

**Chemotherapy
Related
Cognitive
Impairment.
(CRCI)**




**Healing ChemoBrain
with Neurofeedback**



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Outline



1. What is ChemoBrain?
 - A. The person's felt experience.
 - B. The science. Is it ABI?
2. Does chemo-toxicity impact brain tissue and communication networks?
3. What do the Neuropsychological tests show?
4. What is Quantitative Electroencephalography (QEEG), and why it is our most sensitive instrument for detecting mild brain injury?
5. How can neurofeedback rehabilitate the brain, and help with ChemoBrain and other forms of brain injury?
6. How does chemo-toxicity effect executive functioning?

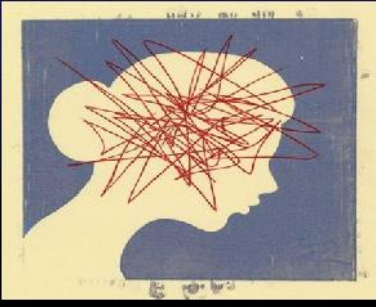
Outline

ChemoBrain

What is it?

Is it serious?

What can I do?




ChemoBrain Impact

Independence

The image shows a portion of the United States flag (stars and stripes) and a document titled "CONGRESS, July 4, 1776. This Declaration of Independence..." with cursive text below.

ChemoBrain Impact

Responses from the Medical Community

A cartoon-style illustration of a male doctor with glasses, wearing a white lab coat and a stethoscope, with his arms crossed.


ChemoBrain Impact

Reactions of Family and Friends

A photograph of four people (three men and one woman) smiling and posing together in front of a red curtain.


ChemoBrain Impact

Money and Work




ChemoBrain Impact

Coping



What is ChemoBrain?

- Cognitive Impairment
 - Memory
 - Attention
 - Processing Speed
 - Executive Functioning
- Caused by Cancer – Treating Drugs



Treatment Induced Changes in Brain Function & Cognition

What is ChemoBrain?

Severity

Trajectory

Mechanisms of Action

What is ChemoBrain?

Temporary (75%-95%)----Persistent (35%)

Subtle (annoying)----Dramatic (disabling)

Acute----Delayed

Stable----Progressive

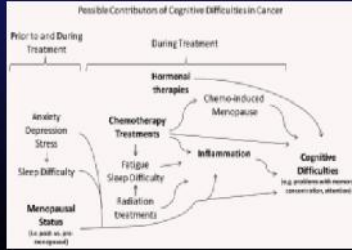
ChemoBrain Mechanisms?

- **Neurotoxicity** – Direct toxic effects of the drug on the CNS cells
McDonald et al. showed **reductions in gray matter volume of frontal and temporal brain regions** over the course of chemotherapy with partial recovery after treatment. These data temporally coincide with functional changes in neurocognitive assessment.
McDonald BC, et al. Gray matter reduction associated with systemic chemotherapy for breast cancer: a prospective MRI study. Breast Cancer Res Treat. 123(3):819-28. [PubMed: 20690040]
- **Inflammatory process** – reduces neuronal transmission
- **Metabolic Abnormalities**
- **Vascular Adverse Effects**

**** most particularly in those who are genetically vulnerable.

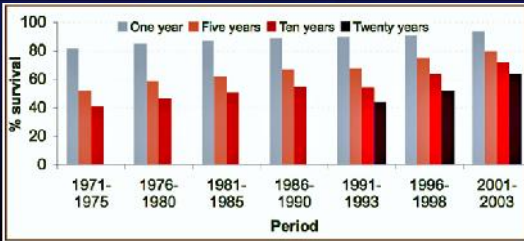
ChemoBrain Mechanisms?

Multiple factors can contribute to cognitive difficulties in cancer patients.



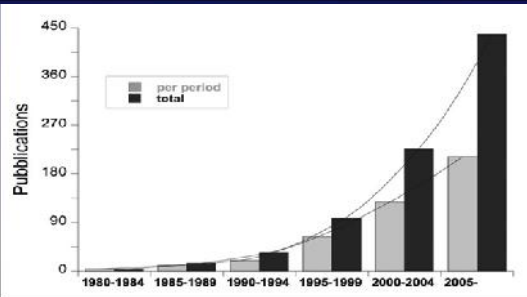
Janelins, Michelle C. et al. (2011). An Update of Cancer and Chemotherapy-Related Cognitive Dysfunction: Current Status. Semin Oncol. 2011 June; 38(3): 431-438. doi:10.1053/j.seminoncol.2011.03.014.

Prevalence – Why is this important?



70 million cancer survivors estimated world-wide in 2020

ChemoBrain - Studies



Assessment

Cognitive Abilities

Achievement

Assessment: Processing

Memory

Attention

Neuropsychological Tests

Neurocognitive tests sensitive to ChemoBrain in breast cancer

Domain	Test	Effect Size
Language	HSCS Language Subtest	Small
Motor Function	Grooved Pegboard	Large
Fepsy	Finger Tapping Test	Moderate
Visuospatial skill	RCFT Copy Test	Moderate
WAIS	Block Design Subtest	Moderate
Verbal Memory	HSCS Memory Subtest	Small

Myers, Jamie S. (2010). Neuropsychological Testing for Chemotherapy Related Cognitive Impairment. In *Chemo Fog: Cancer Chemotherapy-Related Cognitive Impairment*, edited by Rafaia and Tallardia, Landes Bioscience / Springer Science+Business Media, LLC.

Brain Scans; Further Validation



Interventricular Meningioma MRI

MRI Imaging of CHI

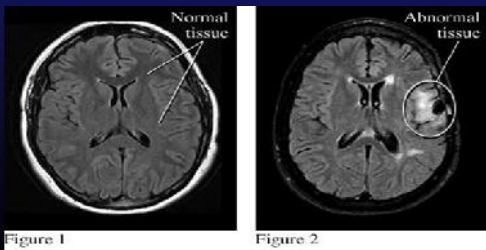


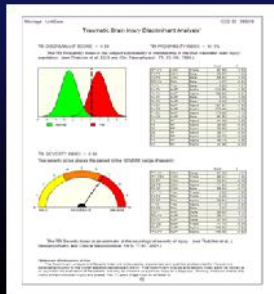
Figure 1

Figure 2

(Gentry, 1990, 1994; Gentry *et al.*, 1988).

QEEG maps

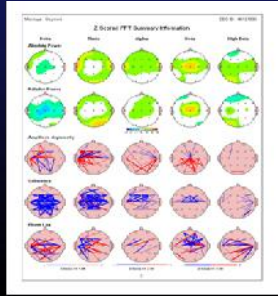
QEEG can discriminate tbi patients from age-matched normal control subjects at accuracies greater than 90%.



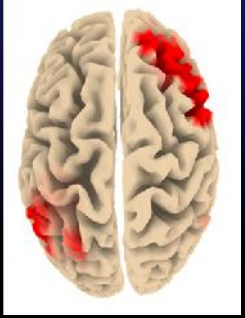
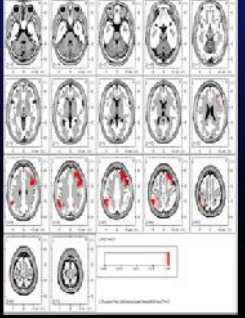
(Thatcher *et al.*, 1989; 2001; Thornton, 1999).

QEEG findings in TBI

- Reduced Power
- Disconnections
- Slowed Transmission



QEEG vs MRI



EEG Assessment Setup



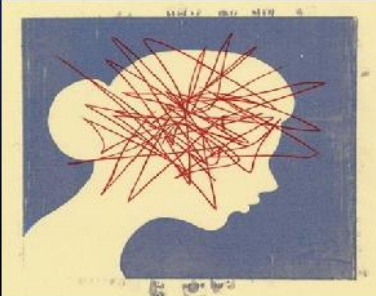
Outline

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Neuroplasticity

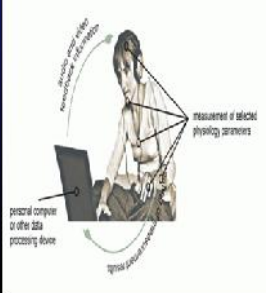
It is now clear that the intrinsic circuitry of the nervous system can be modified throughout life.

Encyclopedia of Neuroscience
B. Kolba. Neuronal Plasticity after Cortical Damage, pp. 727-731
University of Lethbridge, Canada

What is Neurofeedback?

3 Necessary Steps:

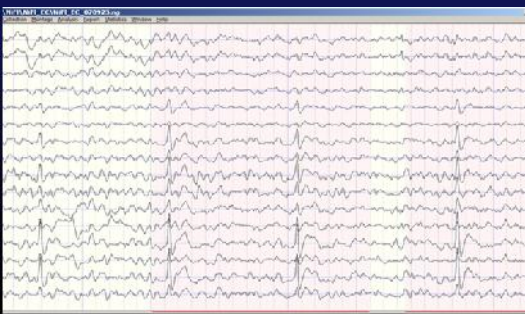
1. Detect and measure neurological process and amplify the signal
2. Convert the electrical signals into an easily understandable form (e.g. 77°F, 172 lbs.)
3. "Show" the signal to the subject as soon as possible after the event has occurred



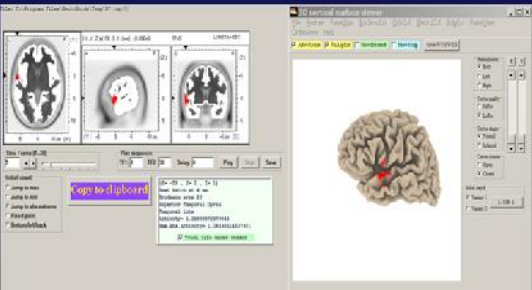
EEG Feedback Setup



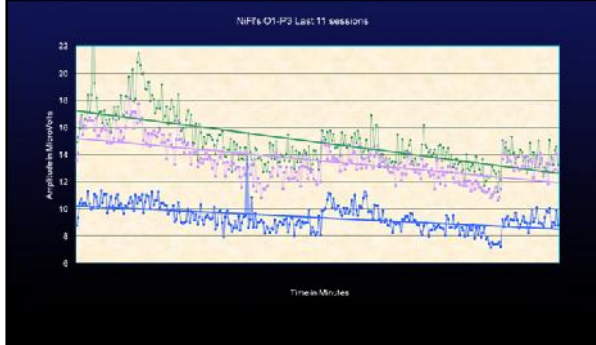
Case Study – Alexia 8 fem



Case Study - Alexia



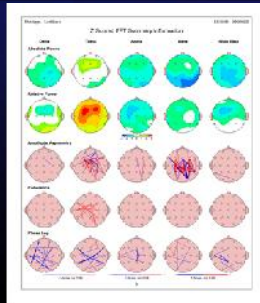
Case Study - Alexia



Example: ADHD

70% of AD/HD have
"Sleepy Brains"

Excessive
Frontal Midline
Slow Waves



Connectivity & White Matter

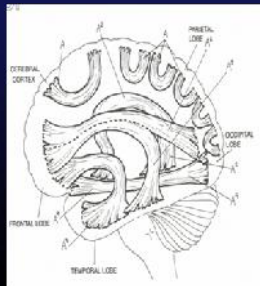
A2 The Cingulum: Connects frontal and parietal lobes with the temporal lobes (thru cingulate gyrus from Fz toPz).

A3 The Uncinate: connects inferior frontal regions and orbital frontal regions (Fp1:BA 10/11) with anterior temporal (Visual/Memory).

A5 The Arcuate: Connects Wernickes and Brocas (F7: BA 45,46,47) (Verbal/ Memory).

A6 The Superior Longitudinal Fasciculus.

A4 The Inferior Longitudinal Fasciculus.



Functional Connectivity

Connectivity; ADHD

Functional Connectivity of Frontal Cortex in Healthy and ADHD Children Reflected in EEG Coherence.

Cerebral Cortex 2006;17:1788-1799
Michael Murias, James M. Swanson, and Ramesh Srinivasan

Connectivity; Blast Injuries

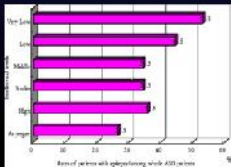
Evidence of disrupted *functional connectivity* in the brain after combat-related blast injury.

Scott R. Sponheim, Kathryn A. McGuire, Seung Suk Kang, Nicholas D. Davenport, Selin Aviyente, Edward M. Bernat, Kelvin O. Lim
NeuroImage 54 (2011)

Connectivity; Seizure

'Functional Connectivity' Is a Sensitive Predictor of Epilepsy Diagnosis after the First Seizure

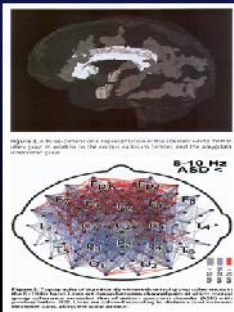
Linda Douw, Marjolien de Groot, Edwin van Dellen, Jan J. Heimans, Harriette E. Romm, Cornelis J. Stam, Jaap C. Reijnen, (2010) PLoS ONE 5(5): e10839



Differences in EEG functional connectivity between epilepsy and non-epilepsy patients after a first suspected seizure were found: patients diagnosed with epilepsy showed **increased synchronization likelihood (SL) in the theta band** when compared to patients who were not diagnosed with epilepsy.

Connectivity; Autism

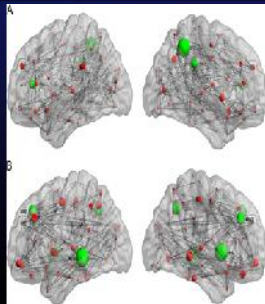
- *Functional connectivity* anomalies underlie the brain dysfunctions in autistic children.
- These neural connectivity disturbances lead to regional brain dysfunctions.
- Autistic children have overlapping neurophysiological dysfunctions.

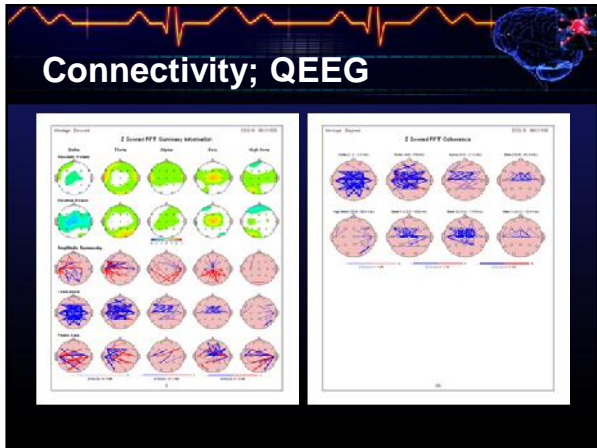


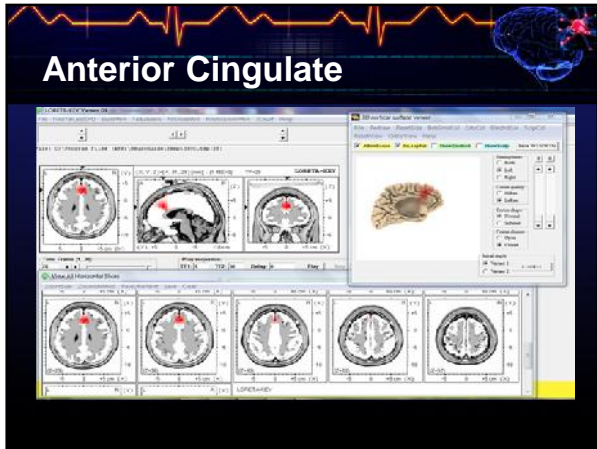
Connectivity – Breast Cancer

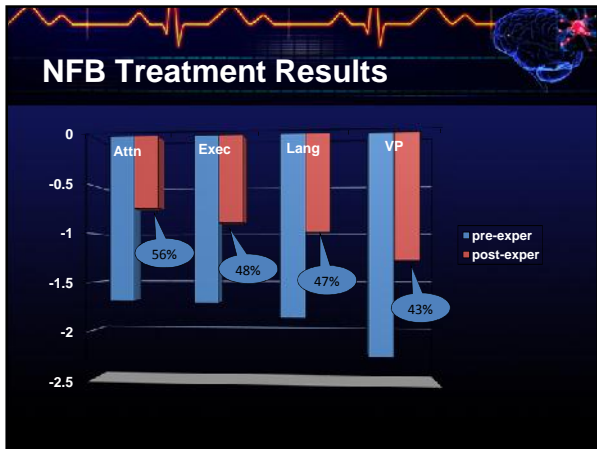
Jennifer Bruno, S.M. Hadi Hosseini, Shelli Kesler (2012). Altered resting state *functional brain network topology* in chemotherapy-treated breast cancer survivors.

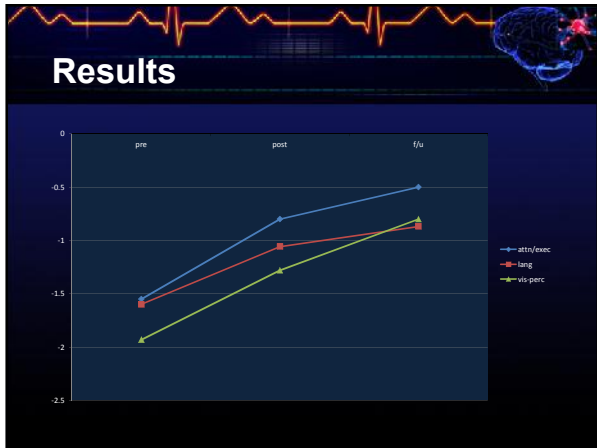
Neurobiology of Disease 48 329–338











Prefrontal Abnormalities

The most common finding across neuroimaging studies of breast cancer, irrespective of imaging modality, is prefrontal cortex abnormality

(de Ruiter et al., 2011; Deprez et al., 2011; Inagaki et al., 2007; Kesler et al., 2009, 2011; Silverman et al., 2007).

Pre-Frontal Cortex: Control

Brodmann areas 9, 10, and 11 make up the pfc. This area is considered the executive control center and is largely inhibitory.

Chicken and Egg?
 Reduced PFC dominance lets other brain modules run wild.
 Excessive "fight, flight or freeze" activity reduces PFC dominance.

Executive Functions

Executive Function	Description
Activation	Organizing, Prioritizing, Planning & Initiating Action
Timeliness	Awareness of time; Scheduling; Time Management
Planning	Imagination, Evaluation, Selection of Possible Options & Outcomes
Attention	Focusing, Sustaining and/or Shifting Attention
Effort	Regulating Level of Alertness, Sustaining Effort and Process Speed
Emotional Control	Modulate Emotions & Manage Frustration
Memory	Utilizing Working Memory; Memory Storage & Retrieval
Action	Self-Monitoring & Regulation of Action

Case Study – ADHD+BPD

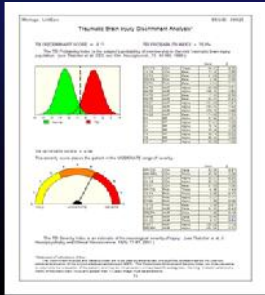
24 yr old female
 77 NFB session total over 10 months
 Moved OoState to attend Graduate school in Psychiatric nursing
 No cutting, no depression, occasions anxiety, no panic, occasional "emotional eating" when stressed

Case Study – Migraine

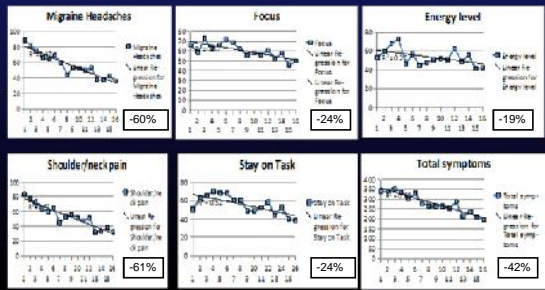
50 Year old Woman
 2nd Car Accident
 Diffuse excess theta frontal focus
 Excessive Hibeta Central
 Main prob = Migraines
 High Anxiety –
 Inattention / forgetful

Case Study – Migraine

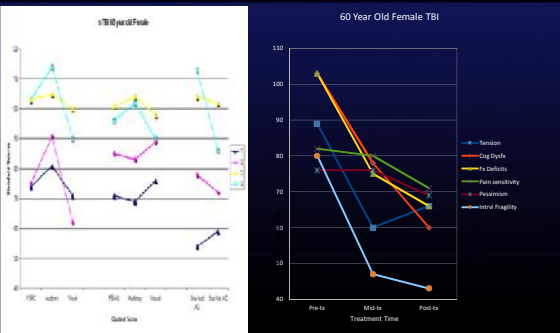
Would come in with Migraine / neck pain
By end of session, pain totally gone "0"
17 Sessions total until PIP insurance cut off the txs, claiming not medically necessary
They still pay for meds!



Case Study - Migraine



Case Study: TBI



Summary

1. Neurofeedback is operant conditioning of the EEG
2. Training an individual's EEG toward normative database
3. Behaviors and symptoms improve along with QEEG

For More Information

www.ISNR.org (International Society for Neurofeedback and Research)

www.bcia.org (Biofeedback Certification International Alliance)

ChemoBrain - Mom

