EEG Imaging and Biofeedback in the Traumatized Brain

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This talk will present current results using an EEG/QEEG-based biofeedback system that takes advantage of sLORETA imaging of regions of interest, in combination with a structured stimulus and analysis procedure. We will present event-related brain activation data from a range of participants and situations including nonclinical, clinical, and forensic populations. The results illustrate instantaneous patterns of activation that are indicative of individual emotional and decision-making patterns.
Capabilities

• Assessment
  • Detailed questionnaire
  • Neurocognitive testing
  • EEG analysis
• Instantaneous imaging and summary images
• Detailed brain mechanism determination
• Correlated with symptoms/behavior
• Neurofeedback
• Analysis and reporting
• Treatment progress

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Types of Trauma

• Physical, e.g. TBI, CTE and emotional
• Single incident
• Sustained, e.g. military service
• Chronic, e.g. in home sexual / physical / emotional
• Produces:
  • PTSD
  • Complex PTSD
  • Anxiety
  • Panic Attacks, Panic Disorder

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Approach to Neurofeedback

• Identify symptom-related deviations
• Target with neurofeedback and related interventions
• Combine “traditional” and novel neurofeedback
  • Power training
  • Connectivity training
  • Z-score neurofeedback
  • sLORETA region of interest (ROI) power and z-scores
• Monitor subjective, behavioral, physiological progress

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Normal Distribution

Photo by Gregory S. Pryor, Francis Marion University, Florence, SC.

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Progress of Live Z-Score Training
Power changes during z-score neurofeedback
Number of Amplitude Z-Scores
outside target range
subject "s"

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Live surface maps and connectivity maps

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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.
Objectives

• Recognize EEG patterns associated with specific emotional responses and states.

• Explain how the frontal cortex participates in the creation of emotional responses to stimuli.

• Describe the brain locations involved in positive and negative emotional responses in normal processes.

• Describe aberrations in normal brain processing, that can lead to abnormal emotional responses or states.

• Explain how different interventions have differing effects on the dynamic control of emotion.

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Or is this not a more realistic scenario, with individuals expressing their own individual char
strengths, and weaknesses?

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Event-related EEG activation imaging
New Methods

- Use of Gamma (activation) rather than Alpha (relaxation)
- Use of sLORETA (brodmann, ROI) rather than surface
- Use of event-related paradigms
- Separation of state and trait characteristics
- Development of emotional and ethical decision-making methods

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Surface – Defiant or Amotivational

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Defiant or bad memory?

Client ID: 0002 HANA
Age: 31.58
Gender: Female
Montage: Linked Ears
Eyes Closed

Neuroguide Loreta Source Reconstruction at 20 Hz

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Amotivational

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Amotivational and social avoidant
During piercing

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Pain Network de-activation (gamma)
Sufi Pain Hubs and Internalized State

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Pain network
Brodmann 2, 3, 17, 24, 32
Alpha Abundance SM strip & temporal - BDx
Toward an Operational Model of Decision Making, Emotional Regulation, and Mental Health Impact

Thomas F. Collura, PhD, QEEG-D, BCN, LPG; Carlos P. Zalaquett, PhD, LMHC; Ronald J. Bonnstetter, PhD; Seria 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.)
Key emotional regulatory centers
primary and secondary emotional response
Emotional sensation -> emotional perception
Emotional Response to Stimuli
A relative balance in beta and gamma waves creating asymmetry in the activity in the frontal lobes is associated with normal mood and emotional state. Increased activity within the left prefrontal cortex can indicate an elevation in mood and positive feelings. De-activation in the left prefrontal cortex alone or in combination with an increase in activity within the right prefrontal cortex can suggest the opposite, being associated with depressive mood or negative thoughts. Instances in which only the right prefrontal cortex activates quickly with an strong increase in gamma waves suggest a strong dislike or avoidance of a particular exposure.

Example Images:
These example images depict the amount of gamma activity present in subjects frontal lobes as they are exposed to different stimuli invoking neutral, positive, and negative responses.

Raw EEG and event markers
The event stimuli being reviewed in this case is:
“A lover’s embrace.”

*Each event marker represents a single stimuli.

Aquired EEG:
An increase in both beta and gamma waves can be seen when also inspecting the acquired EEG of the event.
Background

- Frontal asymmetry associated with mood – approach vs. avoid
- Davidson, Rosenfeld, Baehr
- Left = “positive” – employs sequential processing
- Right = “negative” – employs parallel processing
- Past work used alpha asymmetry – now using gamma
- Not trait only – now looking at state responses to stimuli
- Incorporation of decision-making model
- Application to trauma

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Baseline Mood State Depressed

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<table>
<thead>
<tr>
<th>Reaction to Chocolate Chip Cookies</th>
<th>Aversion to Beer</th>
</tr>
</thead>
</table>

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Physical Health Assessment

Initial Results

NOEL

Red Meat

Running

JENNY

Fresh Fruit

Body Fat

Obese People

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Corvette StingRay “Reverse Test Drive”

Attributes Identified:
Fear, Anticipation
Scanning Environment
Decision-Making
Relaxation
Excitement
Approach
Withdrawal
Automatic Control
# Left-Right Functionality

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Parallel</th>
<th>Serial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemisphere</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>Data Representation</td>
<td>Holographic</td>
<td>Sequential</td>
</tr>
<tr>
<td>Perspective</td>
<td>Visuo-spatial</td>
<td>Temporo-linguistic</td>
</tr>
<tr>
<td>Analogous to</td>
<td>Pictures</td>
<td>Music, speech</td>
</tr>
<tr>
<td>Context</td>
<td>Global (this always...)</td>
<td>Local (in this particular case,...)</td>
</tr>
<tr>
<td>Orientation</td>
<td>Patterns</td>
<td>Lists</td>
</tr>
<tr>
<td>Tasking</td>
<td>Multitasking (may be stressful)</td>
<td>Single-tasking (focused, calm)</td>
</tr>
<tr>
<td>Perspective</td>
<td>Past</td>
<td>Future</td>
</tr>
<tr>
<td>Dimension</td>
<td>Space</td>
<td>Time</td>
</tr>
<tr>
<td>Attribute</td>
<td>Patterns (spatial)</td>
<td>Causality</td>
</tr>
<tr>
<td>Memory</td>
<td>Past patterns, “punishment”</td>
<td>Cause/effect experiences, rules</td>
</tr>
<tr>
<td>Mode of analysis</td>
<td>“the last time...”</td>
<td>“what if...”</td>
</tr>
<tr>
<td>Result</td>
<td>Avoid / Attack</td>
<td>Approach / Remain</td>
</tr>
</tbody>
</table>

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Left-Right Mood Regulation

<table>
<thead>
<tr>
<th>Emotion</th>
<th>Negative</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision cycle</td>
<td>1 analysis</td>
<td>Sequence of n analyses</td>
</tr>
<tr>
<td>Activation sequence</td>
<td>1 “found”</td>
<td>N “not founds” then done</td>
</tr>
<tr>
<td>Priority</td>
<td>Detecting danger</td>
<td>Ensuring safety</td>
</tr>
<tr>
<td>Decision priority</td>
<td>Immediate</td>
<td>Long-term</td>
</tr>
<tr>
<td>Approach</td>
<td>Tactical, here &amp; now</td>
<td>Strategic, future outcomes</td>
</tr>
<tr>
<td>Equation parameters</td>
<td>Pp+=1, Ppf=1</td>
<td>Ps+=1, Psf=1</td>
</tr>
<tr>
<td>Associated behaviors</td>
<td>Run; fight</td>
<td>Breathe; build</td>
</tr>
<tr>
<td>Neurotransmitter</td>
<td>Adrenalin</td>
<td>Serotonin</td>
</tr>
</tbody>
</table>

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Mesial – Dorsolateral distinction

• Mesial – primary emotional sensation
  • Fundamental, initial sense –”nice” or “not nice” – “like” vs. “don’t like”
  • Primary sense of the feeling “feels good” or “feels bad”
  • Trauma may precondition for “danger” response

• Dorsolateral – secondary emotional perception
  • Integrated with memory, imparts meaning
  • Puts feelings into context, “what do we do about these feelings”
  • Can turn interpretation “around”
  • Directly influences decision-making & behavior

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Emotional Decision Making Model
(why we downtrain alpha on the left dorsolateral frontal lobe)
Happiness as a process

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Effects of Trauma

• Local Optimization
• Survival strategy
• Nash Equilibria
• Brain goals vs. individual goals
• Brain plasticity
• What has been learned can be unlearned
• “I’d like to help you out – which way did you come in?”

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Depressed

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Paranoid – nothing is safe

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Chronic Anxiety – anticipating problems
General Anxiety – post trauma
## EMOTIONAL DECISION MODEL
### EDM-2
### 4 COMPONENTS - S4

<table>
<thead>
<tr>
<th>Rs Rp</th>
<th>NOT ACTIVATED</th>
<th>PRIMARY + PLEASURE “Like”</th>
<th>SECONDARY + SAFE “Good”</th>
<th>FULL + APPROACH “Like+Good”</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>0000</td>
<td>0001</td>
<td>0010</td>
<td>0011</td>
</tr>
</tbody>
</table>

**00**
- PRIMARY - "Don’t Like" UNPLEASANT
- SECONDARY - “Not Good” UNSAFE
- FULL + "Don’t Like" AVOID

| 01    | 0100          | 0101                      | 0110                     | 0111                        |

**01**
- PRIMARY + "Suspense Feeling"
- SECONDARY + "+&- "Suspend Judgement" (NAUGHTY)
- PRIMARY + &- "Mixed Judgement" FOLLOW HEART

| 10    | 1000          | 1001                      | 1010                     | 1011                        |

**10**
- PRIMARY + SECONDARY + "Like"
- FULL + "Don’t Like" AVOID

| 11    | 1100          | 1101                      | 1110                     | 1111                        |

**11**
- SECONDARY + "Not Good" UNSAFE
- PRIMARY + SECONDARY + "Mixed Feeling" "Good" (DIETING)
- PRIMARY + SECONDARY + "Good" FOLLOW HEART

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Alpha-Theta Brainwave Neuro-Feedback for Vietnam Veterans with Combat-Related Post-Traumatic Stress Disorder

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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