivity maps. QEEG systems currently lack strong standardization, and a wide range of methods and achievable results exist in the field. Although QEEG uses computer software to produce results, an understanding of basic EEG, and the ability to read and understand raw EEG waveforms, is required in order to competently practice QEEG. Generally, a specialist (e.g. a board certified MD, PhD, QEEG-T or QEEG-D) is consulted to read and interpret QEEG data and produce reports and treatment recommendations, unless the practitioner has appropriate experience and credentials.
Neurofeedback

Neurofeedback is a form of biofeedback training that uses the EEG (Electroencephalogram), also known as the “brain wave” as the signal used to control feedback. Sensors applied to the trainee’s scalp record the brainwaves, which are converted into feedback signals by a human/machine interface using a computer and software. By using visual, sound, or tactile feedback to produce learning in the brain, it can be used to induce brain relaxation through increasing alpha waves. A variety of additional benefits, derived from the improved ability of the CNS (central nervous system) to modulate the concentration/relaxation cycle and brain connectivity, may also be obtained.
Normal Distribution
males vs. females

Photo by Gregory S. Pryor, Francis Marion University, Florence, SC.
From: (C. Starr and R. Taggart. 2003. The Unity and Diversity of Life. 10th Ed. Page 189.)

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Comparing the EEG of an individual with clinical presentations to a database of neurotypical recordings can indicate deviations from the statistical average.
Live Z Scores – 4 channels (248 targets)

| System | Abs | Rel | RelF | RelA | RelA | Z | Abs | Rel | RelF | RelA | RelA | Z |
|--------|-----|-----|------|------|------|---|-----|-----|------|------|------|---|-----|
| Delta 1 [0.4-4.0] | -0.8 | -0.4 | -0.1 | -0.1 | -0.1 | -0.1 | Delta 4 [4.0-8.0] | -0.4 | -0.2 | -0.1 | -0.1 | -0.1 |
| Theta 4 [8.0-12.5] | -0.5 | -0.3 | 0.0 | 0.0 | 0.0 | 0.0 | Theta 4 [4.0-8.0] | -0.4 | -0.2 | -0.1 | -0.1 | -0.1 |
| Delta 1 [12.5-25.5] | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | Delta 4 [12.5-25.5] | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Beta 1 [15.0-18.5] | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | Beta 1 [15.0-18.5] | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| Beta 2 [15.0-18.5] | 0.2 | 1.0 | 0.2 | 0.2 | 0.2 | 0.2 | Beta 2 [15.0-18.5] | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| Beta 3 [18.0-25.5] | 0.2 | 0.9 | 0.2 | 0.2 | 0.2 | 0.2 | Beta 3 [18.0-25.5] | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| Beta 4 [25.5-30.5] | 0.2 | 0.7 | 0.2 | 0.2 | 0.2 | 0.2 | Beta 4 [25.5-30.5] | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |

26 x 4 + 24 x 6 = 248 (104 power, 144 connectivity)
EEG Biofeedback Case Studies Using Live Z-Score Training and a Normative Database

Thomas F. Collura, PhD
Joseph Guan, MM.ED, PhD
Jeffrey Tarrant, PhD
John Bailey, PhD
Fred Starr, MD

ABSTRACT. This article summarizes clinical results using a neurofeedback approach that has been developed over the last several years and is seeing increasing clinical use. All participants used a form of live Z-score training (LZT) that produces sound and video feedback, based on a computation using a normative database to produce multiple targets. The client receives simple feedback that reflects a complex set of relationships between amplitude and connectivity metrics. Changes in the EEG are readily seen that conform to the reinforcement parameters being used in relation to the live Z-scores. In addition, over multiple sessions, QEEG data are seen to change significantly, generally on a path toward overall remediation. In this series of case studies LZT is seen to effectively address EEG abnormalities in a structured fashion and to facilitate normalization of the EEG. In individual cases, specific changes are observed, related to the initial conditions, and the brain’s ability to respond with appropriate changes. Overall, LZT is found to be a relatively efficient form of neurofeedback that can be demonstrated to be effective in a variety of clinical scenarios.
SL - EO Pre and Post

Z Scored FFT Summary Information

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Data from Stark & Lambos
SL - EO Loreta Pre and Post
12 yr old boy with severe developmental delays, aggression, almost non-verbal, significant processing delays, difficulty responding to or following directions. After 40 sessions, his mother reported a reduction in aggression, and an increase in verbalizations, processing speed and his ability to both respond to and follow directions.
Client with ???

• Parents: bipolar, obstructive, moody
• Objective Testing: memory issue(s)
• Questioning: I actually forget
• Parents: we did not know that
Can we obtain copies of results? Yes  No

What brought you in today? depression; anxiety; coping problems; anger; worthlessness; feels like mother relationship is terrible;

How long has this been a problem? on and off 10 years

Have you received any treatment for this problem? If so, what? Why was it not successful? yes; various medications have been tried; Mikhaila is no longer interested in taking medication, even when she was taking it regularly it was a struggle and she wasn't always compliant. Various therapists have been tried each one has either refused to continue to see Mikhaila or Mikhaila has refused to continue to see them

How will you know if we have been helpful? Being able to cope with day to day life without getting hysterical and depressed
Copy to clipboard

(X = 60, Y = -32, Z = -20)
Best Match at 2 mm
Brodmann area 20
Inferior Temporal Gyrus
Temporal Lobe
Activity = -1.61677753925323
Max.Abs.Activity = 1.61677753925323

Track info under cursor
Results of NF

• Remembering dream(s)
• Remembering where she put things
• Stopped self when perturbed by stepfather
• Thought about effect on siblings
Client Amotivational

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Amotivational – Social Withdrawal
Sufi Self-Piercing with Pain Control

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Sufi Pain Hubs and Internalized State

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Concentration/Relaxation Cycle

The Concentration/Relaxation Cycle and EEG Amplitude/Frequency Changes

Amplitude

Frequency

lower frequency
higher amplitude
more synchrony
less neuronal independence

lower amplitude
higher frequency
less synchrony
more neuronal independence

theta
alpha
low beta
high beta

Concentration
Relaxation
Thalamo-Cortical Cycles

1. Excitatory neurons (E) are excited or released from inhibition.
2. Excitatory neurons stimulate inhibitory neurons (I), which dampen excitatory activity.
3. Inhibitory neurons further depress excitatory neurons and are themselves depressed.
4. As inhibitory neurons quiet down, excitatory cells are released from inhibition. The cycle begins anew.
Engineering Diagram of the Brain
Cortical Layers
General Finding

• It is generally found that children with ADD/ADHD who exhibit excess frontal theta, or frontal slow alpha, are inclined to respond favorably to stimulant medication. This is in contrast to children who have other patterns of EEG dysregulation, and who respond differently. The role of stimulant medication in improving behavior can be understood in terms of basic aspects including impulsivity, anticipating consequences, and recognizing possible hazards. By focusing on underlying function rather than observed symptoms, some of the complexity of the “multiple subtypes” of ADD/ADHD can be circumvented. Underlying functional dysregulation patterns thus become biomarkers in their own right, less attached to the diagnosis than they are to the precise dysfunctions at a neuronal level.

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New EEG-based assessment for ADHD
FDA NEWS RELEASE

For Immediate Release: July 15, 2013
Media Inquiries: Symim Rivers, 301-796-8729, symim.rivers@fda.hhs.gov
Consumer Inquiries: 888-INFO-FDA

FDA permits marketing of first brain wave test to help assess children and teens for ADHD

The U.S. Food and Drug Administration today allowed marketing of the first medical device based on brain function to help assess attention-deficit/hyperactivity disorder (ADHD) in children and adolescents 6 to 17 years old. When used as part of a complete medical and psychological examination, the device can help confirm an ADHD diagnosis or a clinician’s decision that further diagnostic testing should focus on ADHD or other medical or behavioral conditions that produce symptoms similar to ADHD.
NEBA Indications

**Indications for Use**

The Neuropsychiatric EEG-Based ADHD Assessment Aid (NEBA®) uses the theta/beta ratio of the EEG measured at electrode CZ on a patient 6-17 years of age combined with a clinician’s evaluation to aid in the diagnosis of ADHD.

NEBA should only be used by a clinician as confirmatory support for a completed clinical evaluation or as support for the clinician's decision to pursue further testing following a clinical evaluation. The device is NOT to be used as a stand-alone in the evaluation or diagnosis of ADHD.

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Bringing Frontal / Mood into the equation

• Frontal asymmetry associated with mood
• Davidson, Rosenfeld, Baehr
• Left = “positive”
• Right = “negative”
• Past work used alpha asymmetry
• New work is using gamma
• Not trait only – now looking at state responses to stimuli
• Incorporation of decision-making model
Toward an Operational Model of Decision Making, Emotional Regulation, and Mental Health Impact

Thomas F. Collura, PhD, QEEG-D, BCN, LPC; Carlos P. Zalaquett, PhD, LMHC;
Ronald J. Bonnstetter, PhD; Serea J. Chatters, PhD

ABSTRACT
Current brain research increasingly reveals the underlying mechanisms and processes of human behavior, cognition, and emotion. In addition to being of interest to a wide range of scientists, educators, and professionals, as well as laypeople, brain-based models are of particular value in a clinical setting. Psychiatrists, psychologists, counselors, and other mental health professionals are in need of operational models that integrate recent findings in the physical, cognitive, and emotional domains, and offer a common language for interdisciplinary understanding and communication. Based on individual traits, predispositions, and responses to stimuli, we can begin to identify emotional and behavioral pathways and mental processing patterns. The purpose of this article is to present a brain-path activation model to understand individual differences in decision making and psychopathology. The first section discusses the role of frontal lobe electroencephalography (EEG) asymmetry, summarizes state-and trait-based models of decision making, and provides a more complex analysis that supplements the traditional simple left-right brain model. Key components of the new model are the introduction of right hemisphere parallel and left hemisphere serial scanning in rendering decisions, and the proposition of pathways that incorporate both past experiences as well as future implications into the decision process. Main attributes of each decision-making mechanism are provided. The second section applies the model within the realm of clinical mental health as a tool to understand specific human behavior and pathology. Applications include general and chronic anxiety, depression, paranoia, risk taking, and the pathways employed when well-functioning operational integration is observed. Finally, specific applications such as meditation and mindfulness are offered to facilitate positive functioning. (Adv Mind Body Med. 2014;28(4):18-33.)
Event-Related EEG Imaging
Key emotional regulatory centers
primary and secondary emotional response
Emotional sensation -> emotional perception

Brodmann Areas 11 & 46

Front View

Side View

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Physical Health Assessment

Initial Results

NOEL 0322NH12

Red Meat  Running

JENNY 0322JM12

Fresh Fruit  Body Fat  Obese People

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APPREHENSIVE
16 BREATHS
Respiration: transport of Oxygen and Carbon Dioxide in and out of the Lungs
PER MINUTE
Figure 13 – Kelly at the end of the driving trial. Her state of alpha shows that her motor area is primed for action, while her right frontal lobe is in a relaxed state. This reflects the intention not to move, or as she put it, to “keep going.”
Emotional Decision Making Model
(why we downtrain alpha on the left dorsolateral frontal lobe)

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Happiness as a process

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New Hardware/Software
Emotional Decision-Making App

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Summary

• Dynamical model of mood regulation and emotional decision-making
• Multicomponent model, distributed functions
• Identification of specific excesses/deficits
• Activation / deactivation
• Connectivity / isolation
• Correlation with EEG parameters, power, connectivity
• Methods for assessment, treatment, treatment effectiveness
• Recognition of trait and state individuality
• Relevant to ASD, ADHD, and other “disorders”