Traumatic Brain Injury

- Acquired vs. Traumatic (ABI vs. TBI)
- Mechanism: TBI, CVA, Anoxic, Toxic, Infection, Tumor, Metabolic, Degenerative
- Severity (GCS, LOC, PTA, Neuroimaging)
- Structural and Functional Neuroimaging
- Functional Impairment
- Cognitive and Emotional Impairments
Occurrence of Brain Injury

- Various studies show that BI incidence rates range from 92 to 618 per 100,000.
- Approx 42,000 - 75,000 people die from acute TBI each year in the U.S.
- Approx 1.5 mln traumatic head injuries occur per year in the U.S.
- 56% of adults had a positive BAC during TBI.
- TBI high-risk groups are: men, ages 15-24 and >64, non-whites, lowest SES.
- Estimated direct and indirect cost of TBI in the U.S. is approx $50 billion per year.
The base of the skull is rough, with many bony protuberances.

These ridges can cause injury to the frontal and temporal lobes of the brain during rapid acceleration.
Diffuse Axonal Injury

- Regular CT or MRI scans are not sensitive enough to pick up this pathology.
- High Res MRI, Diffusion-Tensor Imaging, Tractography or MEG are more sensitive.
The Frontal Lobes are involved in “higher” cognitive functions:

- Executive functions
- Attention control
- Complex Social behavior
- Mental effort & goal pursuit
- Working Memory
- Foresight
- Sequencing
- Motivation
- Judgment
- Impulse control
- Planning
- Emotional regulation
etc.
Making Room for the Frontal Lobes

1. Homo Sapiens
2. Neanderthal
3. Gorilla
4. Dog
5. Horse
6. Dolphin
Traumatic Brain Injury
Cortical Atrophy
Encephalomalacia
Loss of Brain Volume

Severe Alcohol Abuse
Cortical Atrophy
Shrinking of the Gyri
Expansion of the Sulci
Loss of Brain Volume
## Emotional Deregulation after TBI

<table>
<thead>
<tr>
<th>Due to Traumatic Experience</th>
<th>Due to Direct Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Worry about capacity</td>
<td>• Damage to anatomical structures of the brain</td>
</tr>
<tr>
<td>• Anxiety about performance</td>
<td>• Toxic effects of released neurochemicals</td>
</tr>
<tr>
<td>• Social stigma</td>
<td>• Reduced cerebral blood flow (ischemia)</td>
</tr>
<tr>
<td>• Disfigurement</td>
<td>• Reduced metabolism</td>
</tr>
<tr>
<td>• Physical limitations</td>
<td>• Increase in extracellular potassium and intracellular calcium</td>
</tr>
<tr>
<td>• Worry about future</td>
<td></td>
</tr>
<tr>
<td>• Worry about relationships</td>
<td></td>
</tr>
<tr>
<td>• Loss of identities &amp; roles</td>
<td></td>
</tr>
<tr>
<td>• Financial anxiety</td>
<td></td>
</tr>
<tr>
<td>• Sexual anxiety</td>
<td></td>
</tr>
<tr>
<td>• Shame &amp; guilt</td>
<td></td>
</tr>
<tr>
<td>• Etc., etc., etc.</td>
<td></td>
</tr>
</tbody>
</table>
High Rates of Co-morbidity Often Create the Chicken-and-Egg Problem

- Traumatic Brain Injury
- Emotional Deregulation
- PTSD
- Alcohol & Substance Abuse
Core Issues

**TBI**
- Processing speed
- Mental energy
- Organization skills
- Impulse control
- Judgment
- Memory
- Pain

**Leads to**
- Frustration
- Feeling overwhelmed
- Depression
- Risk of alcoh abuse

**PTSD**
- Hyperarousal
- Hypervigilance
- Avoidance
- Numbing
- Detachment
- Social isolation

**Leads to**
- Alcoh/subst use:
  - Self-medicate
  - Relieve Anxiety
  - Avoid memories
  - Socialize

**Alcoholism**
- Compulsive use
- Tolerance & use
- Impulse control
- Judgment
- Withdrawal
- Failed efforts to control
- Increased time using

**Leads to**
- Cognitive impairment
- Emotional deregulation
- Social isolation
- Psychiatric comorbidity
- Risk of TBI
Emotional Self-Regulation Model

STRESS-O-METER

KABOOM!
10
DANGER!
9
DO NOT CROSS THIS LINE!
8
WARNING ZONE
7
CALM
6
RELAXED
5
FOCUSED
4

MY WARNING SIGNS:
1
2
3
4
5

MY COPING STRATEGIES:
1
2
3
4
5
Neurofeedback is a form of biofeedback (it is also known as EEG biofeedback). It teaches a person to control his/her own mental states by controlling brainwaves.

Other types of biofeedback may help a person to increase hand temperature, reduce heart rate, relax muscles, improve sphincter control, increase blood flow, lower blood pressure or reduce sweating.
Neurofeedback Training Is Effective AND Fun
Neurofeedback Training Is Effective AND Fun

Watch on YouTube Northeast Center residents race slot cars using their brainwaves
Brief History of Neurofeedback

- NFB evolved from biofeedback
- Alpha wave research in the early ’70s
- Studies of consciousness
- Computer advancements and QEEG/LORETA
- Normative databases
- NFB involves no medications, has no side effects
- Neurofeedback and ADD
- NFB for treatment, peak performance & communication
- NFB treatment for alcoholism was pioneered by Eugene Peniston and Paul Kulkoski in 1989

International Society for Neurofeedback and Research ([ISNR.org](http://ISNR.org)) offers a comprehensive bibliography on uses of Neurofeedback for treatment of various conditions.

To view the links type in *Comprehensive Bibliography* in the ‘SEARCH SITE’ box

<table>
<thead>
<tr>
<th>Academic Cognitive Enhancement</th>
<th>AD/HD and Learning Disabilities</th>
<th>Addiction</th>
<th>Adverse Reactions and Side Effects</th>
<th>Anger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety</td>
<td>Asthma</td>
<td>Autism</td>
<td>Autoimmune Disorders</td>
<td>Brain Injury</td>
</tr>
<tr>
<td>Cerebral Palsy</td>
<td>Creativity</td>
<td>Chronic Fatigue Syndrome</td>
<td>Cognitive Decline</td>
<td>Coma</td>
</tr>
<tr>
<td>Criminals &amp; Juvenile Offenders</td>
<td>Depression</td>
<td>Developmental Disorders</td>
<td>Dissociative Disorders</td>
<td>Epilepsy</td>
</tr>
<tr>
<td>Fibromyalgia</td>
<td>Headache</td>
<td>Hemoencephalography</td>
<td>Hemispheric Asymmetry</td>
<td>Hypertension</td>
</tr>
<tr>
<td>LENS Neurofeedback</td>
<td>LORETA Neurofeedback</td>
<td>Medical Conditions</td>
<td>Obsessive Compulsive Disorder</td>
<td>Optimal Functioning</td>
</tr>
<tr>
<td>Post Traumatic Stress Disorder</td>
<td>Pain</td>
<td>Parkinson's Syndrome</td>
<td>Premenstrual Syndrome</td>
<td>Review Articles</td>
</tr>
<tr>
<td>Schizophrenia</td>
<td>Sleep</td>
<td>Slow Cortical Potentials</td>
<td>Spasticity</td>
<td>Standards</td>
</tr>
<tr>
<td>Stroke</td>
<td>Theoretical Treatises</td>
<td>Tinnitus</td>
<td>Tourette’s Syndrome</td>
<td>Withdrawal</td>
</tr>
</tbody>
</table>

[Z-Score Neurofeedback Training](#)

*Comprehensive Bibliography in .pdf format*
What Causes Brainwaves?

Electrical charges build up on the membranes of neurons, followed by a discharge. These impulses travel down the axons and the dendrites to other neurons.

Synchronized discharges of neurons create electrical currents in the brain. These currents, when recorded, are called the Electroencephalogram or the EEG. First EEG was recorded by Dr. Hans Berger in 1925.
Move Over, Hubble

Dr. Jeff Lichtman’s fluorescent “brainbows”
Brainwave Characteristics

Frequency

Describes how fast the waves are. Measured in Hertz (Hz) or cycles per second.

The standard frequency bands are:

- Delta: 1-4 Hz
- Theta: 4-8 Hz
- Alpha: 8-12 Hz
- Beta: 12-28 Hz
- Gamma: 28-40 Hz

Amplitude

Describes how powerful the waves are. Measured in microVolts (μV);

Coherence

Describes how consistently waves from different locations are locked in phase. Reflects degree of neuronal connectivity.
Quantitative EEG (QEEG) is an imaging technique used to visualize electrical activity in the brain.

Recorded the same way as the regular EEG. The data acquired are used to compute brainwave power, ratios, symmetry, phase lag and coherence. It is also used to create topographic color-coded maps of brain activity;

The QEEG findings are compared to a normative database, which consists of several hundred normal individuals;

QEEG results are often displayed as Z scores, which represent standard deviations from the mean.
The QEEG results are displayed as Z scores (standard deviations from the mean) and span from –3 to +3;

A Z score of 0 represents the norm and is color-coded green;

When it comes to brainwaves, higher is not better: Electrical activity that is too high or too low may be equally problematic.
QEEG and LORETA

LORETA (Low Resolution Electromagnetic Tomography Analysis) is performed using data obtained in the QEEG recording.

LORETA employs standard MRI atlas images with anatomical Talairach coordinates for 3-dimensional gray matter modeling.
Example 1

Normal QEEG.

The obtained EEG data are compared to the normative database (*Thatcher’s Lifespan Database*) and presented as color-coded maps.

The variability of brainwave power seen here does not exceed 1.5 Standard Deviations above or below the mean.
Example 2

Raw EEG tracings and QEEG.

27-year-old man with frontal TBI and depression.
Example 3

This person sustained a typical Coup-Contrecoup TBI in a car accident 6 months ago.

The initial impact was to the left frontal area; it knocked the brain against the opposite side of the skull and caused bruising in two places.

Red color in the maps indicates significantly increased slow wave activity (Delta and Theta) in the Frontal regions. This slow wave activity is elevated more than 3 Standard Deviations above the norm.
Example 4

20-year-old college student with ADD – before and after smoking marijuana
JEAN: a 49-year-old woman with severe depression, anxiety and alcohol/opiate abuse.

Reduced activity in the left Frontal Lobe and elevated activity in the Anterior Cingulate (especially in the Brodmann area 25) are commonly seen in depression.
Example 5a  JEAN: Nine Months and 20 NFB Sessions Later

Before and After Neurofeedback Treatment
Example 6

48-year-old man with severe depression and cocaine addiction.
Example 7

13-year-old boy with ADD:
Before and after 25 Neurofeedback sessions
Criteria for Successful Neurofeedback Training

- Clear understanding of how it can help and how it can’t
- Sufficient level of cognitive ability – arousal, attention & memory (however, some argue that it’s not required)
- No psychosis (delusions, hallucinations)
- Motivation and time to practice and learn a new skill
- Measurable criteria for tracking progress
- Ability to find insurance coverage or to pay for it
- Properly trained and certified Neurofeedback provider
- Treating the person, not the brainwaves
The End

Thank you!

Victor Zelek, Ph.D.
Director, Neuropsychology Service
Northeast Center for Special Care, Lake Katrine, NY
www.northeastcenter.com