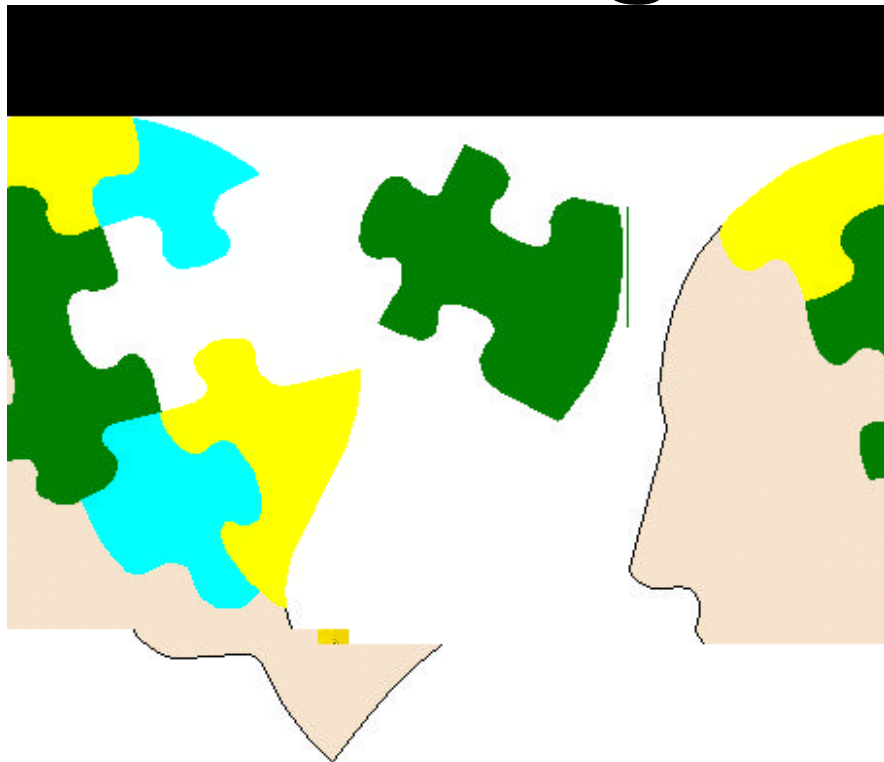


# Evolution and Revolutions in Cognitive & Neurobehavioral Rehabilitation Following Brain Injury



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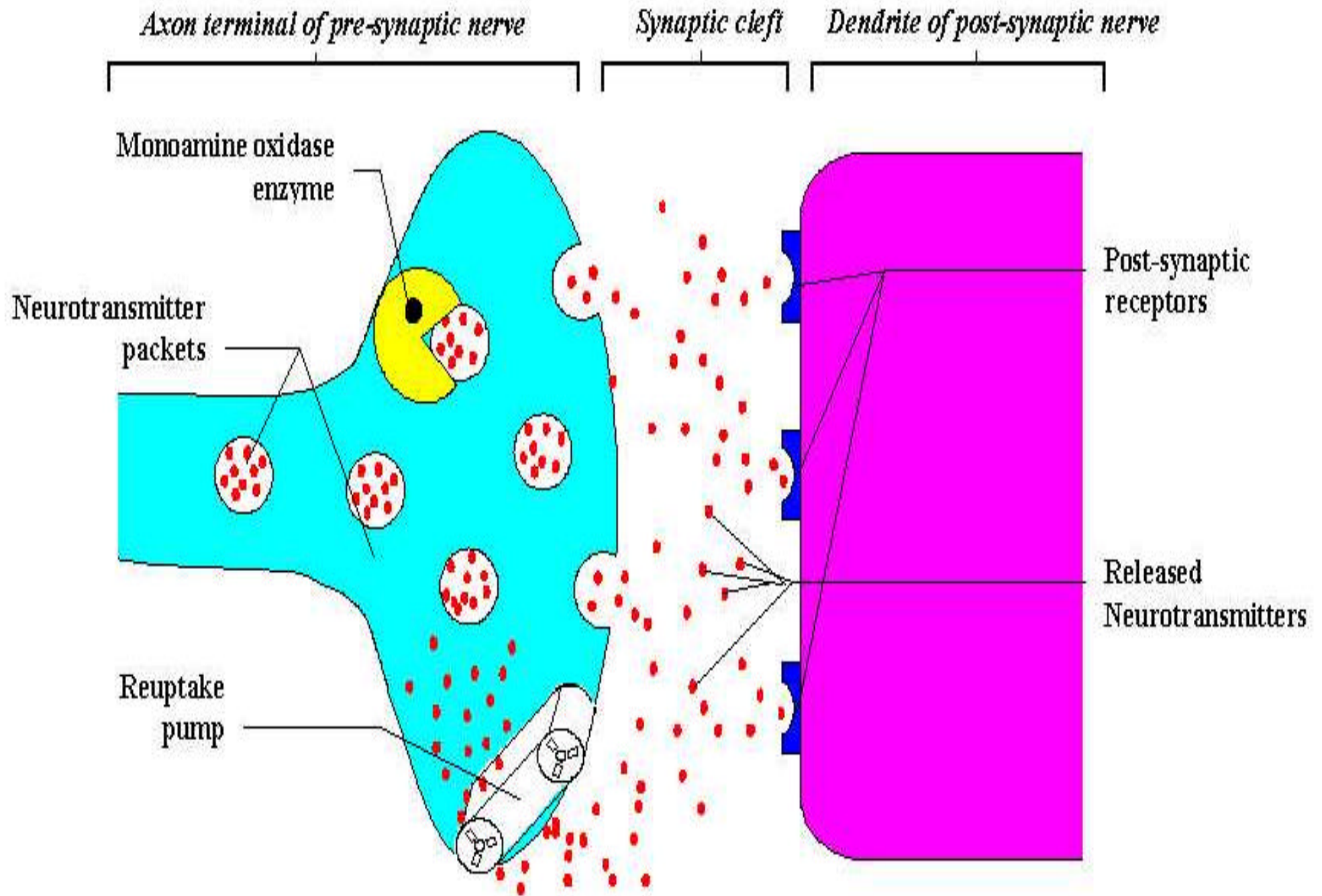
# Rehabilitation Prognosis

- **Early: Cajal's (1928) dictat: CNS is hard wired, consequences of damage immutable**
- **New Research: 3 R's of NeuroRehab -**
  - **Retraining reorganises neural circuits and networks**
  - **Replacement of cells and chemical messengers**
  - **Regrowth of axons, dendrites, and synaptic connections**

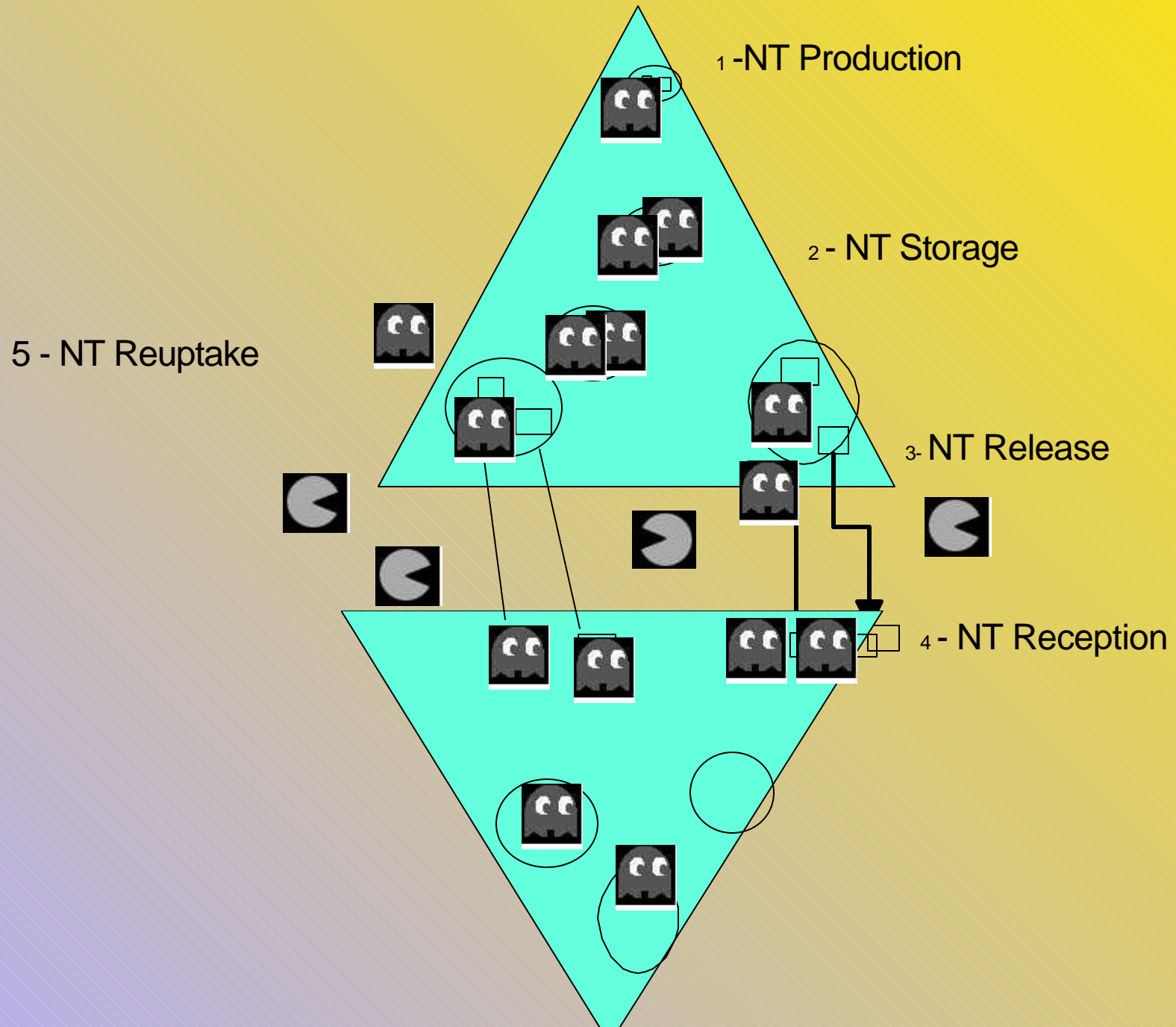
# Rehabilitation Advances: Outline

- I. Combination Neuropharmacologic and Neuropsychologic Rehabilitation
- II. Forced Use Interventions
- III. Neurophysiologic Rehabilitation Strategies
- IV. Neurobehavioral Retraining and Reorganization Strategies
- V. Integrated Multi-System Rehabilitation

# NEUROTRANSMISSION



# NEUROTRANSMISSION *(Cont.)*



# I. Empirical Evidence: Effects of CDP-Choline

- Decreases Cerebral Insufficiency
- Accelerates Stroke Recovery and enhances acute cerebral infarction treatment (multi-center study)
- Retards Progression of Alzheimer's Disease
- Shown value as co-therapy for Parkinson's
- Shown benefit in treatment of severe Depression.
- Shown suggested benefit for Tx of Dyskinesia
- Increases Cerebral Blood Circulation and Oxygen utilization:
  - **Has been used as a Brain circulation stimulator to treat disturbances of consciousness following Brain injury or surgery**
  - **Improves Learning ability and Produces Memory Enhancement Effects (especially in memory impaired, elderly & rats)**



## Empirical Evidence: Effects of CDP-Choline: *(continued)*

- Beneficial neuroendocrine, neuroimmunomodulatory, vasoregulatory and neurophysiological effects are described
- The active Lipotrope form of Choline normally produced within the body
- Readily passes through blood-brain barrier directly into CNS, activates the synthesis of critical components in cell membranes, boosts levels of neurotransmitters such as acetylcholine, and enhances Cerebral energy metabolism
- Boosts mitochondrial energy production, causes the re-absorption of cerebral edema caused by trauma or stroke

# CDP-Choline: The New Form of Choline

- Safe - no serious cholinergic side effects, well tolerated @ 500-1000mg / day.
- Multiple mechanisms of action suggest potential in treatment of various forms of cerebrovascular disease, head trauma and some types of brain aging. CDPc exhibits a neuroprotective effect in blood flow deficits to brain caused by trauma and stroke.
- In patients with head trauma, CDP-c accelerated post- traumatic coma recovery and restoration of walking. The CDP-treated group demonstrated better functional results and reduced hospital stays. In a study of patients with less-severe head trauma, CDP-c improved cognitive and memory deficits.



# Citicholine and Neuropsychological Training after TBI (Leon-Carrion, et al, 2000)

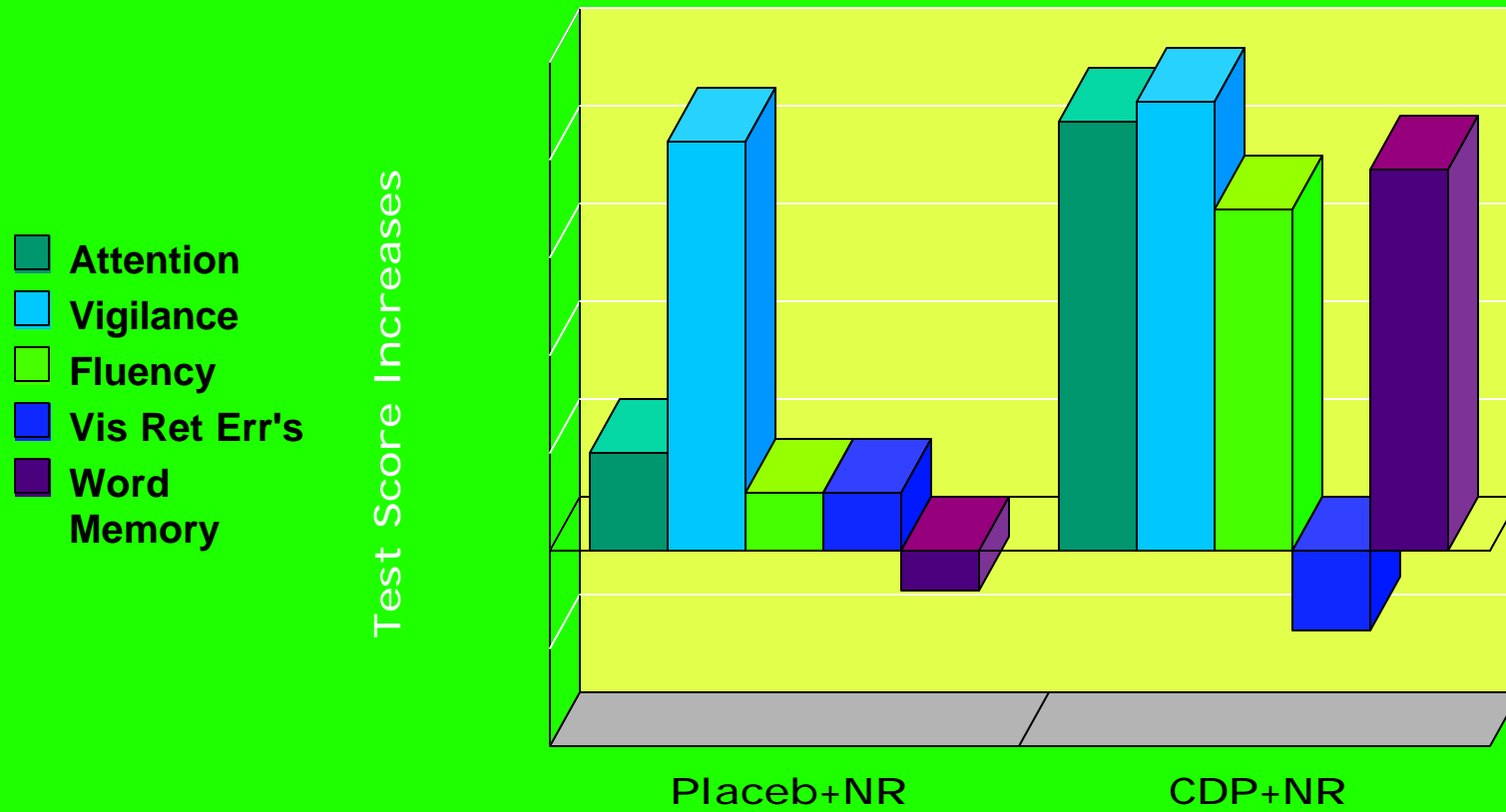
- Experiment 1
  - Subjects: N=7 GCS<8; Post>6mos; Severe Memory Deficits (functional, testing)
  - Assessment:
    - ▶ Measured rCBF Pre, Post CDPcholine
  - Results:
    - ▶ Severe Hypoperfusion, Left Temporobasal, esp. infero-posterior
    - ▶ Specific rCBF Normalization post CDPc

# Citicholine and Neuropsychological Training after TBI (Leon-Carrion, et al, 2000)

## ■ Experiment 2

- Subjects: N=10; GCS<8; Post>6mos; Severe Memory Deficits (functional, testing)
- Treatment
  - ▶ Group A: 3 Mos MemTX + Placebo
  - ▶ Group B: 3 Mos MemTX + CDPc
- Results: **Only MemTraining + CDPc improved Memory**
- Conclusion: **Normalizing Blood Flow and then Exercising Memory Processes through Ecological Rehabilitation Will Improve Memory Function**

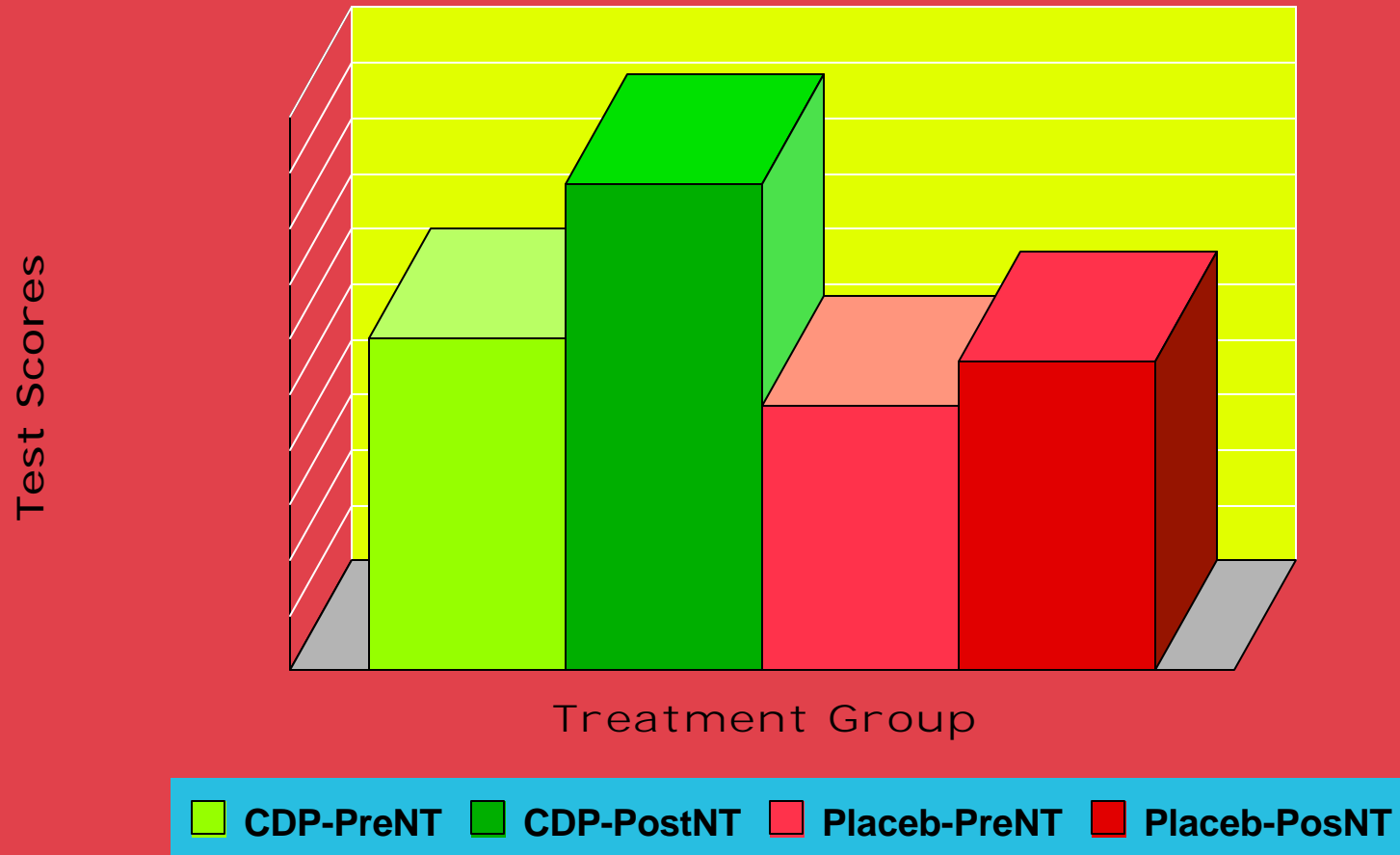
# Neuropsychological Recovery Cognitive Test Change



Leon-Carrion et al, 2000

# Neuropsychological Recovery

## Verbal Fluency



Leon-Carrion et al, 2000

# Citicholine and Neuropsychological Training after TBI (Leon-Carrion, et al, 2000)

## ■ Overall Conclusions

- Severe Memory Disorders Post-TBI Associated with Severe Left Temporobasal Hypoperfusion
- CDP-c specifically Normalizes Left Temporobasal rCBF
- CDP-C with Ecological Memory Training Improves Memory
- **To Rehabilitate Memory/ Functionally Recover, First Restore Blood Flow and then Apply Exercise / Training while Maintaining Blood Flow**
- **CDP-c appears to be a Cognitive Drug with Specific Use for Treatment of Organic Memory Disorders**

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# Citicholine and Neuropsychological Training after TBI (Leon-Carrion, et al, 2000)

## ■ References

- Clark, Warach, Pettigrew, Gammons & Sabounjian (1997). A randomized dose-response trial of citicholine in acute ischemic stroke patients. *Neurology*, 49, 671-678.
- Leon-Carrion, et al (2000). The role of citicholine in neuropsychological training after traumatic brain injury. *NeuroRehabilitation*, 14, 1, 33-40.
- Secades & Frontera (1995). CDP-choline: pharmacological and clinical review. *Methods Find Exp Clin Pharmacol*, 17 Suppl B:, 2-54.
- Spiers, Myers, Hochanadel, Liberman & Wurtman (1996). Citicholine improves verbal memory in aging. *Archives of Neurology*, 53, 441-448.

## II. Constraint-Induced Movement Therapy (CIMT)

- Controlled experiments document efficacy in producing large improvements in limb use in real-world environments after CVA
- Involves constraining movements of the less-affected arm with a sling for 90% of waking hours for 2 weeks, while intensively training use of the more-affected arm
- Induces concentrated, repetitive practice of more-affected limb
- Neuroimaging and transcranial magnetic stimulation studies show massed practice of CIMT produces a massive use-dependent cortical reorganization that increases the area of cortex involved in the innervation movement of the more-affected limb

# Constraint-Induced Movement Therapy (CIMT) *(continued)*

- To date, used effectively for:
  - Upper limb of Chronic and subacute CVA
  - Upper limb of Chronic TBI
  - Lower limb of CVA patients
  - Focal hand dystonia of musicians
  - Phantom limb pain
- 
- Derived from non-human primate experiments
  - Carl Lashley and equipotentiality

# Constraint-Induced Movement Therapy (CIMT) *(continued)*

- **Several Converging Lines of Evidence: Nonuse of a Single Deafferented Limb is a Learned Conditioned Suppression of Movement**
  - Substantial neurologic injury --> depression in motor and/or perceptual function that is greater than will be the case after spontaneous recovery of function takes place
  - Initial depression of activity lasts 2-6 months following forelimb deafferentation; afterwards progressive regaining of movement ability takes place
  - Animal with one deafferented limb attempts to use it postoperatively, but cannot
  - It begins to function adequately with 3 limbs, reinforcing 3 limb function

# Constraint-Induced Movement Therapy (CIMT) *(continued)*

- Continued attempts to use deafferented limb produces failure, pain, incoordination, falling, etc., resulting in punishment of attempts, and suppression of efforts.
- Nonuse response tendency persists, preventing monkeys from learning that after several months, the limb is Potentially Usable
- Conclusion: Animals never learned they could eventually use the limb (Learned Nonuse)

# Constraint-Induced Movement Therapy (CIMT) *(continued)*

- Movements of a deafferented limb were prevented with restraining device for 3 months.
- After restraint removed, animal used limbs as predicted  
Conclusion: Animals never learned they couldn't use limb (Learned Nonuse)
- 
- In utero deafferentation of limb
  - In utero = movement restraint
- At birth, purposive use of limb, progressively improving to normal when mature



# Constraint-Induced Movement Therapy (CIMT) *(continued)*

## ■ Use Dependent Cortical Reorganization

- Five TMS, EEG, MEG studies with humans, and one study of monkeys indicate: Cortical reorganization is associated with therapeutic effect of CIMT. After use training:
  - ▶ Area surrounding the infarct (usually not used for hand control) was recruited
  - ▶ Ipsilateral hemisphere limb control area was recruited

## ■ Mechanism of Action

- (1) Changing learning contingencies reinforces Use Learning, inhibits Nonuse Learning
- (2) Sustained, repeated practice of functional arm movements induces expansion of contralateral cortical area controlling movement and recruitment of new ipsilateral areas.

# Constraint-Induced Movement Therapy (CIMT) *(continued)*

- **Andrews and Stewart (1979):**
  - **Stroke Recovery: He can, but does he?**
  - **ADL's performed less well at home vs hospital in 25-45% of cases**
- **Taub et al (1999) Learned Nonuse?.**
  - **"Most patients, despite exhibiting a pronounced motor deficit, probably have a considerable latent capacity for motor improvement"**

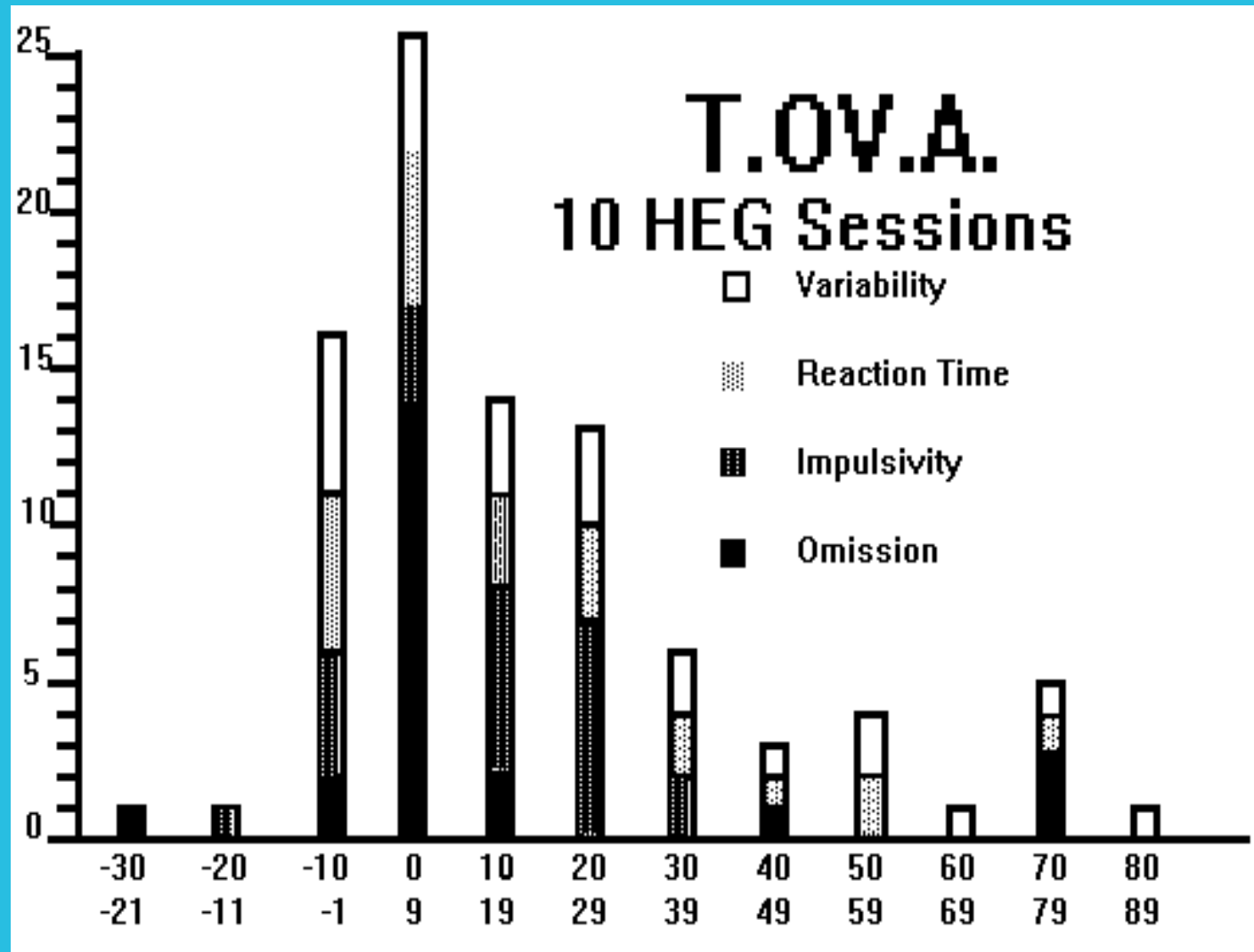
## IIIa. Brain Blood Flow

# Biofeedback: Intentional Increase of Cerebral Blood Oxygenation:

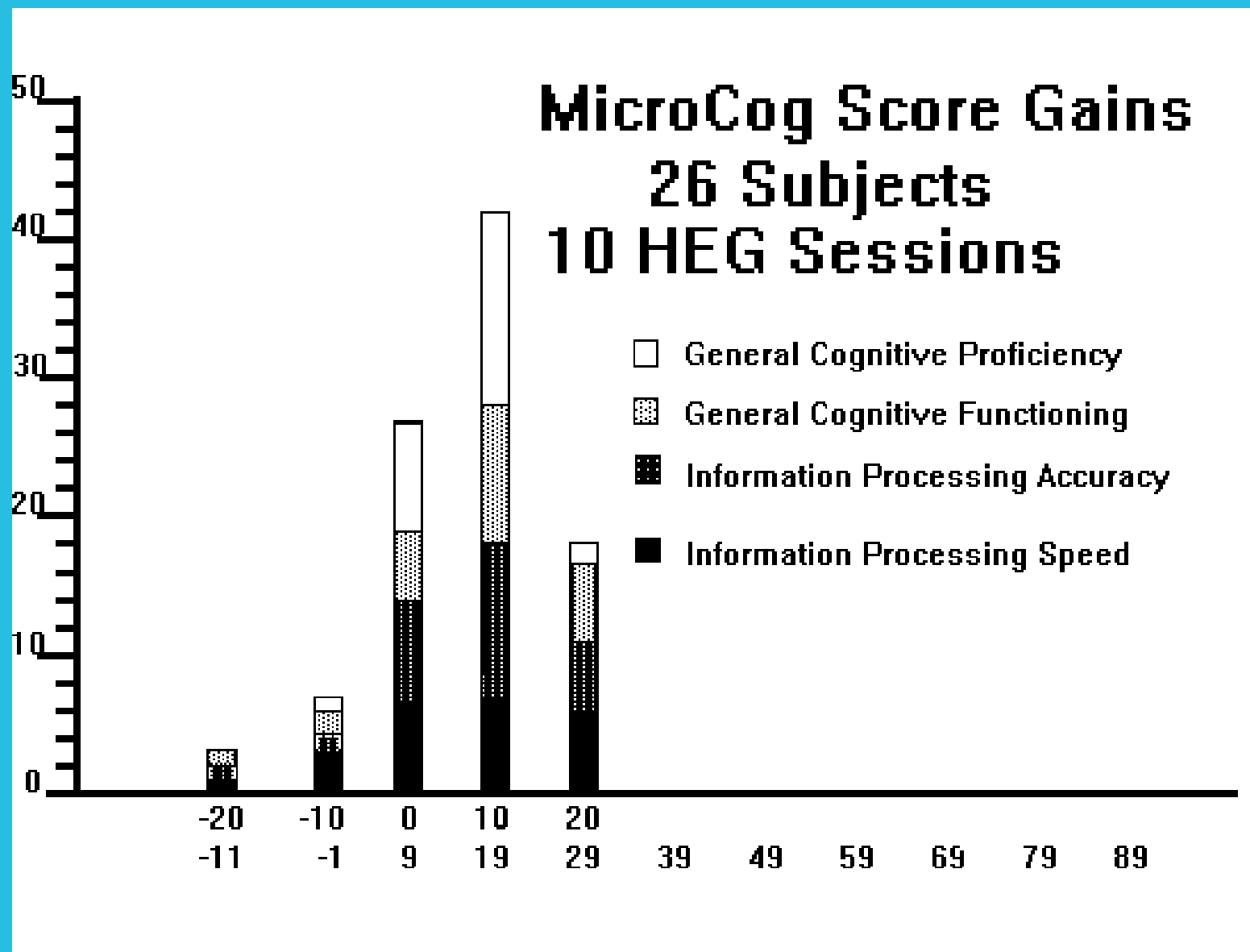
Hershel Toomim, et al, Biocomp Research Institute, Los Angeles, UCLA

- Introduces intentional enhancement of (rCBO<sub>2</sub>) in specific cerebral locations as a localized brain exercise.... study shows increased vascularity, activated capillary beds, improved cognitive function.
- PET, SPECT and fMRI studies using have located regional cerebral oxygenation (rCBO<sub>2</sub>) patterns associated with specific cognitive functions and dysfunctions. (2-5).
- Pre-post analysis revealed significant relationship between repeated rCBO<sub>2</sub> exercise of varying intensity and improvement of brain function as measured by the T.O.V.A. (Inattention, Impulsivity, Reaction time, and Reaction time variability)... Treatment group demonstrated 13 point avg. T.O.V.A. gain vs. control group after ten treatment sessions.

# Contribution of T.O.V.A variables to distribution of experimental gains



# Histogram of contribution of cognitive MicroCog global variables to experimental gains



## CONCLUSIONS:

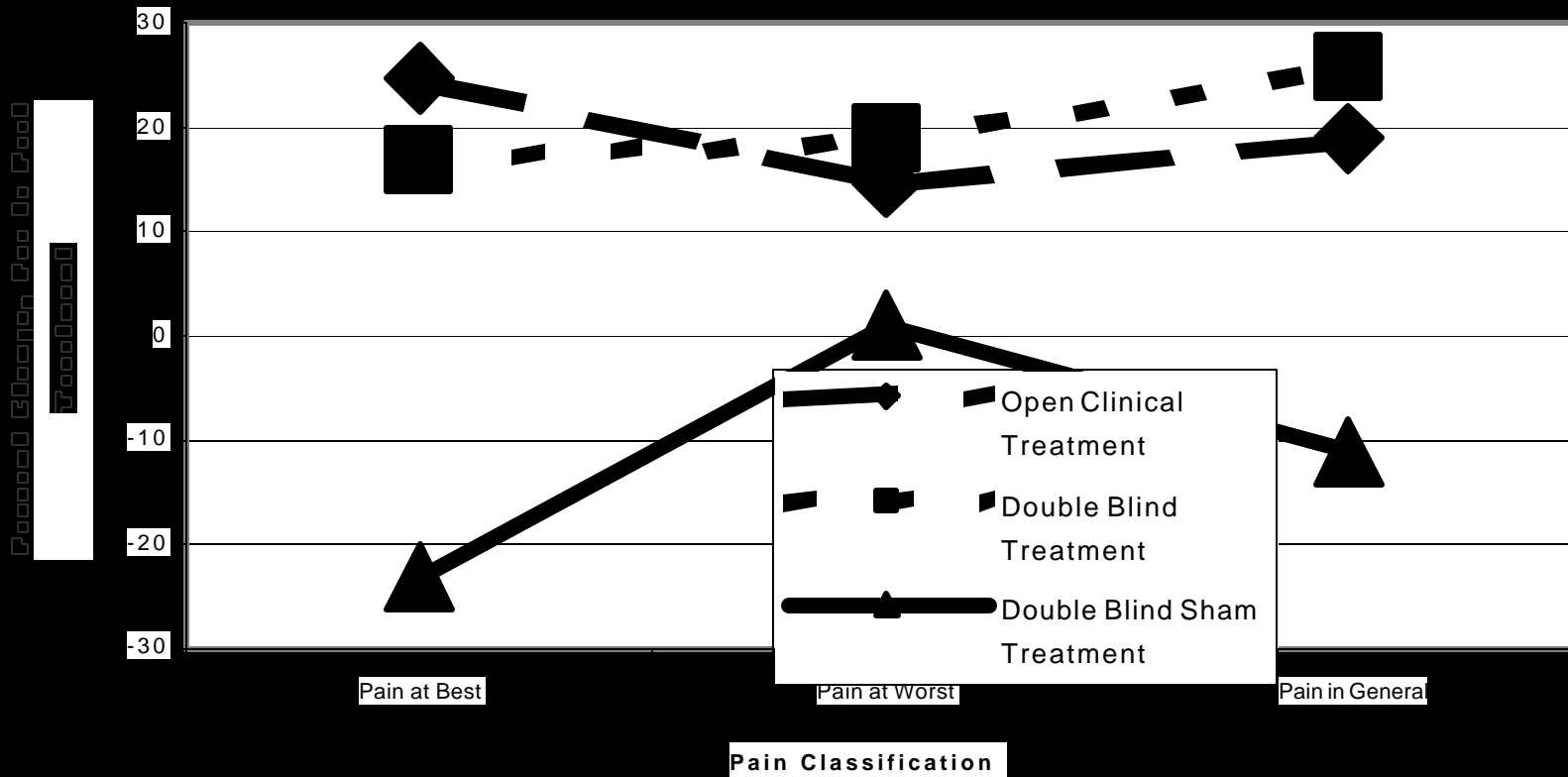
The authors find the evidence strongly suggests a new dimension of brain therapy resulting from an easily implemented ability to direct blood to deficient areas. Application to stroke, depression, schizophrenia, autism, chronic fatigue, epilepsy, traumatic brain injury, and memory loss need active pursuit. Increasing the effectiveness of blood borne medications at required brain locations is a possibility. These remain to be studied under controlled conditions.

... inexpensive, portable instrument system comprising HEG... simple application... the ease of learning control of cortical blood oxygenation/flow, make its practical use in therapy simple and convenient... We do not know that such exercise is always beneficial, but unwanted side effects are negligible in our experience. Its attributes and effects provide therapists, physicians and scientists the means to explore and develop an extensive new field in both therapeutic and basic research.

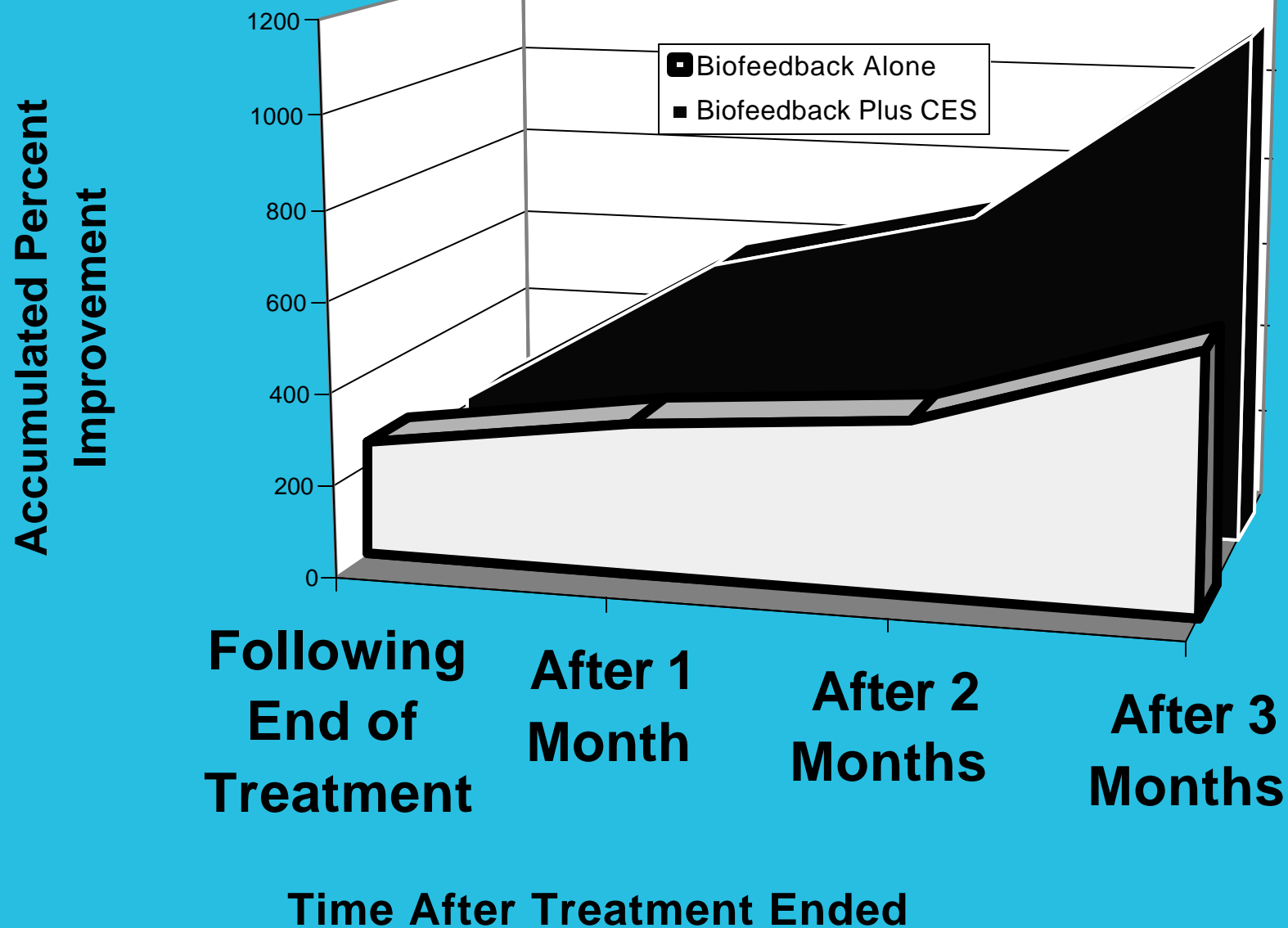


# IIIb. CranioElectrotherapy Stimulation

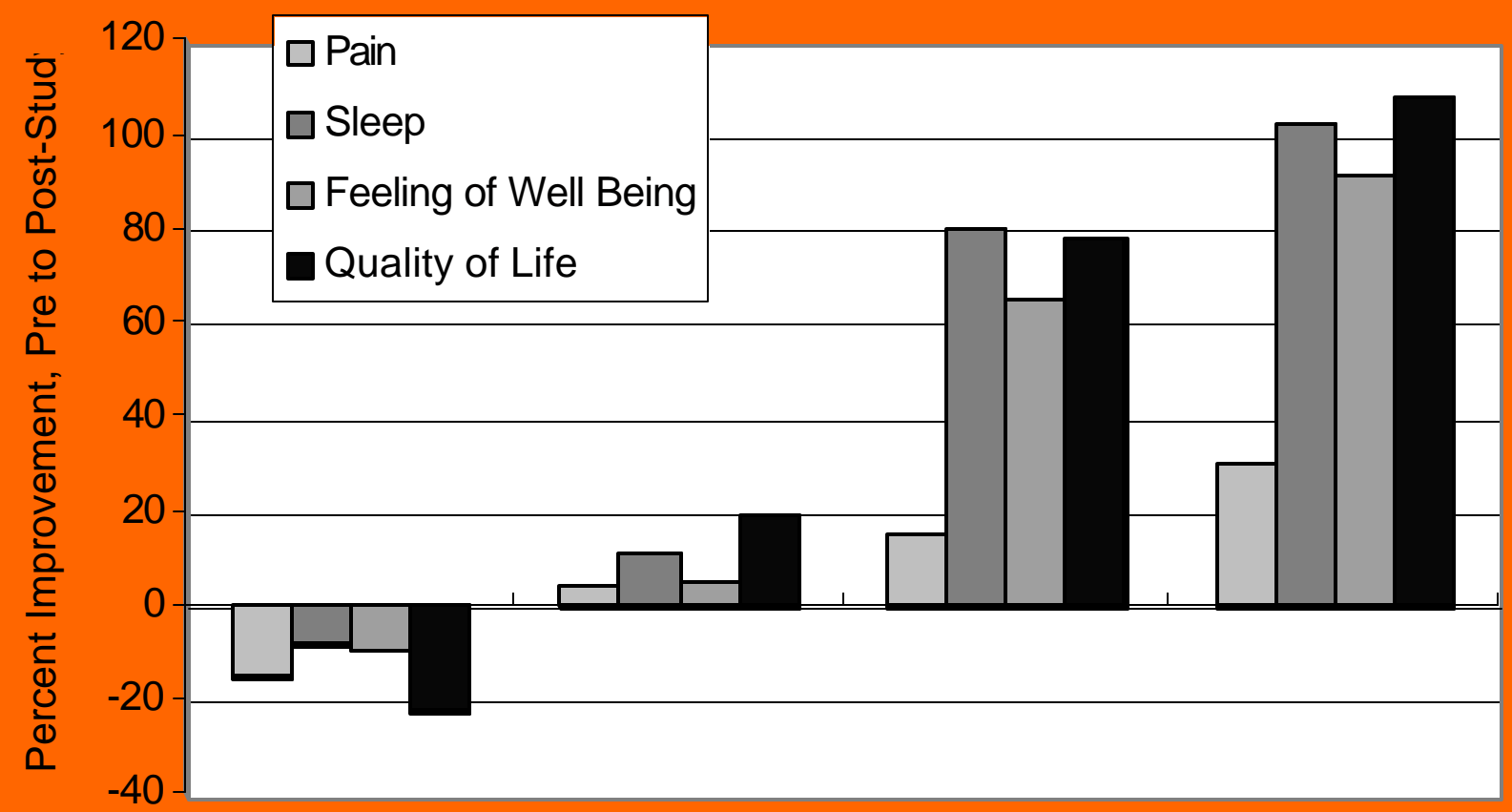
Fig. 1 The Effect of Microcurrent Treatment on Chronic Spinal Pain



# Frequency of Migraine Headaches, Times Intensity



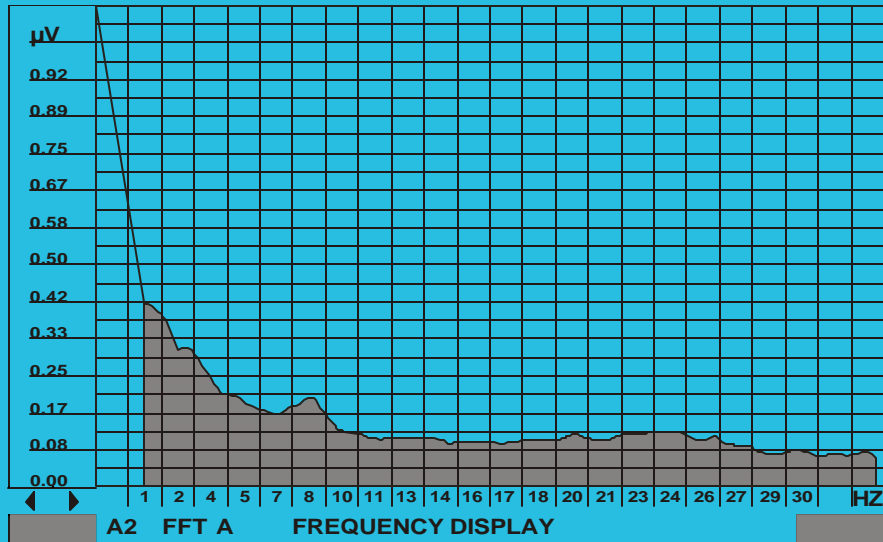
# Response of Patients on Self Rating Scales AIMA Fibromyalgia Study



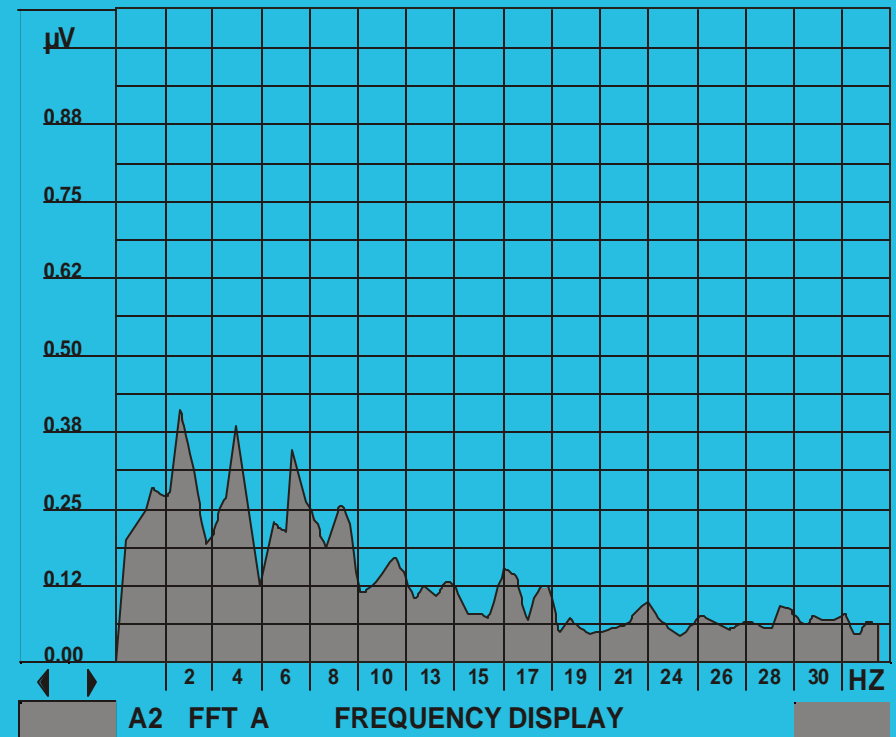
# Changes in Fibromyalgia Patients following Three Weeks of Alpha-Stim CES Treatment



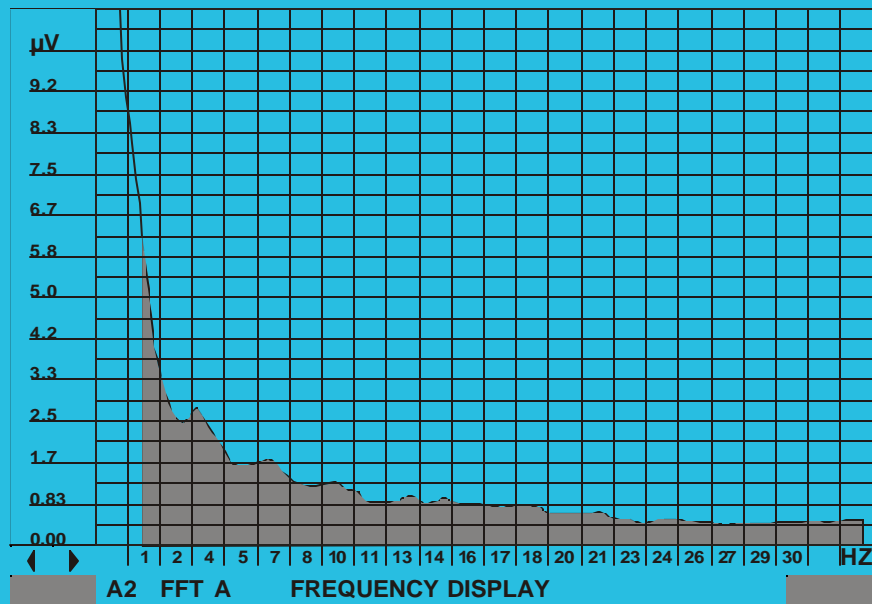
2 min averaged EEG RMS Fast Fourier Transform in a typical person without persistent cognitive or physical symptoms: amplitudes on vertical axis; EEG frequency on horizontal.



FFT of a typical TBI patient with persistent cognitive, psychological and somatic symptoms > 2 years.

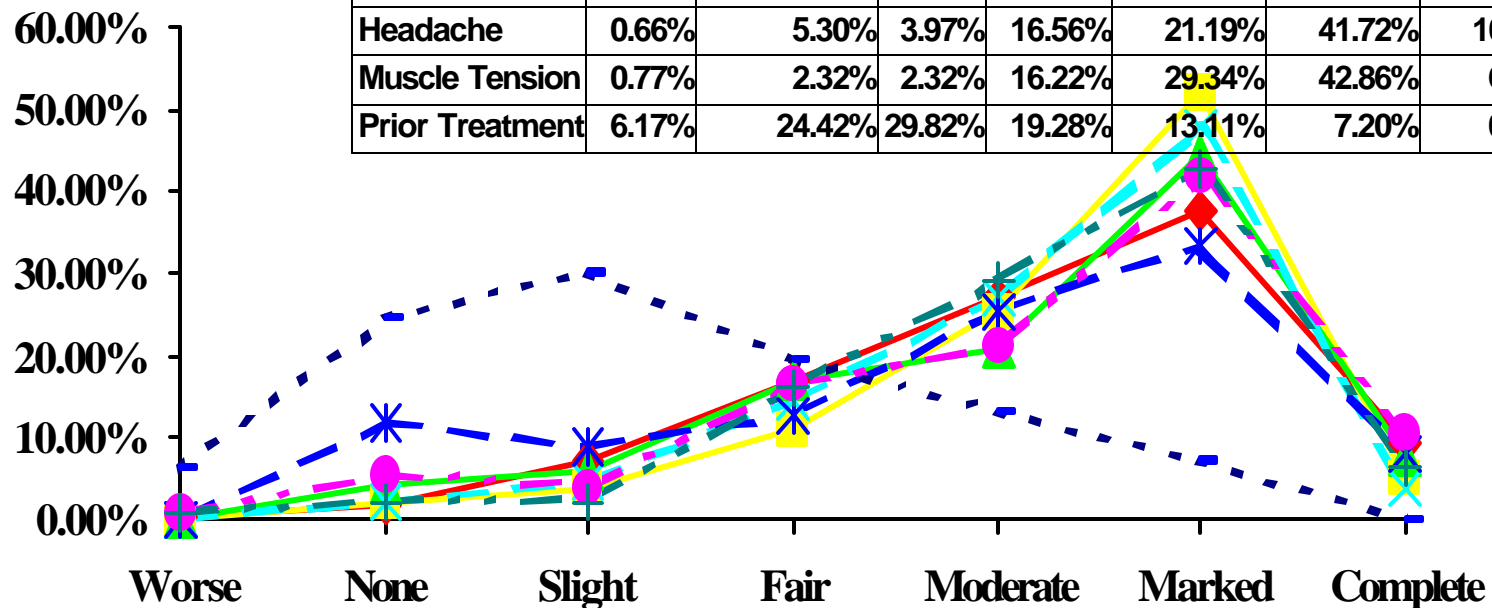


FFT of the EEG of same TBI patient following 15 min CES treatment



# CES Post Marketing Survey (N=1,414)

	Worse	None	Slight	Fair	Moderate	Marked	Complete
Pain	0.35%	1.75%	6.99%	16.78%	26.92%	37.76%	9.44%
Anxiety	0.00%	2.29%	5.98%	16.85%	20.65%	44.57%	7.61%
Depression	0.00%	4.35%	5.98%	16.85%	20.65%	44.57%	7.61%
Stress	0.00%	2.32%	4.63%	14.29%	27.03%	47.88%	3.86%
Insomnia	0.00%	11.85%	8.89%	12.59%	25.19%	33.33%	8.15%
Headache	0.66%	5.30%	3.97%	16.56%	21.19%	41.72%	10.60%
Muscle Tension	0.77%	2.32%	2.32%	16.22%	29.34%	42.86%	6.18%
Prior Treatment	6.17%	24.42%	29.82%	19.28%	13.11%	7.20%	0.00%





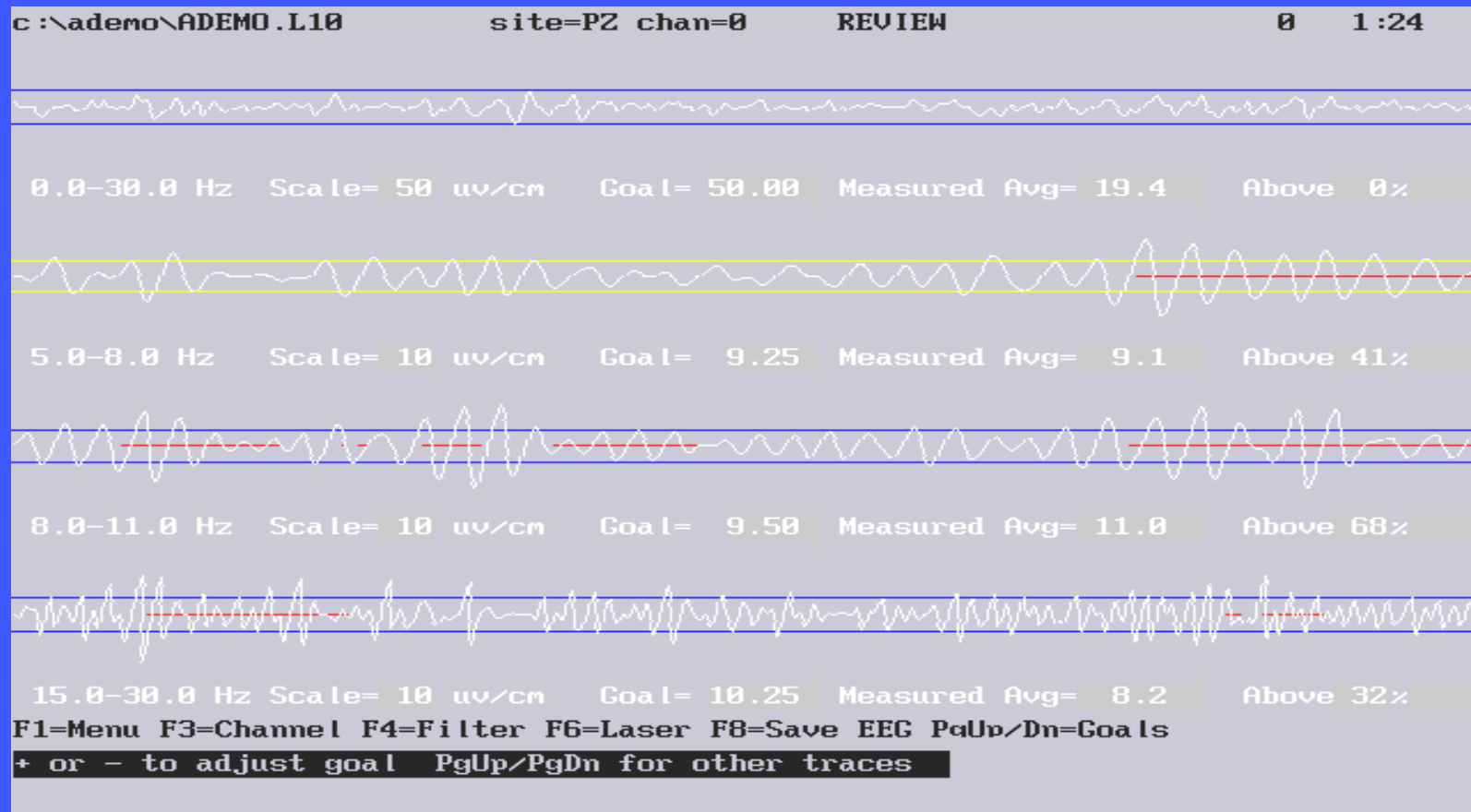
# EEG Biofeedback and Remediation of Post Concussive Symptoms

## **BIOFEEDBACK:**

- **A System / Procedure for**
- 1) Measuring a physiologic process/parameter;
- 2) Converting the output to an understandable (unit of measure) form, and;
- 3) Feeding back the information in a sensory form (visual and/or auditory) to increase awareness of those processes.

# BIOFEEDBACK (cont.)

- ... a means for teaching self-control of physiological processes, often previously thought out of our voluntary control, by augmenting sensory feedback...  
A means of Psycho-physiologic Self-Correction
- *(Patho-physiologic normalization)*



# Why Train the EEG?

- Change the physiologic basis of psychopathology, including helping improve behavior, mood, and attention
- Stabilize the central nervous system
- Research Basis: M. Barry Sterman
  - 1967 Suppression of Seizures in Epileptics following EEG feedback training
  - 60% reduction in seizure activity
  - Technology came from cats and study of jet fuel induced seizures in pilots

# EEG Biofeedback Training: Old & New

## The Historical Background

60's: Joe Kamiya demonstrated that EEG information feedback could produce deliberate altering of EEG

- Alpha activity trained while subject's eyes were closed

60's: M. Barry Stermann at UCLA did sleep studies on cats and discovered 14 Hz SMR rhythm in sleep and waking, and that it could be trained, with effects on sleep.

- NASA approached about rocket fuel inducing seizures in personnel
- Rocket fuel induced seizures in cats
- Cats that underwent SMR brain wave training had a significantly higher seizure threshold

- Lengthy research period followed
- Rigorous demonstration that seizure incidence, intensity & duration could be reduced with 12-15Hz range EEG training
  - Most High Alpha / SMR training for seizures done on very severe cases.
  - Training was lengthy (40 sessions)
  - Equipment was expensive and trainers were PhD level and expensive
- 
- It was observed that hyperactivity in epileptics also seemed to subside with the training.
- 
- Recent Air Force studies pilots revealed that Good B2 Bomber Pilots had more between task alpha bursts
  - Alpha training previously became popular, but was relatively esoteric

# ADHD work grew out of epilepsy studies.

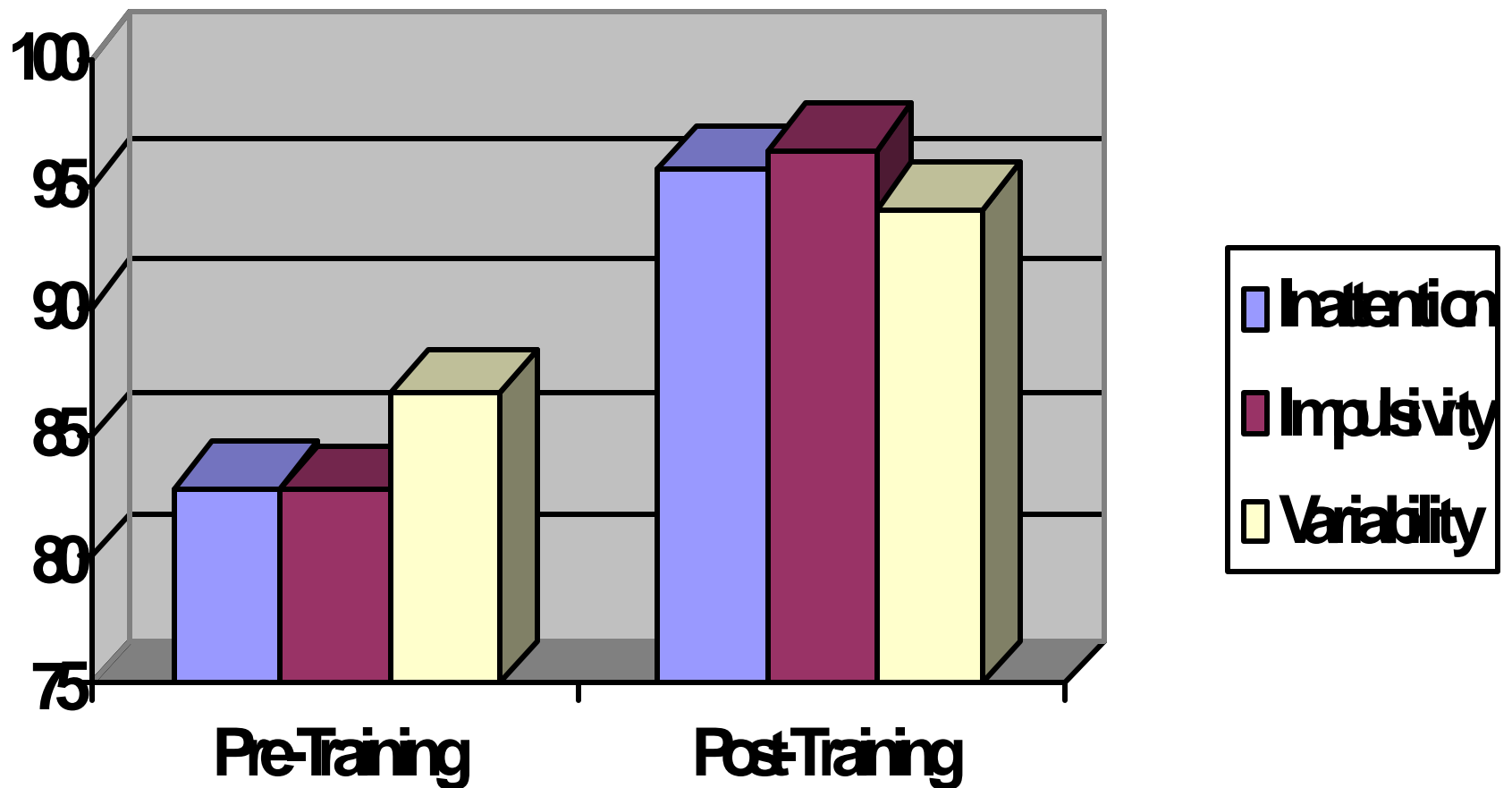
- Joel Lubar established that EEG Training could help with Hyperactivity, ADD, and Learning Disabilities.
- Clinical work found EEG Biofeedback helpful with a broader range of conditions.
- Since early 1980's, many clinical reports of treating TBI Symptoms with EEG neurofeedback.
- Bruner (1989) used high alpha / SMR (10-14 hertz) training in three cases - All 3 showed return to pre-morbid functioning.
- Tansey (1983, 1991) and others have used SMR - 14 hertz - Also reported good results
- Ayers (1987, 1991) does a lot of work with TBI population
- ▶ Diffuse EEG slowing is typical nonspecific finding.
- ▶ Ayers (1987): EEG of a TBI patient: petit mal variant activity in 3- 5 Hz range in damaged cortical area....a generalized slowing of the EEG, most predominate at injury site.
- 
- Neurofeedback Strategy: Normalization of the EEG.

# Lubar's Research on Neurofeedback in Children with ADD at the Univ. of Tennessee After 40-60 Sessions

- 80% effective in more than 1000 children
- Average increase in grade level on standardized tests is 2.5 years
- Typical increase in IQ test scores of 8-19 points
- Average Grade Point Average improves 1.5 levels (C to B+)



# EEG Biofeedback Effects on Adults With Problems Paying Attention



# Flexyx Neurotherapy System: Len Ochs, PhD (EEG Driven Stimulation)

- Monitors and analyzes EEG signals for Abnormality
- EEG information guides feedback (photic stimulation or entrainment)
- Feedback changes the EEG pattern
- Disrupts the EEG activity that is entrained on dysfunction.
- Typically results is lower amplitude slow waves, and more flexible functioning
- Shift in amplitude is accompanied by a reduction of symptoms

- NIH studies for TBI, Fibromyalgia Traumatic Brain Injury patients have been seen to easily recover ability to take in information, improve in short-term memory, organization, sequencing, prioritizing, sensory discrimination, initiation, confidence, assertiveness, and sense of humor. Depression, irritability, and explosiveness
- Mean treatment time of 6-20 sessions
- As with All Neurofeedback, non-invasive, non-pharmacological, and non-psychotherapeutic
- Effects have persisted at 3 year follow up

# Treatment of Chronic Fatigue with Neurofeedback and Self-Hypnosis

D. Corydon Hammond, Ph.D.

## Pre-Post Treatment and Follow-up Percentile Scores on the Profile of Mood States

	Pre-Tx	Post-Tx	5 Months	7 Months	9 Months
<b>Fatigue:</b>	95.5%	31%	34.5%	65.5%	58%
<b>Vigor:</b>	33%	84%	46%	69.2%	84%
<b>Confusion:</b>	81.6%	2.3%	3.6%	4.5%	6.7%

# The Habit Retraining Model of Brain Injury Rehabilitation for Incremental Achievement of Important Life Goals

By: **Michael F. Martelli, Ph.D.**

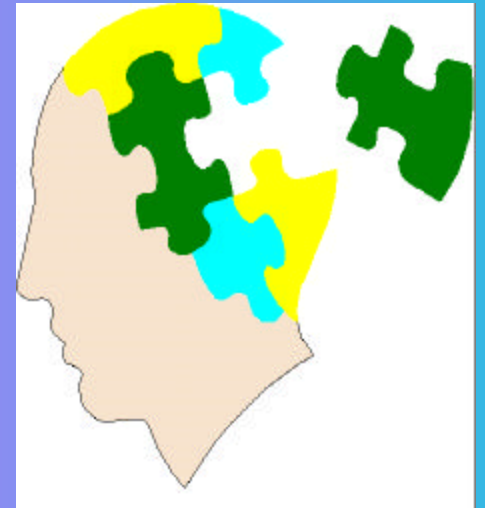
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**As Presented at:**

**Villa Martelli Disability Resources**

**WebSite**

**<http://VillaMartelli.com>**



# REHABILITATION

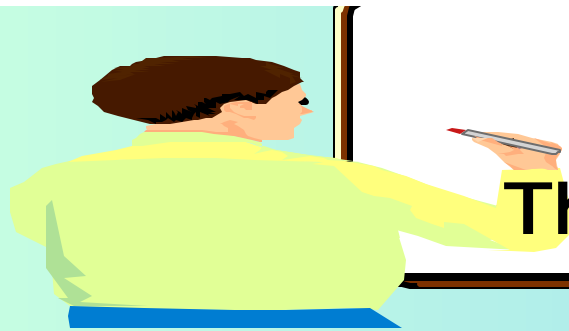
The Systematic Process of:

- Removing Obstacles to Independence
- Accessing Opportunities for Stepwise Achievements (*Of Desired Goals*) in the areas of Love, Work and Play!
- Changing Destiny!

# HABIT RETRAINING

## REHAB Ingredients: The 3 P's

- **Plan:** A strategy or design for stepwise progress toward a desired outcome. Most plans are based on task analyses, or breaking seemingly complex tasks down into simple component steps, and proceeding in a list wise fashion. Clearly, the more specific, concrete, and obvious, the more likely the plan will work.
- **Practice:** Repetition is the cement for learning which makes complex and cumbersome and boring tasks more automatic and effortless. With practice and repetition, even complex tasks become automatic and habitual. That is, a habit, or automatic robots, performs the tasks for us without special effort, energy, concentration, memory, and so on.
- **Promoting Attitude:** A facilitative attitude provides the motivation that fuels persistence & mobilization of energy necessary for accomplishment of a progressive series of desirable but challenging goals.



# Task Analysis: The basic LEARNing strategy



- TA: **Breaking a task into single, logically sequenced steps & recording in a Checklist** and then checking off each step as it is completed.
- TA's always **make task initiation, completion & follow through much easier**....greatly improve performance despite limitations in memory, attention, energy, initiative, ability to sustain performance, organization...any other difficulty.
- TA's **reduce demand and energy consumed** by reasoning and problem solving associated with planning, organizing & having to recall, make decisions & prioritize appropriate steps and sequences for both **basic and complex tasks**.
- TA's **(re)establish** efficient **habit routines** that make up normal everyday activity. **30 to 1000** consistent **repetitions** produce **automatic habits**
- **Ingredients** for (re)building automatic habits are the **3 P's: Plan, Practice, Promoting Attitude**. The result is (re)habilitation, or increased efficiency accomplished by removing obstacles to independence.



# Catastrophic Reaction

Early: Acute  
Overwhelming  
Anxiety /  
Distress

**COPING**

Successful  
- Maximal  
Recovery/  
Adaptation

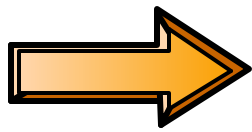
Unsuccessful

Failure  
Producing/  
Progress  
Blocking  
Attitudes

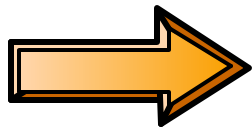
Deterioration



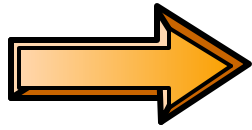
# The Five Commandments *of Rehabilitation*



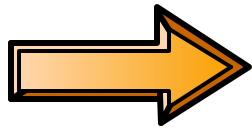
**Thou Shall Make Only Accurate Comparisons.**  
*Thou shall not make false comparisons.*



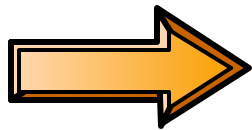
**Thou Shall Learn New Ways to Do Old  
Things.**



**Thou Shall Not Beat Thyself Up...Instead,  
Thou Shall Build Thyself Up!**



**Thou Shall View Progress as a Series of Small  
Steps**



**Thou Shall Expect Challenge & Strive to Beat  
IT**



# Rehabilitation Imperative

- ✓ **First - Want to Improve**
  - ✓ Want to Get Better More than you Want Anything Else
- ✓ **Second - Believe that You Can Improve**
- ✓ **Third - Set a Series of Gradual, Incremental Goals so that You Can Improve *in small steps!***

# Rehabilitation RX for NeuroRehabilitation

- Lobby for Application of Best Available Interventions in Research and Practice
- Implement Biopsychosocial Models and Integrated Combination Treatment Methodologies
- Discard Pseudoscientific Pesimissm
- Adopt Proportionality in Critical Self Examination of NeuroRehabilitative Research & Practice
- Use Task Analyses for Generating Best Practices for Every Aspect of Rehabilitation (e.g., 3 P's for Pt, Staff Competence, with Shaping, Neurophysiologic Interventions, Medical / Physical Treatments,...)

Additional Areas (Part II)  
STEM CELL  
LOCOMOTOR THERAPY  
EMG Neuromuscular  
Reeducation  
Anti-Fatigue (Provigil)  
KINESTHETIC IMAGERY



- **The Beginning**