ADHD & Neurofeedback

The Original Research

- · Lubar, J. F. (1977). Electroencephalographic biofeedback, methodology and the management of epilepsy. Pavlovian Journal of Biological Science, 12, 147-189.
- · Shouse, M. N. & Lubar, J. F. (1978). Physiological bases of hyperkinesis treated with methylphenidate. Pediatrics, 62, 343-351.
- · Shouse, M. N., & Lubar, J. F. (1979). Sensorimotor rhythm (SMR) operant conditioning and methylphenidate in the treatment of hyperkinesis. Biofeedback and Self-Regulation, 4, 299-311.
- · Lubar, J. F., Shabsin, H. S., Natelson, S. E., Holder, G. S., Woodson, S. F., Pamplin, W. E., & Krulikowski, D. I. (1981). EEG operant conditioning in intractable epileptics. Archives of Neurology, 38, 700-704.
- · Lubar, J. O., & Lubar, J. F. (1984). Electroencephalographic biofeedback of SMR and beta for treatment of attention deficit disorders in a clinical setting. Biofeedback and Self-Regulation, 9, 1-23.

Later Peer Reviewed Studies

- · Mann, C. A., Lubar, J. F., Zimmerman, A. W., Miller, B. A., & Muenchen, R. A. (1992). Quantitative analysis of EEG in boys with attention deficit/hyperactivity disorder (ADHD). A controlled study with clinical implications. Pediatric Neurology, 8, 30-36.
- · Lubar, J. F., Swartwood, M. O., Swartwood, J. N., & O'Donnell, P. (1995). Evaluation of the effectiveness of EEG neurofeedback training for ADHD in a clinical setting as measured by changes in T.O.V.A. scores, behavioral ratings, and WISC-R performance. Biofeedback and Self-Regulation, 20, 83-99.
- · Lubar, J. F., Swartwood, M. O., Swartwood, J. N., & Timmermann, D. L. (1995). Quantitative EEG and auditory event-related potentials in the evaluation of Attention-Deficit/Hyperactivity disorder: Effects of methylphenid ate and implications for neurofeedback training. Journal of Psychoeducational Assessment (Monograph Series Advances in Psychoeducational Assessment) Assessment of Attention-Deficit/Hyperactivity Disorders, 143-204.

Many Studies Followed

- In collaboration with researchers from Tubingen University (Germany), Radboud University (Nijmegen, the Netherlands), Brainclinics and EEG Resource Institute a so-called meta-analysis was conducted on all published research about Neurofeedback treatment in ADHD. **This meta-analysis included 15 studies and 1194 ADHD patients.** Based on this study - which was published in the July issue of EEG and Clinical Neuroscience - it could be concluded that Neurofeedback can indeed be considered an Evidence-Based treatment for ADHD. **The results show that neurofeedback treatment has large and clinically significant effects on Impulsivity and Inattention and a modest improvement of Hyperactivity.**

- Arns, M., de Ridder, S., Strehl, U., Breteler, M. & Coenen, A. Efficacy of Neurofeedback Treatment in ADHD: The effects on Inattention, Impulsivity and Hyperactivity: a Meta-Analysis. EEG and Clinical Neuroscience; 40(3), 180-189.

MRI Research & Neurofeedback

Changing Function of the Brain

MRI Research shows that EEG Biofeedback changes the functioning of the brain.

- **Functional magnetic resonance imaging investigation of the effects of neurofeedback training on the neural bases of selective attention and response inhibition in children with attention-deficit/hyperactivity disorder.**
- **Beauregard M**, **Lévesque J**.
- Centre de Recherche en Neuropsychologie et Cognition, Département de Psychologie, Université de Montréal, Montréal, Canada. mario.beauregard@umontreal.ca
- Two functional magnetic resonance imaging (fMRI) experiments were undertaken to measure the effect of neurofeedback training (NFT), in AD/HD children, on the neural substrates of selective attention and response inhibition. Twenty unmedicated AD/HD children participated to these experiments. Fifteen children were randomly assigned to the Experimental (EXP) group whereas the other five children were randomly assigned to the Control (CON) group. Only subjects in the EXP group underwent NFT. EXP subjects were trained to enhance the amplitude of the SMR (12-15 Hz) and beta 1 activity (15-18 Hz), and decrease the amplitude of theta activity (4-7 Hz). Subjects from both groups were scanned one week before the beginning of NFT (Time 1) and 1 week after the end of NFT (Time 2), while they performed a "Counting Stroop" task (Experiment 1) and a Go/No-Go task (Experiment 2). At Time 1, in both groups, the Counting Stroop task was associated with significant activation in the left superior parietal lobule. For the Go/No-Go task, no significant activity was detected in the EXP and CON groups. At Time 2, in both groups, the Counting Stroop task was associated with significant activation of the left superior parietal lobule. This time, however, there were significant loci of activation, in the EXP group, in the right ACC, left caudate nucleus, and left substantia nigra. No such activation loci were seen in CON subjects. For the Go/No-Go task, significant loci of activation were noted, in the EXP group, in the right ventrolateral prefrontal cortex, right ACcd, left thalamus, left caudate nucleus, and left substantia nigra. No significant activation of these brain regions was measured in CON subjects. These results suggest that NFT has the capacity to functionally normalize the brain systems mediating selective attention and response inhibition in AD/HD children.
- PMID: 16552626 [PubMed - indexed for MEDLINE]

Neurofeedback Changes Brain Structure

Clinical EEG and Neuroscience
00(0) 1-8

DOI: 10.1177/1550059413476031
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Neurofeedback Training Induces Changes in White and Gray Matter

J. Ghaziri[1], A. Tucholka[2], V. Larue[1], M. Blanchette-Sylvestre[1], G. Reyburn[1], G. Gilbert[2], J. Lévesque[1], and M. Beauregard[1,2,3]

Abstract

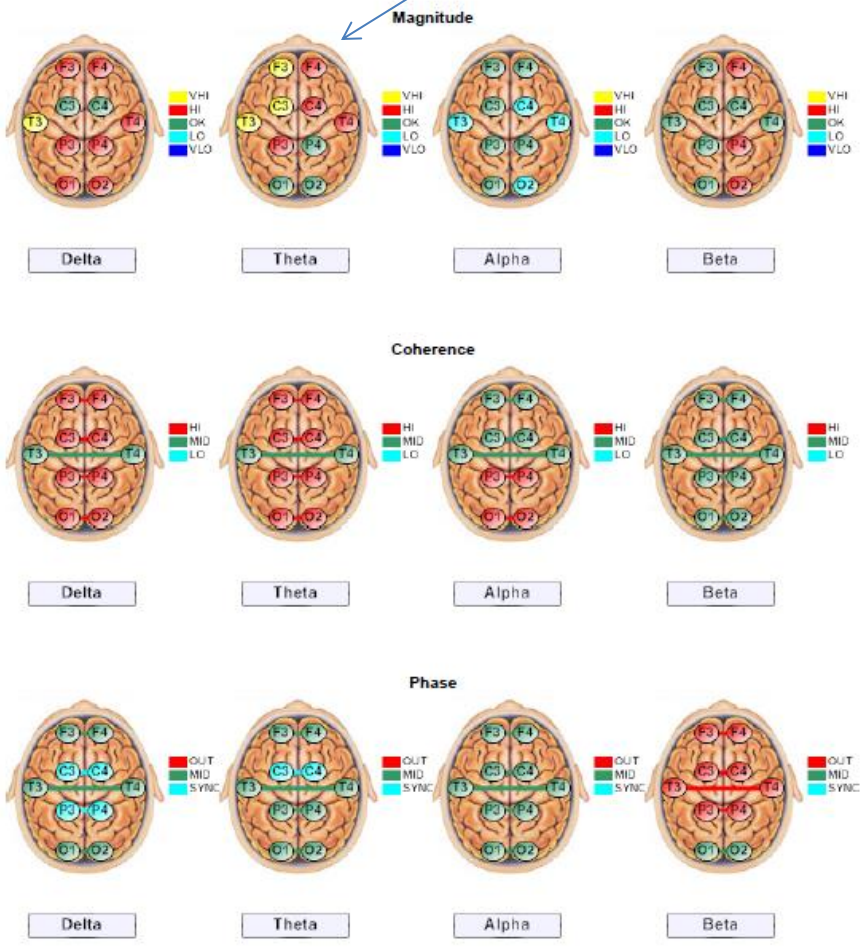
The main objective of this structural magnetic resonance imaging (MRI) study was to investigate, using diffusion tensor imaging, whether a neurofeedback training (NFT) protocol designed to improve sustained attention might induce structural changes in white matter (WM) pathways, purportedly implicated in this cognitive ability. Another goal was to examine whether gray matter (GM) volume (GMV) might be altered following NFT in frontal and parietal cortical areas connected by these WM fiber pathways. Healthy university students were randomly assigned to an experimental group (EXP), a sham group, or a control group. Participants in the EXP group were trained to enhance the amplitude of their β1 waves at F4 and P4. Measures of attentional performance and MRI data were acquired one week before (Time 1) and one week after (Time 2) NFT. Higher scores on visual and auditory sustained attention were noted in the EXP group at Time 2 (relative to Time 1). As for structural MRI data, increased fractional anisotropy was measured in WM pathways implicated in sustained attention, and GMV increases were detected in cerebral structures involved in this type of attention. After 50 years of research in the field of neurofeedback, our study constitutes the first empirical demonstration that NFT can lead to microstructural changes in white and gray matter.

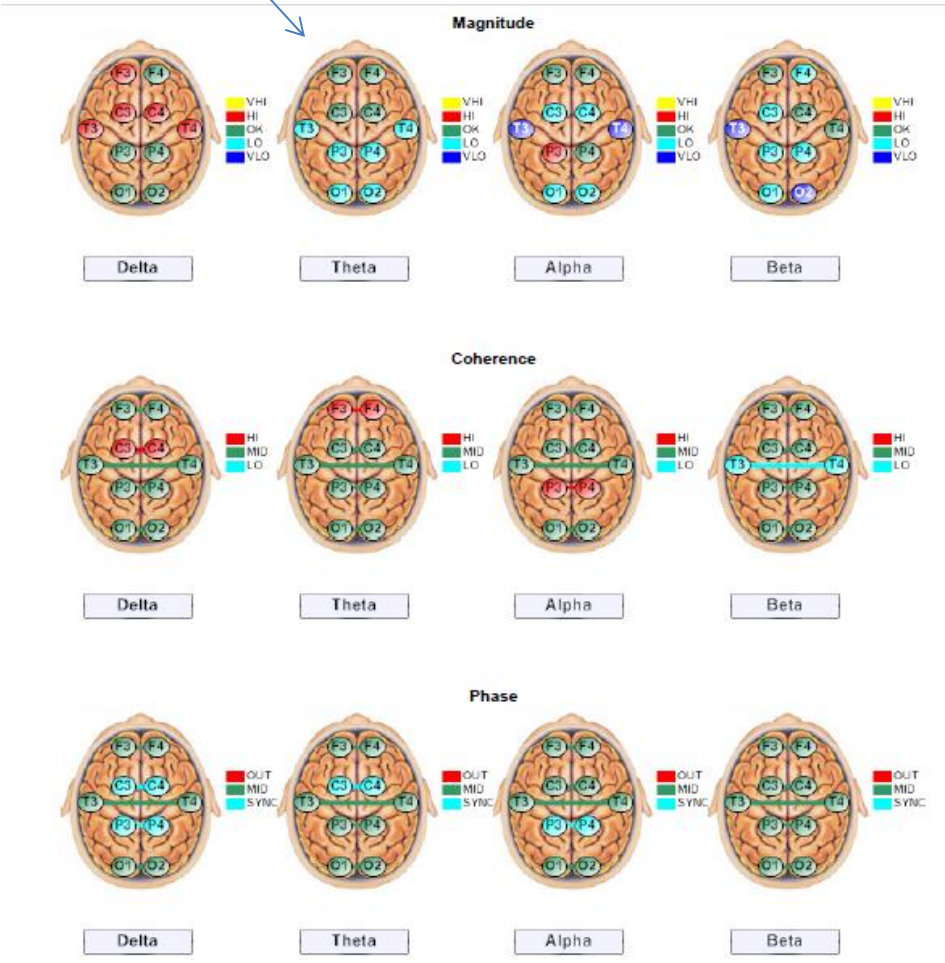
Keywords

neurofeedback, structural magnetic resonance imaging, white matter, gray matter, sustained attention

Pre Post ADHD Child: 40 Sessions

Significant Theta Reduction





Inhibit Theta Using Two Channel Protocol #2

Typical Changes In ADHD

- Improved Behavior
- Improved School Performance 1-2 grade levels.
- Increase IQ by

  5-15 points.
- Reduced Medications.

(Hammond, 2006)

American Academy of Pediatrics

ADDRESSING *Mental Health* CONCERNS IN PRIMARY CARE
A CLINICIAN'S TOOLKIT

EVIDENCE-BASED CHILD AND ADOLESCENT PSYCHOSOCIAL INTERVENTIONS

This report is intended to guide practitioners, educators, youth, and families in developing appropriate plans using psychosocial interventions. It was created for the period November 2012–April 2013 using the PracticeWise Evidence-Based Services (PWEBS) Database, available at www.practicewise.com. If this is not the most current version, please check the American Academy of Pediatrics mental health Web site (www.aap.org/mentalhealth) for updates.

Problem Area	Level 1- BEST SUPPORT	Level 2- GOOD SUPPORT	Level 3- MODERATE SUPPORT	Level 4- MINIMAL SUPPORT	Level 5- NO SUPPORT
Anxious or Avoidant Behaviors	Cognitive Behavior Therapy (CBT), CBT and Medication, CBT with Parents, Education, Exposure, Modeling	Assertiveness Training, Attention, CBT for Child and Parent, Cultural Storytelling, Family Psychoeducation, Hypnosis, Relaxation, Stress Inoculation	Contingency Management, Group Therapy	Biofeedback, CBT with Parents Only, Play Therapy, Psychodynamic Therapy, Rational Emotive Therapy	Assessment/Monitoring, Attachment Therapy, Client Centered Therapy, Eye Movement Desensitization and Reprocessing (EMDR), Peer Pairing, Psychoeducation, Relationship Counseling, Teacher Psychoeducation
Attention and Hyperactivity Behaviors	Behavior Therapy and Medication, Biofeedback, Parent Management Training, Self-Verbalization	Contingency Management, Education, Parent Management Training (with Problem Solving, or with Teacher Psychoeducation), Physical Exercise (with or without Relaxation), Social Skills and Medication, Working Memory Training	Biofeedback and Medication	Parent Management Training and Social Skills, Relaxation, Self-Verbalization and Contingency Management, Social Skills	Attention Training, Client Centered Therapy, CBT, CBT and Anger Control, CBT and Medication, Family Therapy, Parent Coping/Stress Management, Parent Management Training and Self-Verbalization, Problem Solving, Psychoeducation, Self-Control Training, Self-Verbalization and Medication, Skill Development
Autism Spectrum Disorders	Intensive Behavior Therapy, Intensive Communication Training	Parent Management Training, Peer Pairing, Physical/ Social/Occupational Therapy	None	Cognitive Behavior Therapy, Massage, Social Skills	Auditory Integration Training, Biofeedback, Eclectic Therapy, Hyperbaric Treatment, Modeling, Structured Listening

PracticeWise, the proprietary company that creates the American Academy of Pediatrics "Evidence-based Child and Adolescent Psycho-social Interventions" has just ***elevated biofeedback to "Level 1 - Best Support" as an intervention for Attention Problems.***

The brain is capable of changing and remodeling itself

The Research Community Reports The Real Findings

- In a recent paper *Update on attention-deficit/hyperactivity disorder* published in Current Opinion in Pediatrics Katie Campbell Daley reviewed the research and practice standards on treatment of ADHD. Dr. Campbell serves on the staff of the Department of Medicine, Children's Hospital Boston and in the Department of Pediatrics of the Harvard Medical School. She concluded:
-
- "Overall, these findings support the use of multi-modal treatment, including medication, parent/school counseling, and EEG biofeedback, in the long term management of ADHD, with EEG biofeedback in particular providing a sustained effect even without stimulant treatment...parents interested in non-psychopharmacologic treatment can pursue the use of complementary and alternative therapy. The therapy most promising by recent clinical trials appears to be EEG biofeedback."

More Recently

Eur Child Adolesc Psychiatry
DOI 10.1007/s00787-010-0109-5

ORIGINAL CONTRIBUTION

Neurofeedback training in children with ADHD: 6-month follow-up of a randomised controlled trial

Holger Gevensleben · Birgit Holl · Björn Albrecht · Dieter Schlamp · Oliver Kratz · Petra Studer · Aribert Rothenberger · Gunther H. Moll · Hartmut Heinrich

Received: 8 September 2009 / Accepted: 31 March 2010

Abstract Neurofeedback (NF) could help to improve attentional and self-management capabilities in children with attention-deficit/hyperactivity disorder (ADHD). In a randomised controlled trial, NF training was found to be superior to a computerised attention skills training (AST) (Gevensleben et al. in J Child Psychol Psychiatry 50(7): 780–789, 2009). In the present paper, treatment effects at 6-month follow-up were studied. 94 children with ADHD, aged 8–12 years, completed either 36 sessions of NF training ($n = 59$) or a computerised AST ($n = 35$). Pre-training, post-training and follow-up assessment encompassed several behaviour rating scales (e.g., the German ADHD rating scale, FBB-HKS) completed by parents. Follow-up information was analysed in 61 children (ca. 65%) on a per-protocol basis. 17 children (of 33 dropouts) had started a medication after the end of the training or early in the follow-up period. Improvements in the NF group ($n = 38$) at follow-up were superior to those of the control group ($n = 23$) and comparable to the effects at the end of the training. For the FBB-HKS total score (primary outcome measure), a medium effect size of 0.71 was obtained at follow-up. A reduction of at least 25% in the primary outcome measure (responder criterion) was observed in 50% of the children in the NF group. In conclusion, behavioural improvements induced by NF training in children with ADHD were maintained at a 6-month follow-up. Though treatment effects appear to be limited, the results confirm the notion that NF is a clinically efficacious module in the treatment of children with ADHD.

Keywords ADHD · Neurofeedback · Randomised controlled trial (RCT) · Follow-up · Children

Introduction

And It Continues . . .

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Resting-state EEG gamma activity in children with Attention-Deficit/Hyperactivity Disorder

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EEG
Gamma

ABSTRACT

Objective: Children with Attention-Deficit/Hyperactivity Disorder (AD/HD) have well-described abnormalities in the four traditional EEG bands. However, to date the gamma band has not been widely investigated. This study investigated resting-state EEG in children with AD/HD and matched controls, with a particular focus on gamma activity.
Method: Forty children with AD/HD, and 40 age- and sex-matched controls, participated. EEG was recorded from 19 sites during an eyes-closed resting condition and Fourier transformed to provide estimates for absolute and relative power in the delta, theta, alpha, beta and gamma bands.
Results: Children with AD/HD had elevated levels of absolute delta and theta power, and decreased levels of absolute beta and gamma power, compared to controls. With relative power measures, children with AD/HD showed enhanced delta and theta activity, with reduced alpha, beta and gamma activity. Inattention scores on the Conners' Parent Rating Scale were negatively correlated with absolute gamma.
Conclusions: These patients demonstrate the typical EEG profile in the eyes-closed resting state, over the delta, theta, alpha and beta bands, associated with AD/HD. In addition, compared with controls, they demonstrate reduced absolute and relative gamma activity. These differences appear to contribute importantly to their dysfunctional stimulus processing, and impact their behavioural outcomes.
Significance: This resting-state study extends the well-established fast-wave EEG deficits in children with AD/HD to the gamma band, and links that to increased inattention, which is of special importance in understanding their cognitive-processing problems.

qEEG Findings Fail To Support Unidimensional Disorder Theory

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International Journal of Psychophysiology 58 (2005) 81 – 93

INTERNATIONAL JOURNAL OF PSYCHOPHYSIOLOGY

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The neurophysiology of attention-deficit/hyperactivity disorder

Flavia di Michele[a,b,c], Leslie Prichep[a], E. Roy John[a], Robert J. Chabot[a,*]

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Received 23 September 2004; received in revised form 8 January 2005; accepted 27 January 2005
Available online 24 June 2005

Abstract

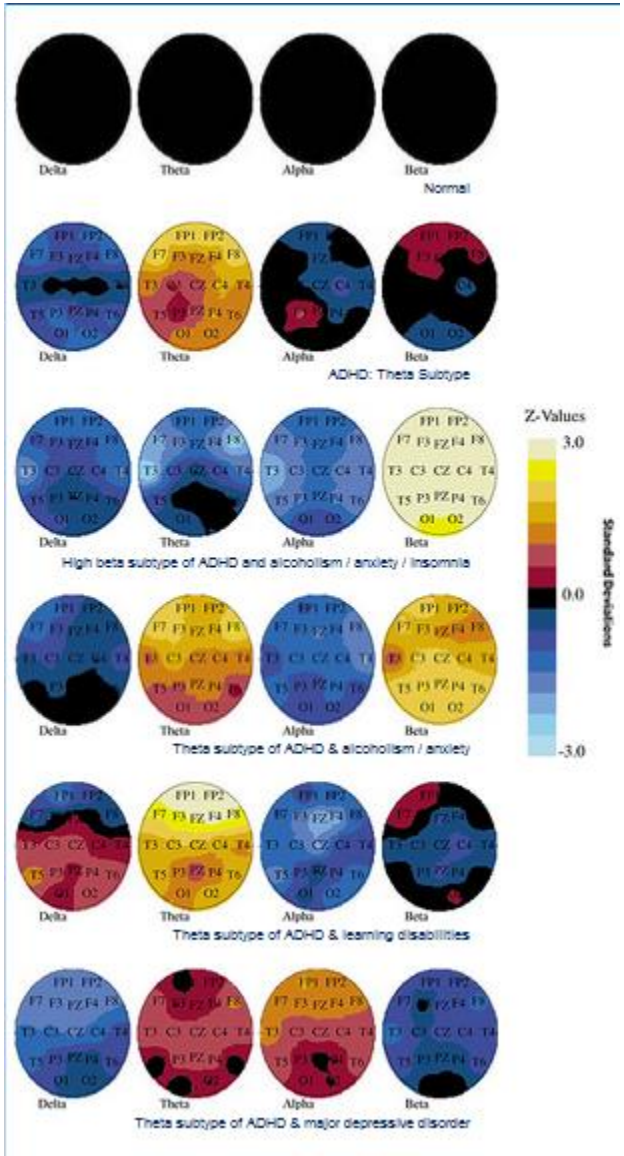
Recent reviews of the neurobiology of Attention-Deficit/Hyperactivity Disorder (AD/HD) have concluded that there is no single pathophysiological profile underlying this disorder. Certainly, dysfunctions in the frontal/subcortical pathways that control attention and motor behavior are implicated. However, no diagnostic criteria or behavioral/neuroimaging techniques allow a clear discrimination among subtypes within this disorder, especially when problems with learning are also considered. Two major Quantitative EEG (QEEG) subtypes have been found to characterize AD/HD. Here we review the major findings in the neurophysiology of AD/HD, focusing on QEEG, and briefly present our previous findings using a source localization technique called Variable Resolution Electromagnetic Tomography (VARETA). These two techniques represent a possible objective method to identify specific patterns corresponding to EEG-defined subtypes of AD/HD. We then propose a model representing the distribution of the neural generators in these two major AD/HD subtypes, localized within basal ganglia and right anterior cortical regions, and hippocampal, para-hippocampal and temporal cortical regions, respectively. A comprehensive review of neurochemical, genetic, neuroimaging, pharmacological and neuropsychological evidence in support of this model is then presented. These results indicate the value of the neurophysiological model of AD/HD and support the involvement of different neuroanatomical systems, particularly the dopaminergic pathways.

Conclusions

6. Conclusions

The diagnostic category AD/HD, as defined by APA, seems not to fit with the real heterogeneity of the symptoms exhibited in AD/HD and must be explained by multiple specific causes. Even though the intent of DSM-IV is to provide hierarchically organized categories of mental disorders that aid clinicians in differential diagnosis, certain criteria are too restrictive. In regard to AD/HD and LD, these are considered two mutually exclusive and non-overlapping entities. By this definition, a child cannot simultaneously meet criteria for AD/HD and LD. It is clear that AD/HD is a heterogeneous disorder. Therefore, it cannot be conceptualized as only one disease entity with a very narrow phenotype and a distinct etiology. Rather, it is believed to constitute a spectrum of disorders that subsume different subtypes of a larger population of children with attention and learning problems. To date, AD/HD is diagnosed solely on the basis of patterns of observable behavior. It has been difficult to identify specific biochemical or neurophysiological tests that may contribute to more accurate diagnosis. Identifying a biological measure that could aid in this distinction would help to refine diagnostic criteria and may provide more specific diagnostic tests for AD/HD and LD.

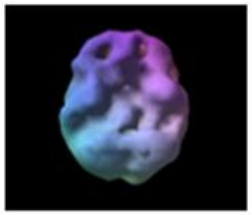
Clinical Evidence Is Supportive



Gurnee, Robert:
Compliments of The
ADD Clinic Scottsdale
Arizona

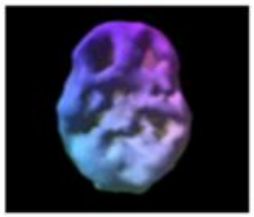
Amen's 6 Spect Subtypes

Combined



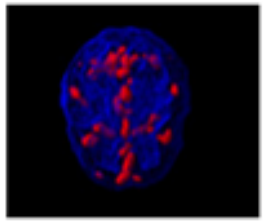
Undersurface view, rest. Mild decrease prefrontal area

Inattentive



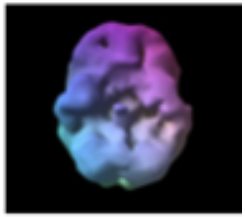
undersurface view, NO MEDS. Poor prefrontal and temporal lobe activity

Overfocused



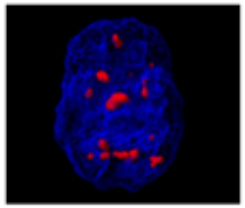
Top down active view. Increased cingulate activity

Temporal Lobe



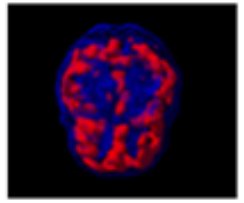
Undersurface view. Decreased left temporal lobe activity

Limbic



Underside active view. Increased limbic activity

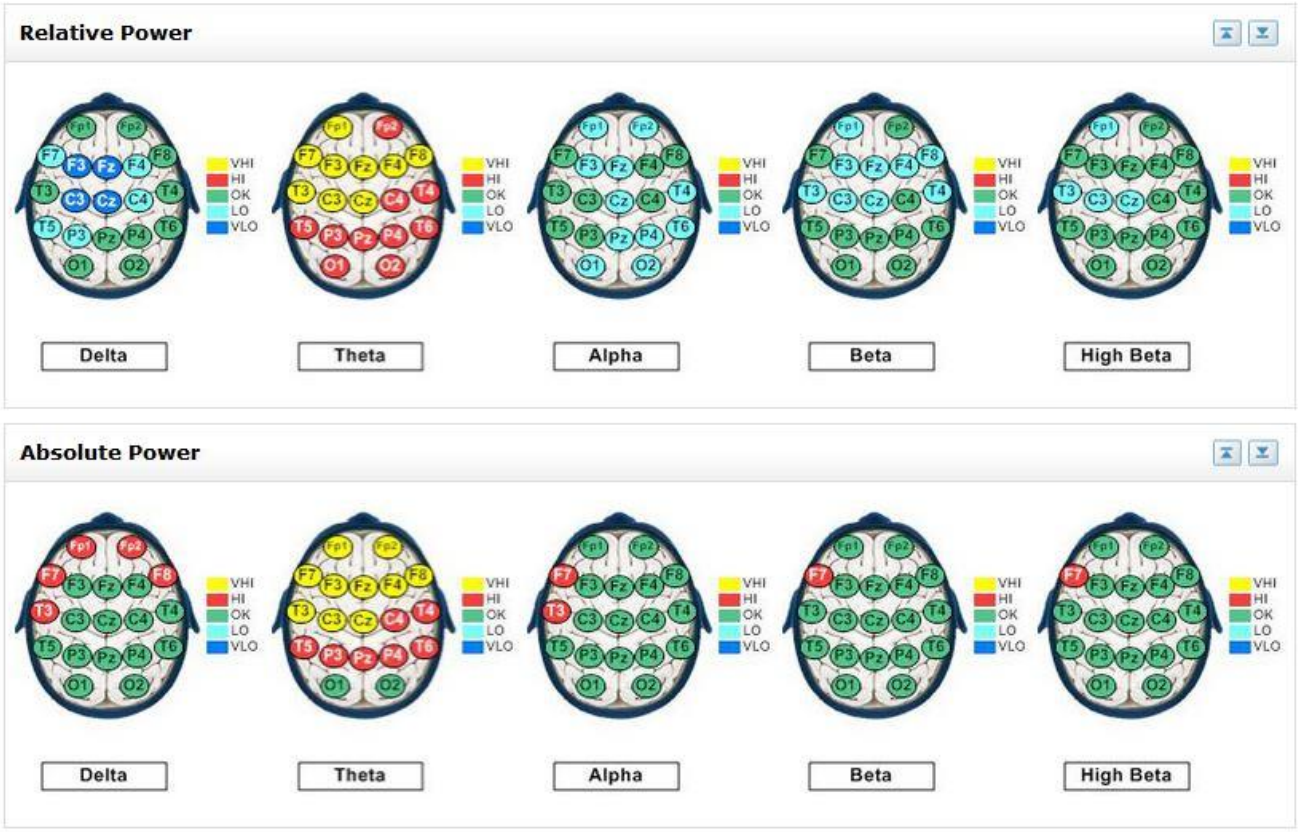
Ring of Fire



Top down active view. Increased activity in the cingulate, lateral parietal, frontal and temporal lobes

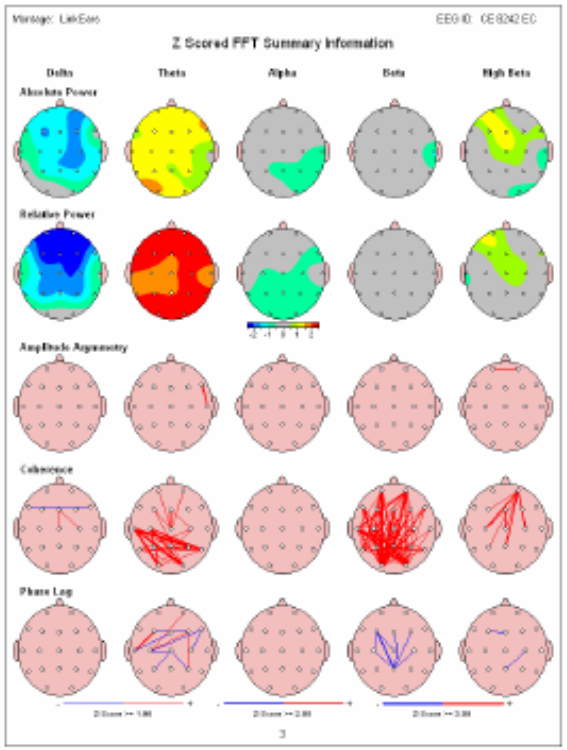
Do Not Match 5 qEEG Subtypes Identified

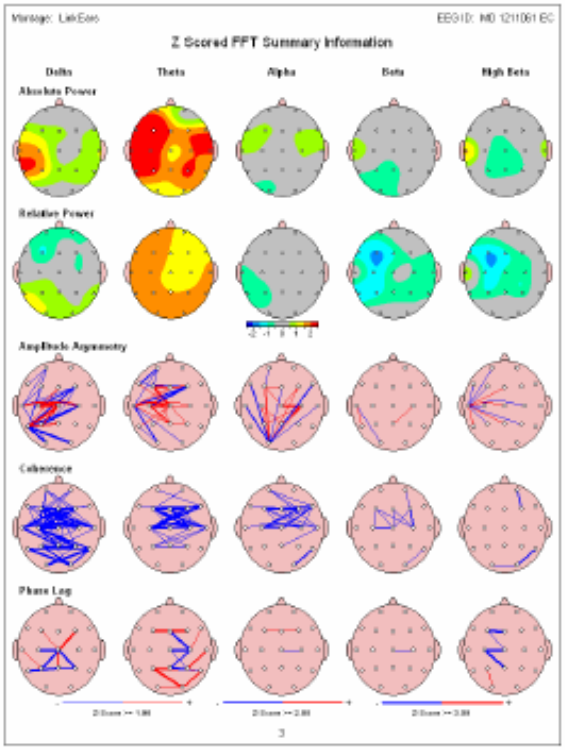
Classic ADHD Pattern



NOTE: Low Beta Phenotypes Are Often More Commonly Found

ADD Type Theta vs Over 75





Inhibition of Default

- Reduces (attenuates) in activity during focused attentional network activation.
- Reduces activity during memorization tasks.
- Reduces in activity during novel motor tasks.
- Reduces in response to intentional network activity (Buckner et al)

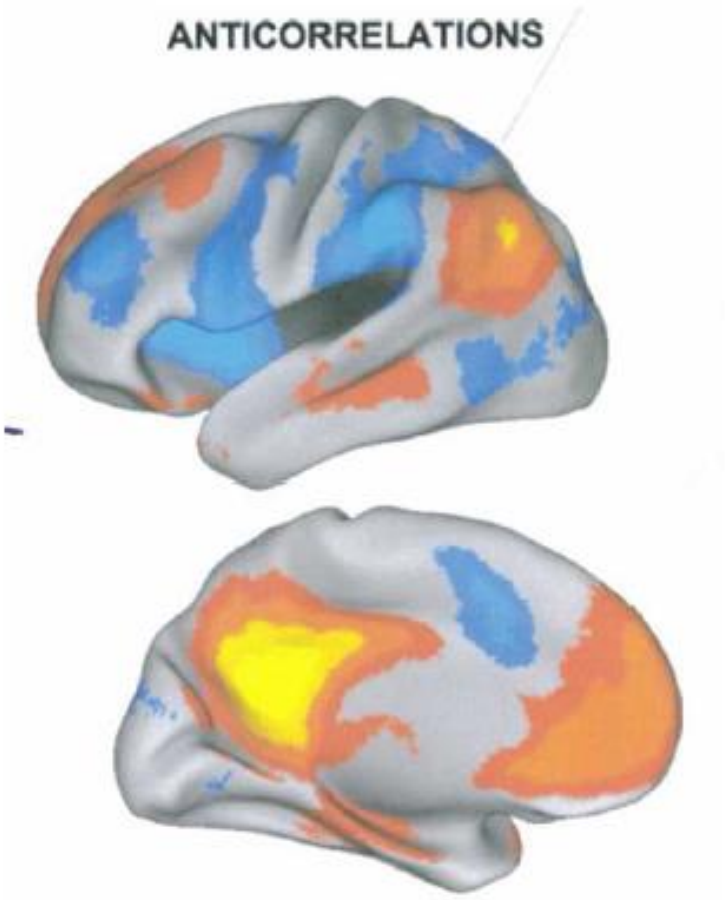


FIGURE 15. Intrinsic activity suggests that the default network is negatively correlated (anticorrelated) with brain systems that are used for focused external visual attention. Anticorrelated networks are displayed by plotting those regions that negatively correlate with the default network (shown in blue) in addition to those that positively correlate (shown in red). These two anticorrrelated networks may participate in distinct functions that compete with one another for control of information processing within the brain. Data are the same as analyzed for FIGURE 7.

Excitation of Default Network Navigating Social Interactions

- Self-reflective thoughts and judgments that depend on inferred social and emotional content. dMPFC
- Episodic memory HF
- Fantasy, daydreams, envisioning the future, past ruminations, moral judgments, inferring thoughts of others PCC.

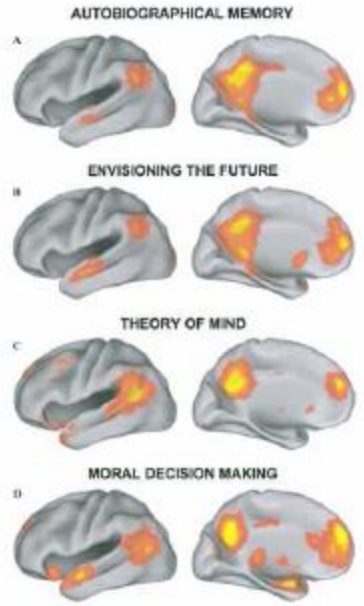


FIGURE 12. The default network is activated by diverse forms of tasks that require mental simulation of alternative perspectives or imagined scenes. Four such examples from the literature illustrate the generality. **(A)** Autobiographical memory: subjects recount a specific, past event from memory. **(B)** Envisioning the future: cued with an item (e.g., dress), subjects imagine a specific future event involving that item. **(C)** Theory of mind: subjects answer questions that require them to conceive of the perspective (belief) of another person. **(D)** Moral decision making: subjects decide upon a personal moral dilemma. Data come from prior studies and are here displayed using procedures similar to FIGURE 2. Data in A and B are from Addis et al. (2007). Data in C uses the paradigm of Saxe and Kanwisher (2003). Data in D is from Greene et al. (2001). Note that all the studies activate strongly PCC/Rsp and dMPFC. Active regions also include those close to IPL and LTC, although further research will be required to determine the exact degree of anatomic overlap. It seems likely that these maps represent multiple, interacting subsystems.

Two Thetas

Midline vs Temporal Lobe

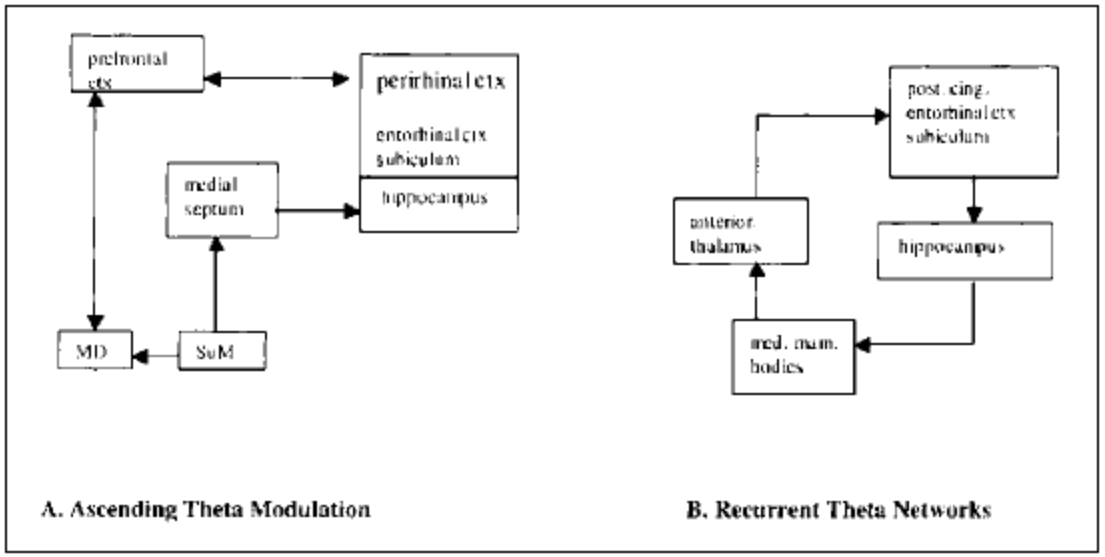
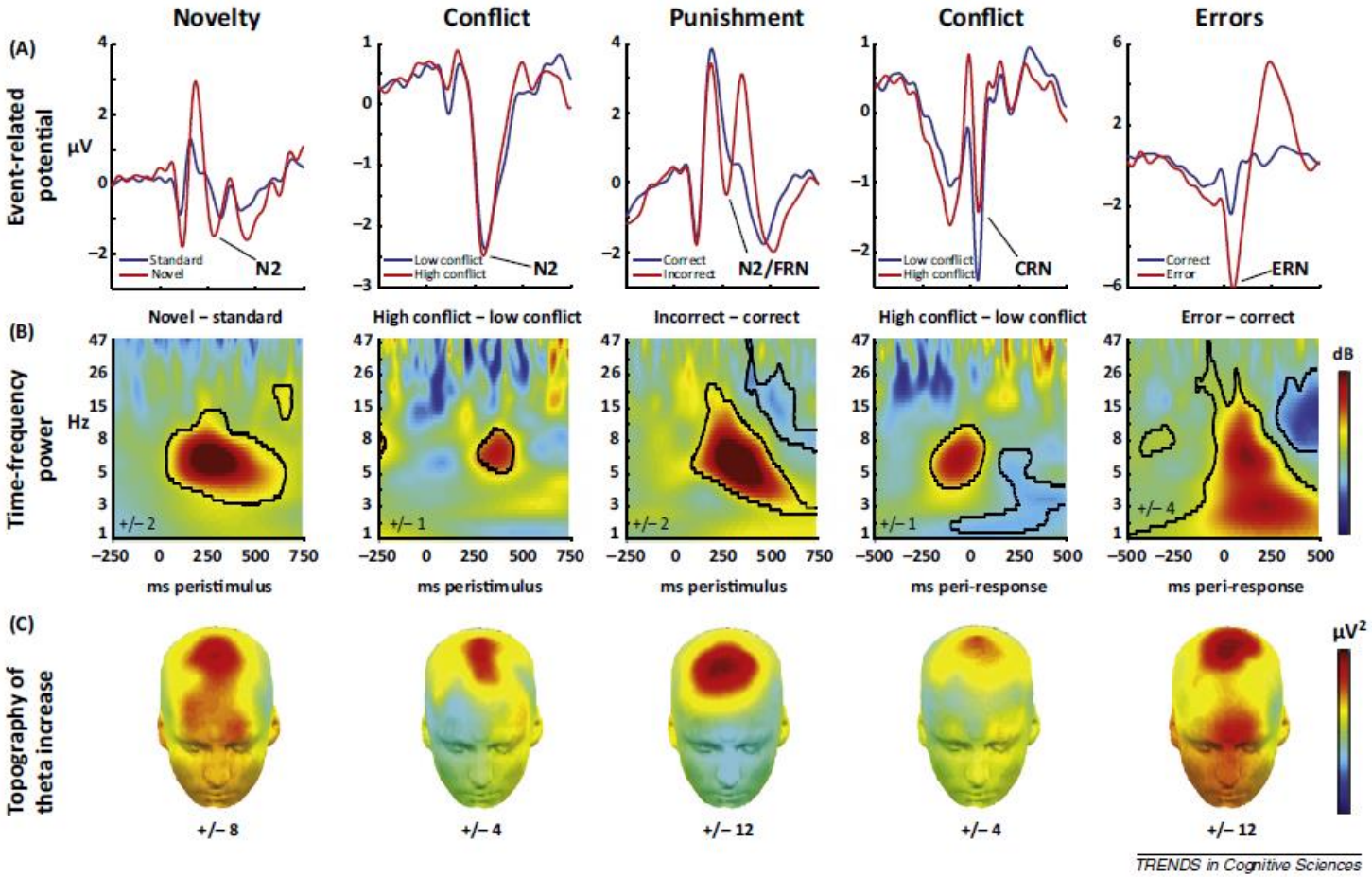


Fig. 1 – *Schematics of the pathways involved in A. ascending theta modulation and B. recurrent theta networks described in text. Abreviations: ctx – cortex, MD – mediodorsal thalamus, SuM – supramammillary nucleus, post. cing. – posterior cingulate, med. mam. bodies – medial mamillary bodies.*

Not All Theta Is Bad
Theta and Insight



Idling Zone of Default System

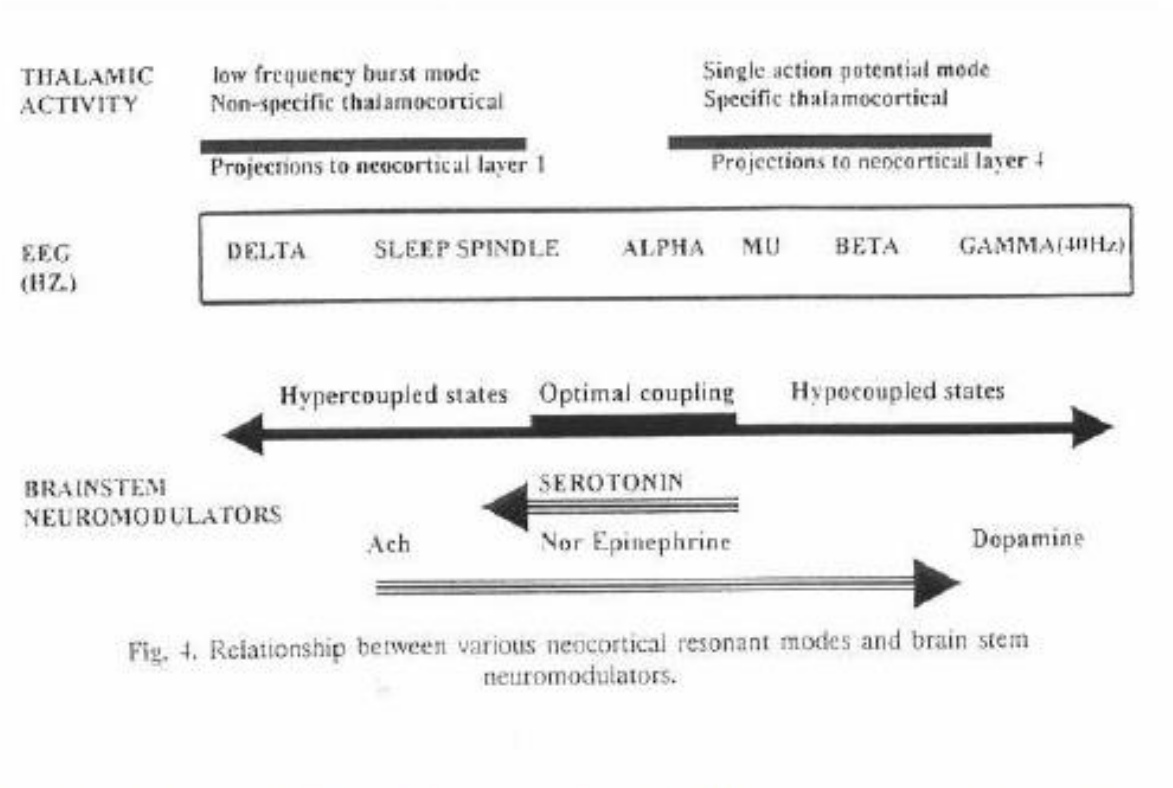


Fig. 4. Relationship between various neocortical resonant modes and brain stem neuromodulators.

- **Activation levels in the optimal idling zone reflect functional connectivity**

ADD Pathways

Or Depression vs Attention Problems ?

Depression Pathways

ADD Pathways

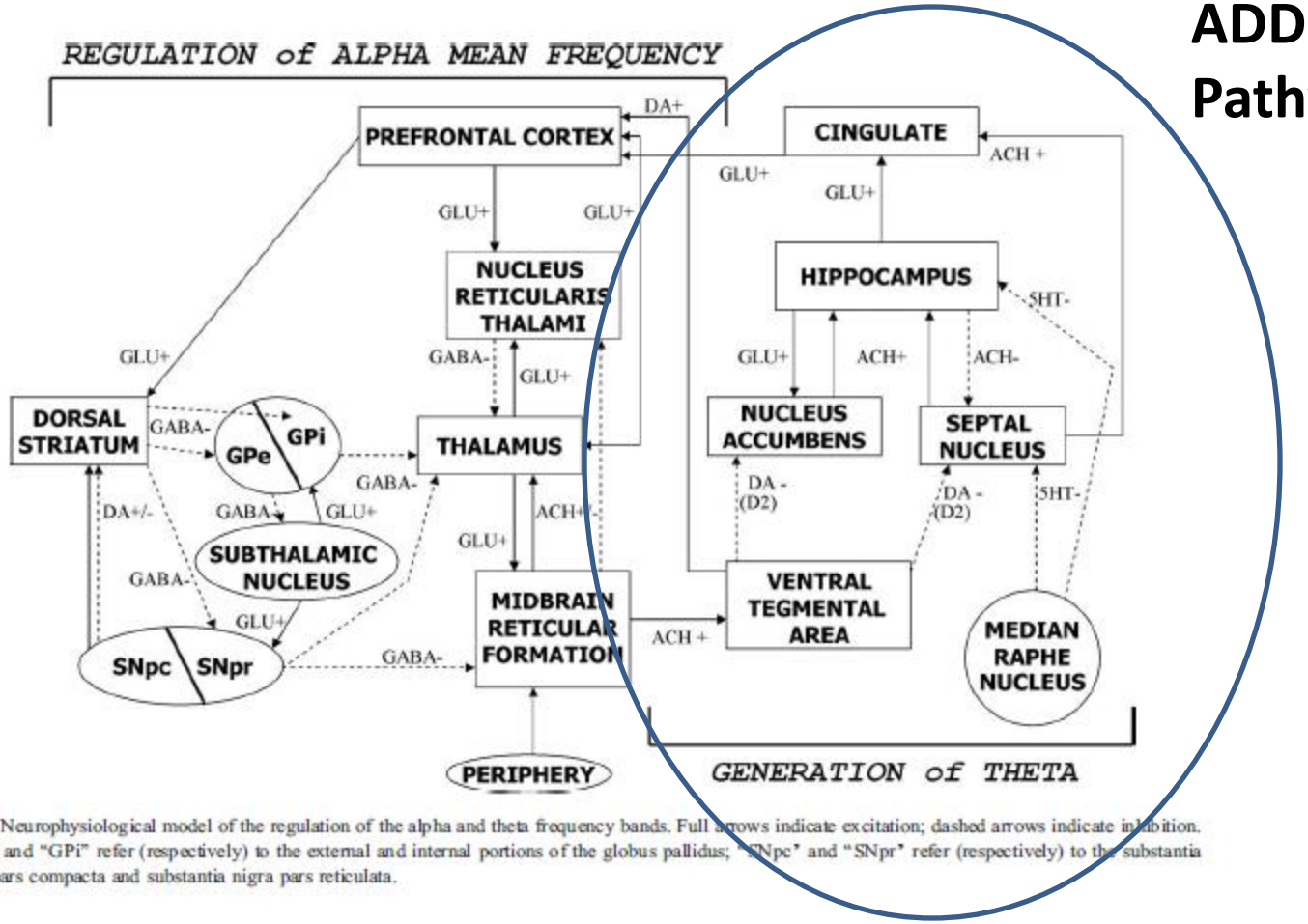
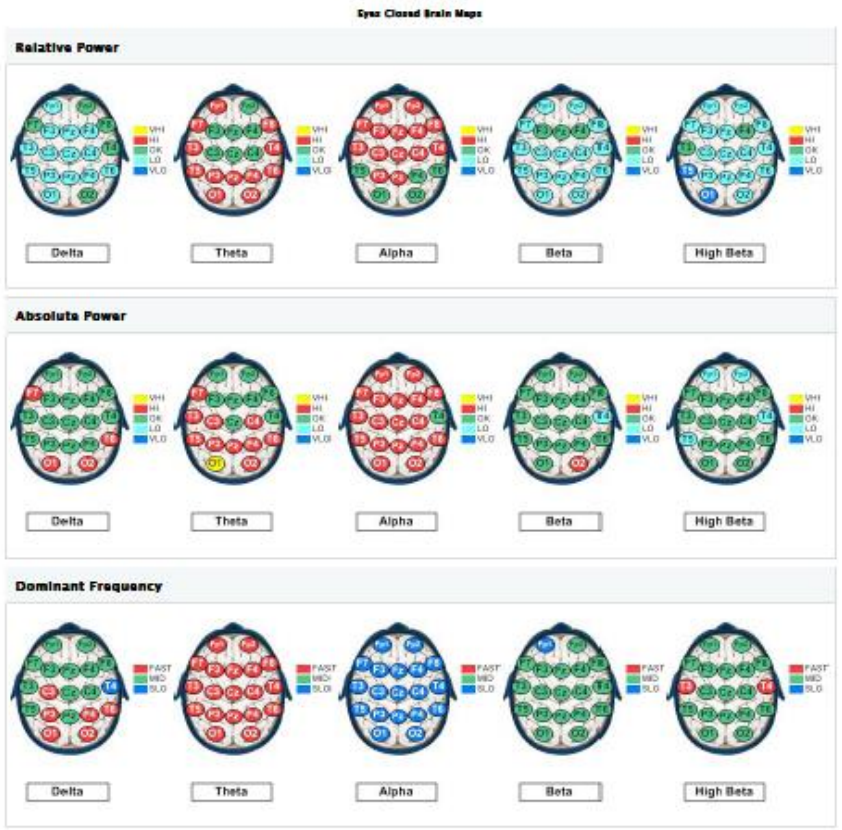


Fig. 1. Neurophysiological model of the regulation of the alpha and theta frequency bands. Full arrows indicate excitation; dashed arrows indicate inhibition. "GPe" and "GPi" refer (respectively) to the external and internal portions of the globus pallidus; "SNpc" and "SNpr" refer (respectively) to the substantia nigra pars compacta and substantia nigra pars reticulata.

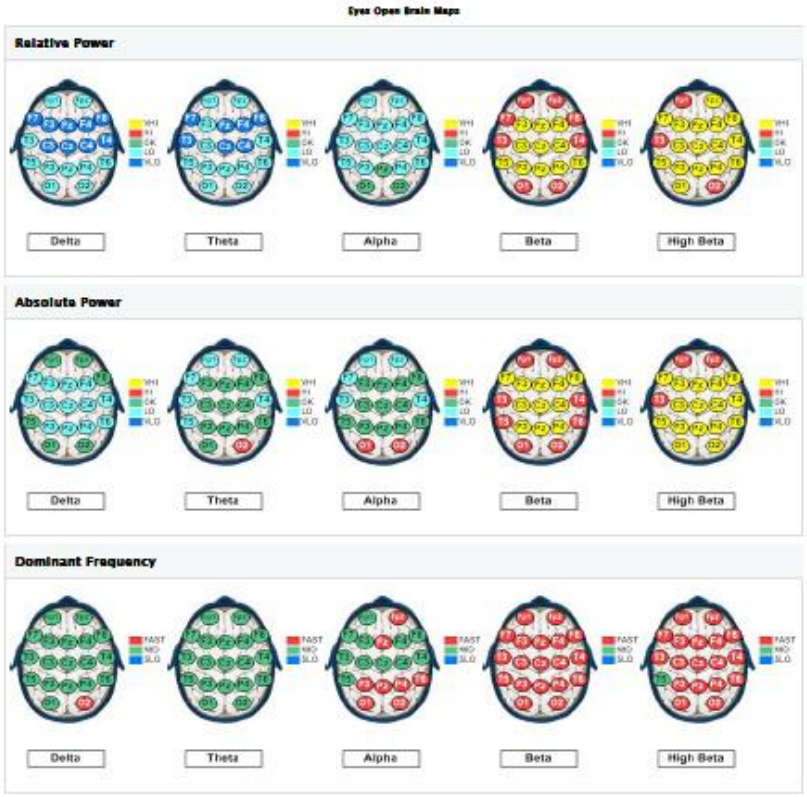
Michele et al, 2005

Diagnosed With ADHD

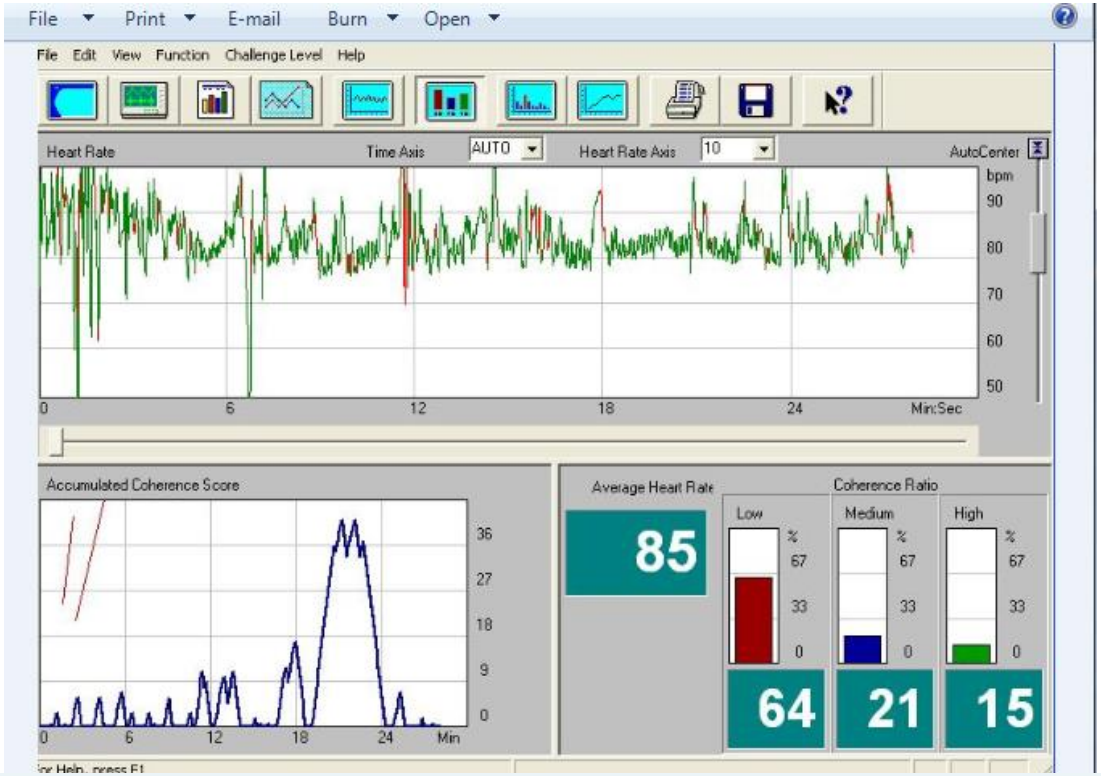


Testing revealed depression as key issue.

Diagnosed With ADD



Testing revealed key issue was anxiety.


File
Print
E-mail
Burn
Open
File Edit View Function Challenge Level Help
Heart Rate
Time Axis
AUTO
Heart Rate Axis
10
AutoCenter
bpm
90
80
70
60
50
0
6
12
18
24
Min:Sec
Accumulated Coherence Score
36
27
18
9
0
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6
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Average Heart Rate
85
Coherence Ratio
Low
Medium
High
%
67
33
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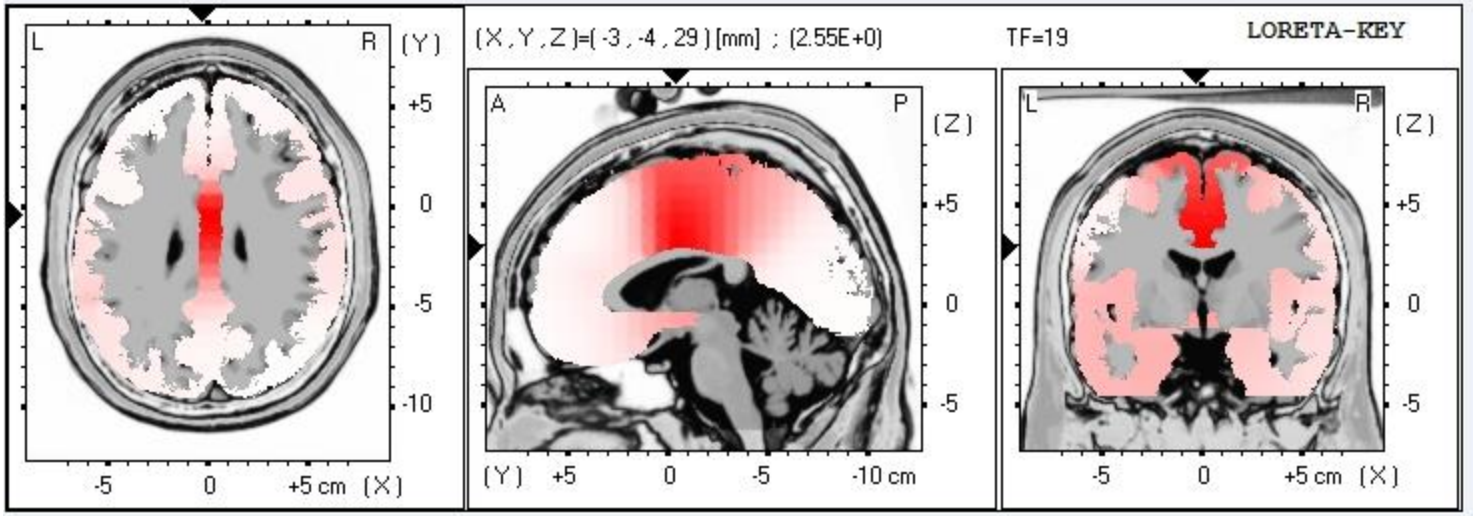
64
21
15


L
R
(Y)
+5
0
-5
-10
-5
0
+5 cm (X)
(X,Y,Z)=(-3 , -4 , 29) [mm] ; (2.55E+0)
TF=19
LORETA-KEY
A
P
(Z)
+5
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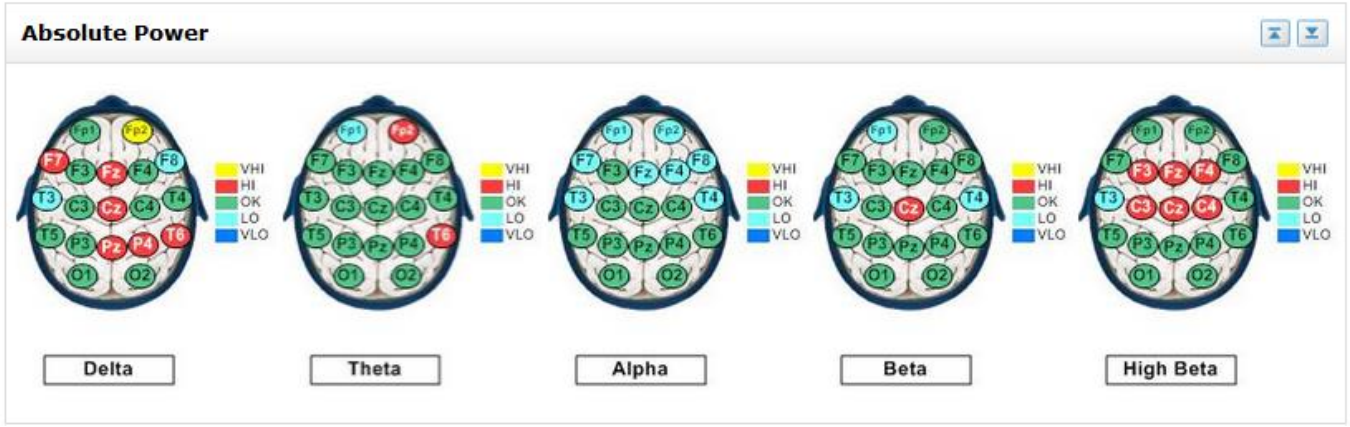
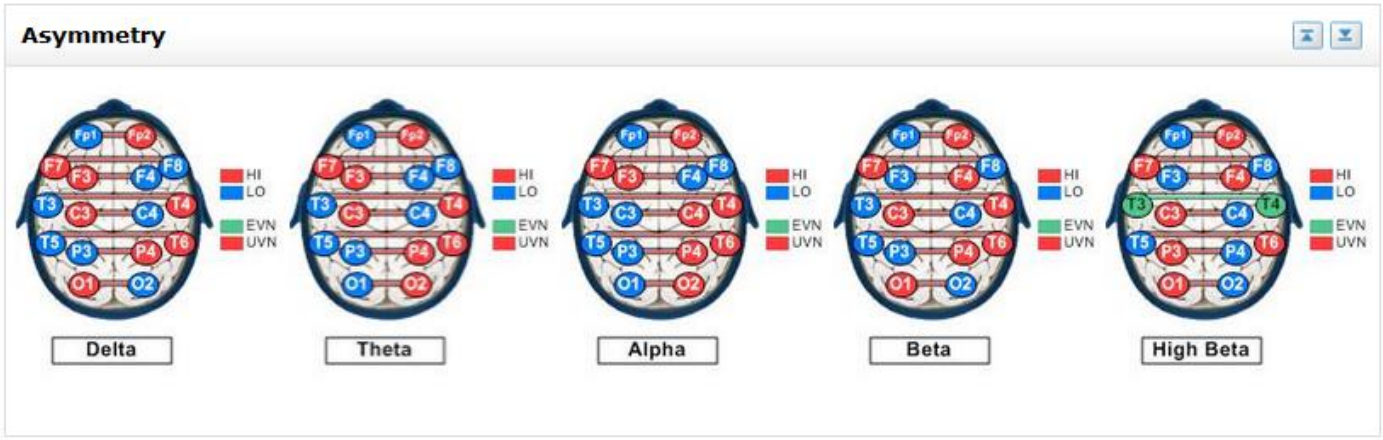
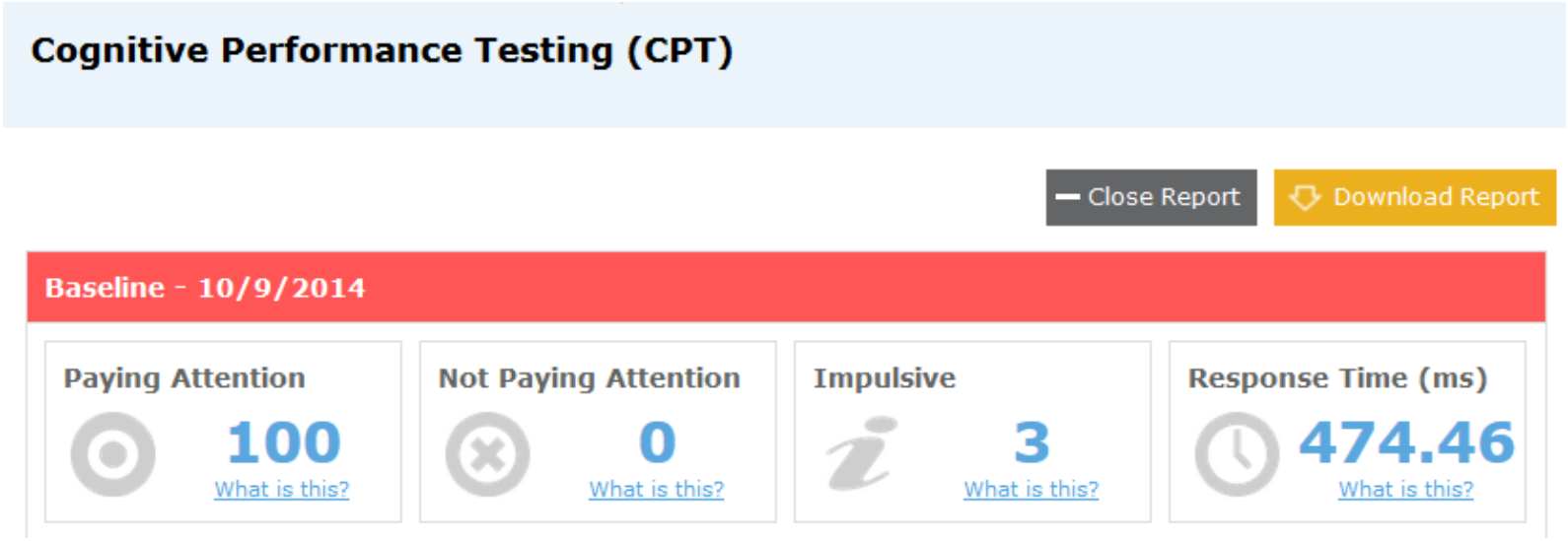
+5 cm (X)

Diagnosed With ADHD

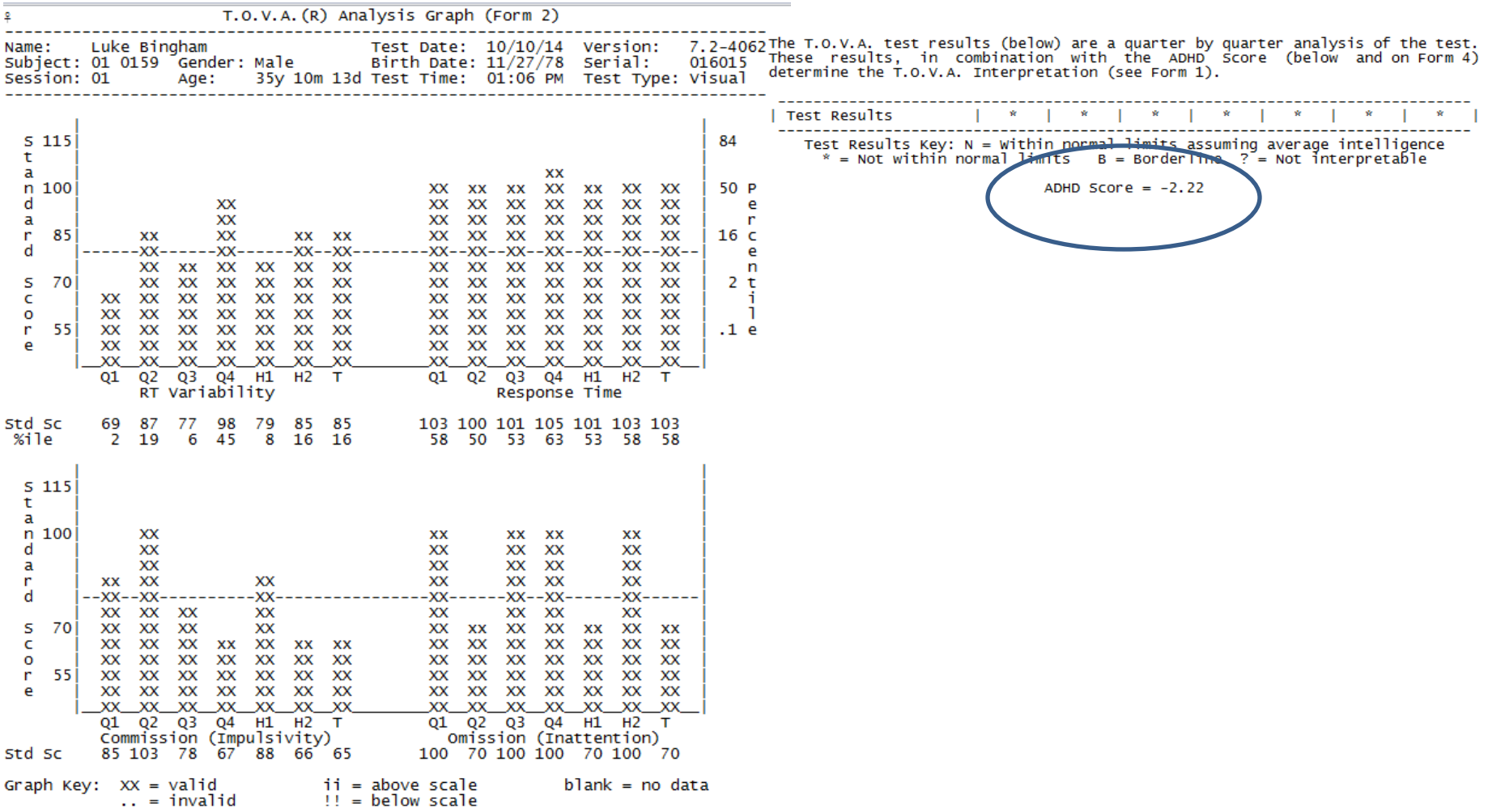




CPT Testing For Attention



TOVA Confirmation



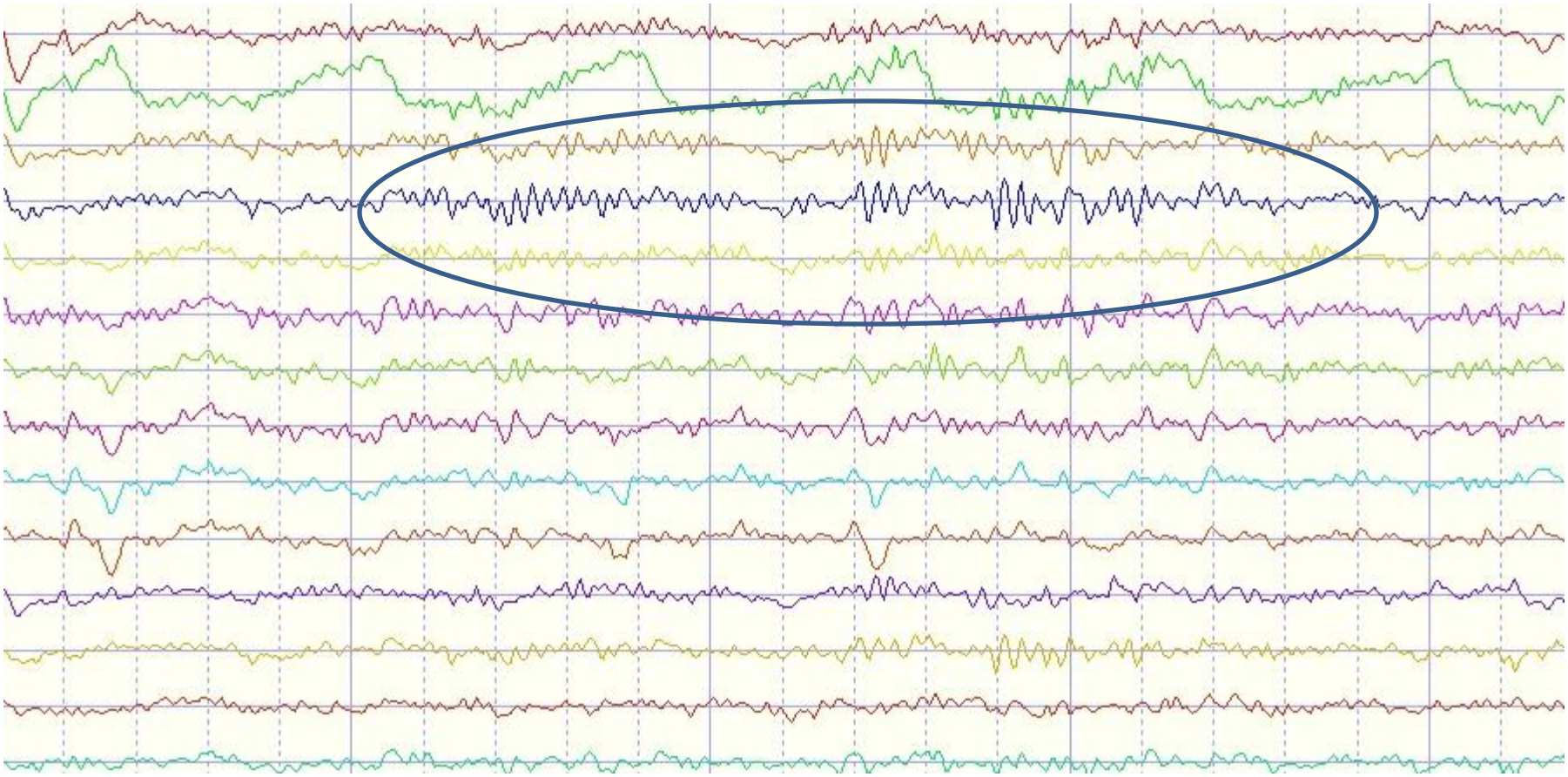
The T.O.V.A. test results (below) are a quarter by quarter analysis of the test. These results, in combination with the ADHD Score (below and on Form 4) determine the T.O.V.A. Interpretation (see Form 1).

Test Results	*	*	*	*	*	*	*

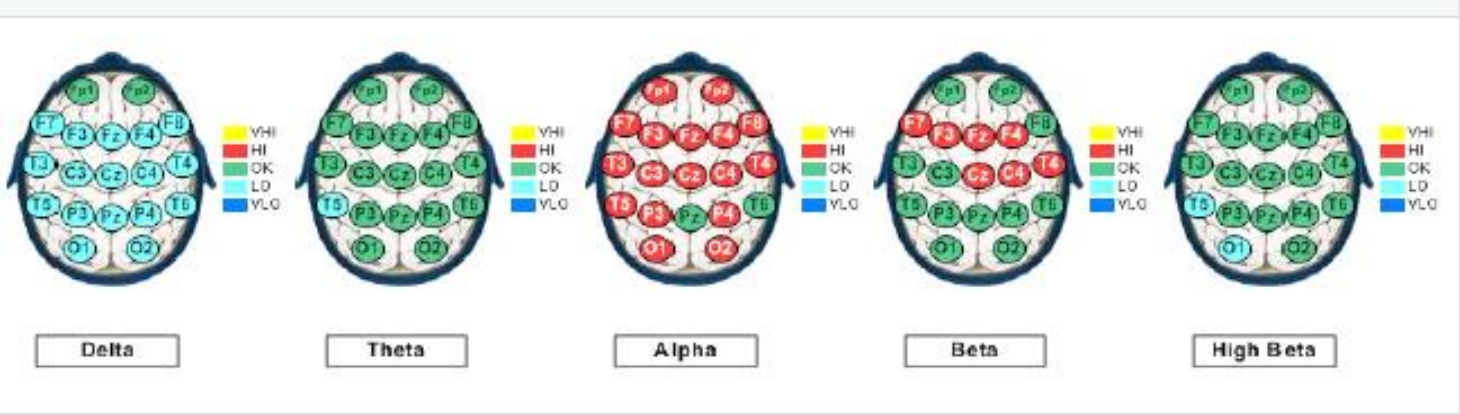
Test Results Key: N = Within normal limits assuming average intelligence
* = Not within normal limits B = Borderline ? = Not interpretable

ADHD Score = -2.22

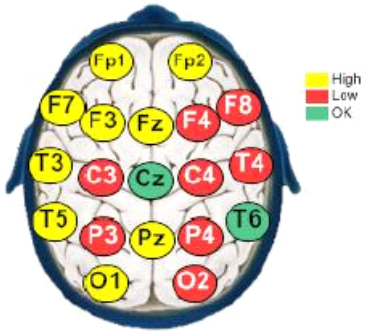
Beta Spindles



Diagnosed With ADD 2



CEC Analysis



CEC Response Assessment

Category	Response Count	Average Response	Category Score
Attention	6	2.33	14.00
Memory	11	2.36	26.00
Impulsive	7	1.86	13.00
Depression	7	2.71	19.00
Anxiety	9	2.11	19.00

* Red indicates an abnormally high score.

CEC Responses

Answer	Question
3	Lack Of Motivation/ Poor Follow through
3	Procrastination/Puts Things Off
3	Difficulty With Decisions
3	Daydreams Or Spaces Out
3	Careless Mistakes
3	Poor Short Term Memory

Metabolics ?

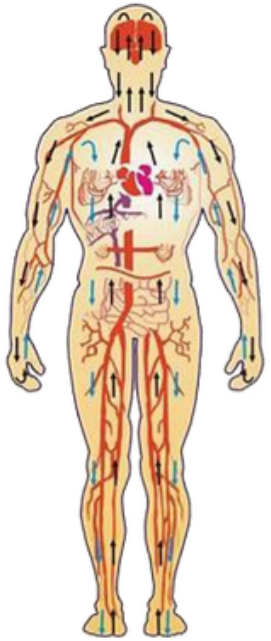
Normal Dominant Frequency

Metabolic Assessment

Probability	Score	Metabolic Category	Symptoms Reported
●	9	Pituitary	Insomnia
●	4	Thyroid (hyper)	Insomnia
●	6	Adrenals	Insomnia Fatigue Non-restorative sleep
●	3	Blood Sugar	Irritable with missed meals Eating relieves fatigue
●	1	Thyroid (hypo)	Fatigue
●	1	Kidney	Fatigue
●	1	Cardio-Vascular	Fatigue
●	1	Liver	Fatigue
●	1	Somatic	Restless Legs

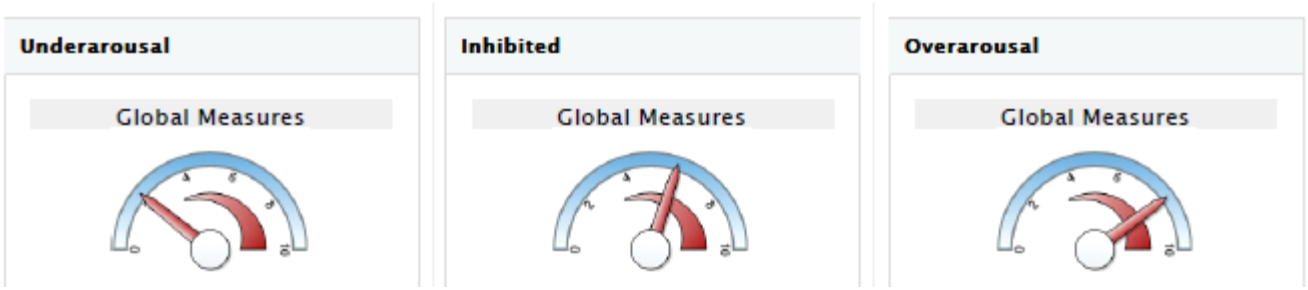
Probability Legend

● Minimal ● Low ● Moderate ● High

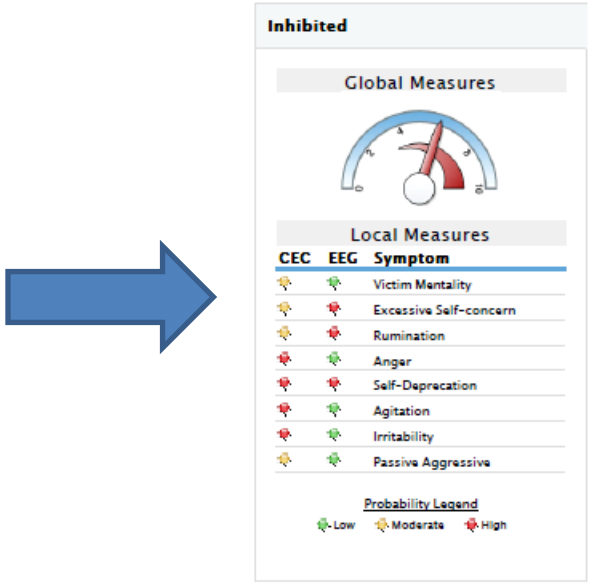


Dashboard

An Emotional Profile



Note that the EEG is largely showing green lights while the CEC showing mostly red and yellow lights.



Executive Functions ?

Executive Processing

CEC	EEG	Symptom
		Attention
		Categorization
		Decision Making
		Filtering Difficulties
		Motivation
		Problem Solving
		Socio-Emotional Decision Making

Memory Processing

CEC	EEG	Symptom
		Declarative
		Episodic
		Procedural
		Sequential
		Short Term
		Short Term (Digit Span)
		Working

Math Comprehension

CEC	EEG	Symptom
		Math Comprehension

Verbal Processing

CEC	EEG	Symptom
		Dialogue Organization
		Short Term Verbal
		Tonal Inflection and Comprehension Difficulties
		Tone Sequencing
		Verbal Sequencing

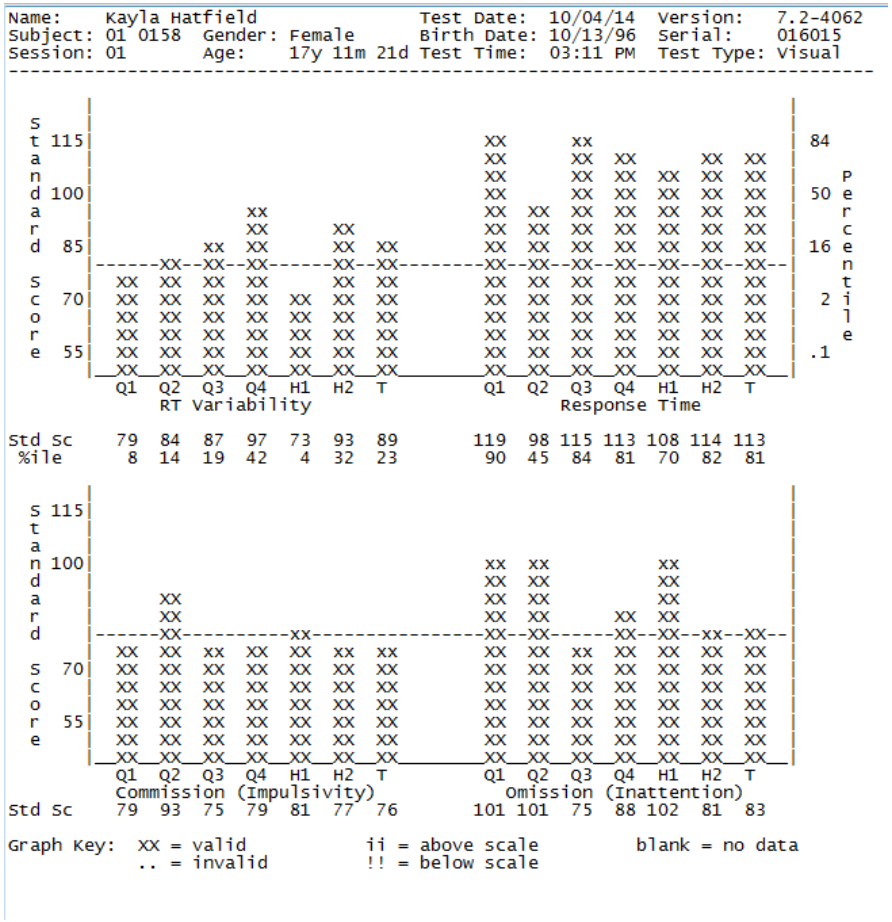
Visual Processing

CEC	EEG	Symptom
		Event Sequencing
		Facial Decoding & Recognition
		Figure Memory
		Short Term Visual Memory
		Spatial Sequence

Reading Comprehension

CEC	EEG	Symptom
		Processing Speed
		Reading Comprehension

TOVA



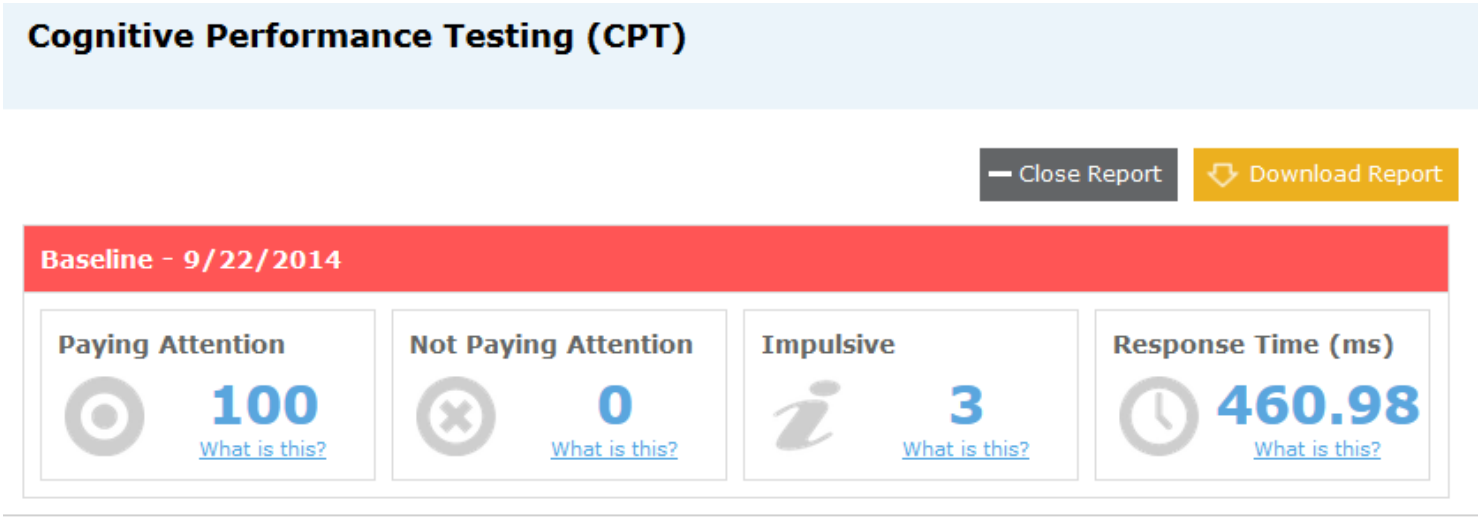
The T.O.V.A. test results (below) are a quarter by quarter analysis of the test. These results, in combination with the ADHD Score (below and on Form 4) determine the T.O.V.A. Interpretation (see Form 1).

Test Results	*	N	*	*	*	*	*

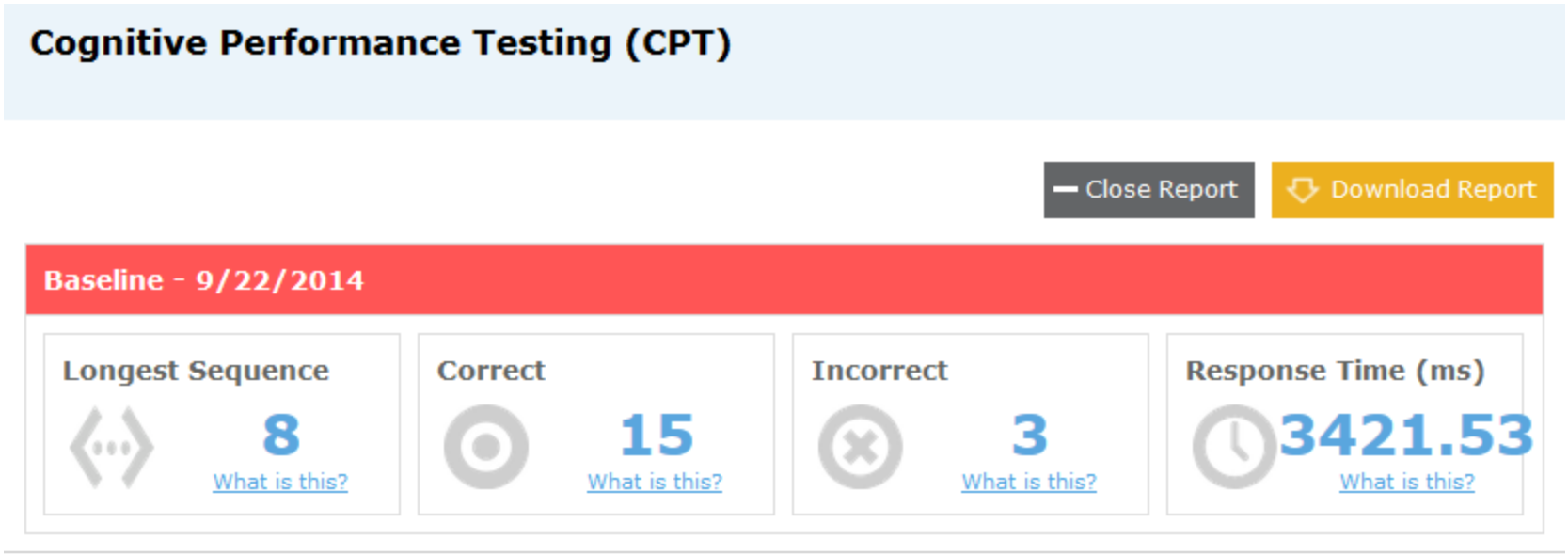
Test Results Key: N = Within normal limits assuming average intelligence
* = Not within normal limits B = Borderline ? = Not interpretable

ADHD Score = -2.08

CPT For Attention

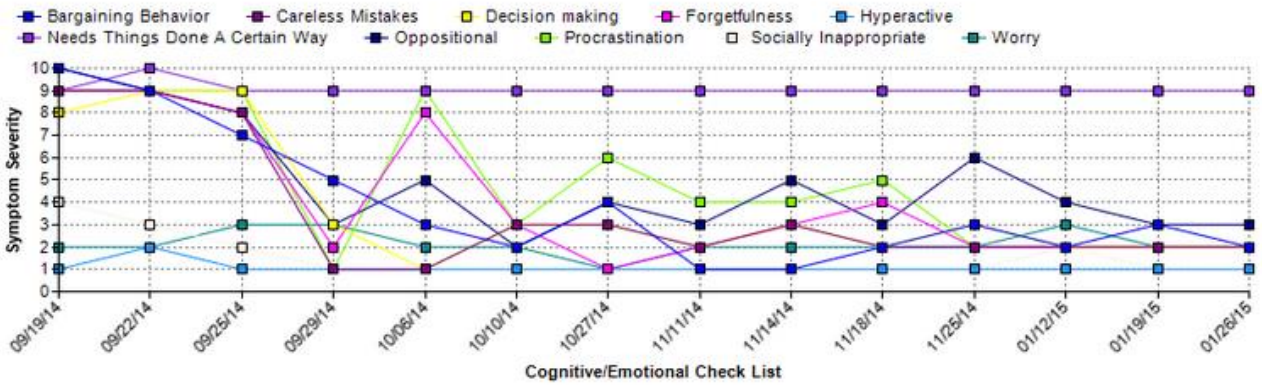


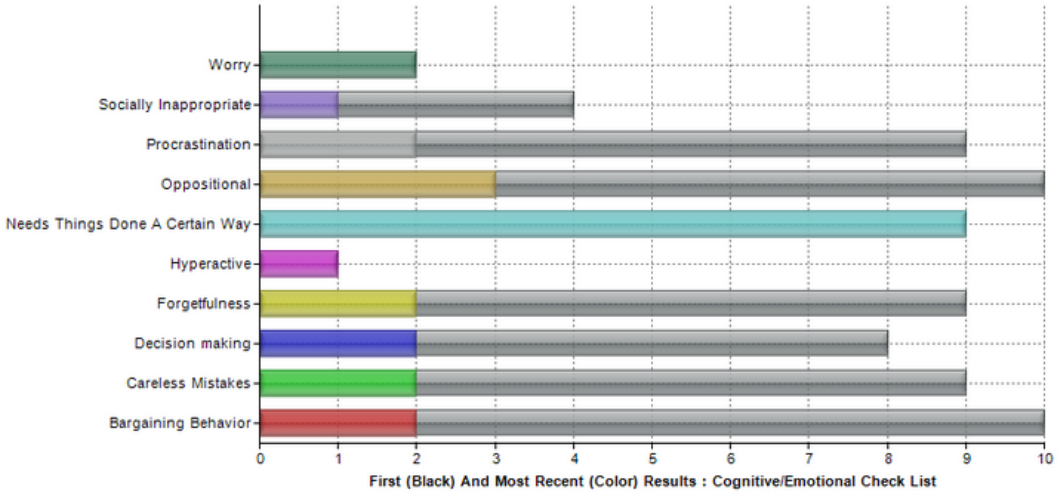
CPT Short Term Memory



Asymmetry Is Key Measure
Mood Issue, Not ADD

Significant Changes In Five Sessions Asymmetry Training

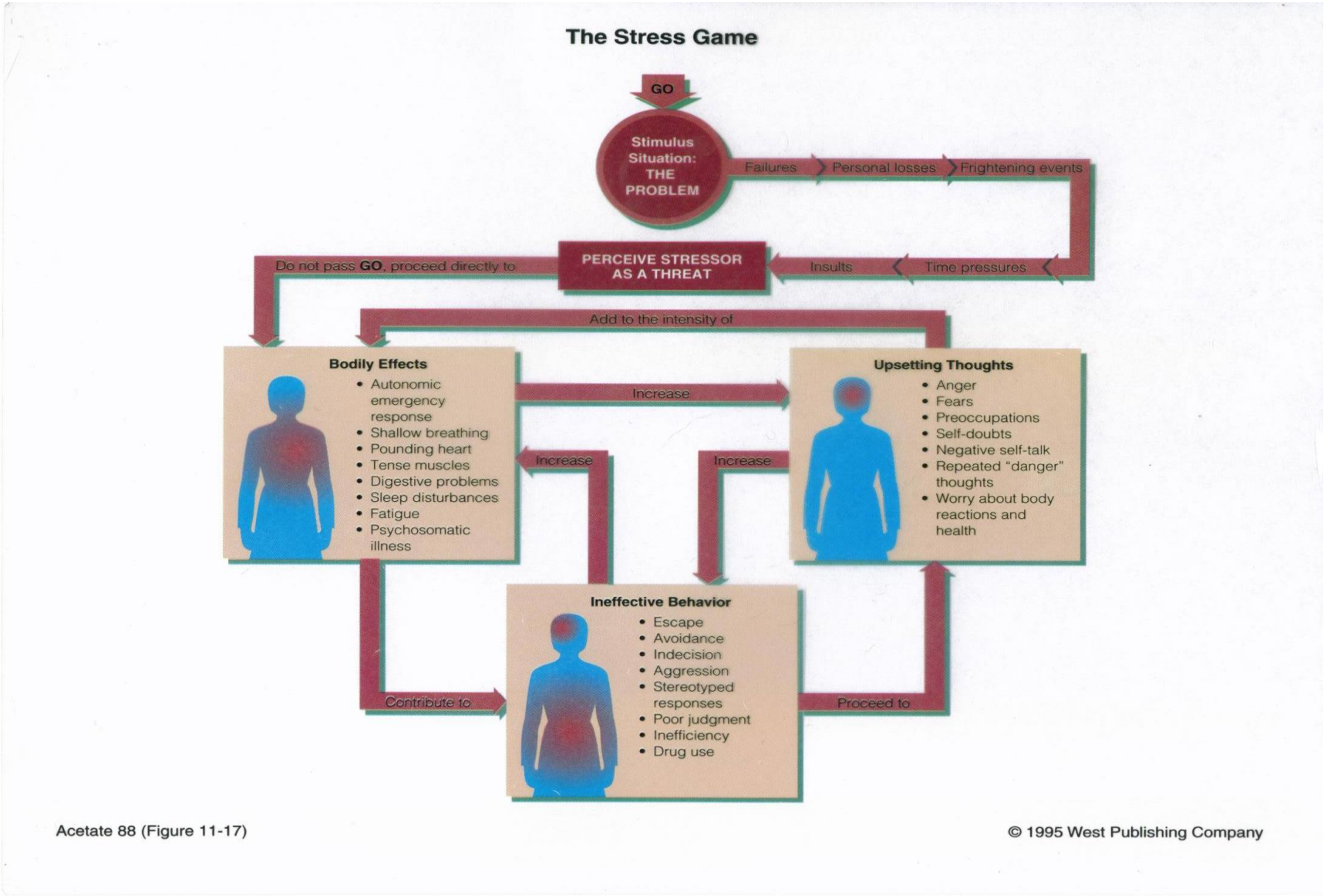




External Factors Interfering With Biofeedback Training

- Poor Sleep
- Poor Diet
- Lack of Exercise
- Physical Trauma
- Mental Trauma
- Trauma Inducing Social Environments
- Trauma Inducing Physical Environments

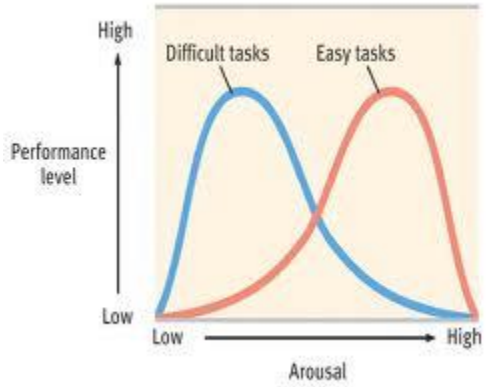
Stress, Arousal & Physiology



Arousal & Social Accuracy

Factors That Modify Behavior

- Individuals who cannot adjust their level of CNS arousal to the proper level required to perform a task are likely to make excessive errors in social exchanges.
- Excessive errors reduce their ability to successfully achieve their goals and get their needs met, resulting in distress.
- The ability to continuously monitor ongoing social cues and respond appropriately is a function of CNS processing as well as proper socialization.



Sterman's Arousal Theory

Connecting Arousal To Brainwave Correlates

- Sterman's research indicates that arousal is highly correlated with function in the human brain.
- Without the proper level of vigilance individuals cannot pay attention to ongoing social interaction.
- Without the proper level of sensorimotor integration individuals cannot control the behavior they emit in social environments.
- Without the proper cognitive integration individuals cannot make the correct social decisions.

Three Systems of brain activity influence thalamic generation of field potentials (Sterman, 1996).

- 1. Vigilance

If vigilance is withdrawn then theta brainwaves appear.

- 2. Sensorimotor Integration

If sensorimotor inputs are withdrawn then SMR brainwaves appear.

- 3. Cognitive Integration

If cognitive processing is withdrawn then alpha brainwaves appear.

Too Much Arousal

Worry Impairs Cognitive Performance

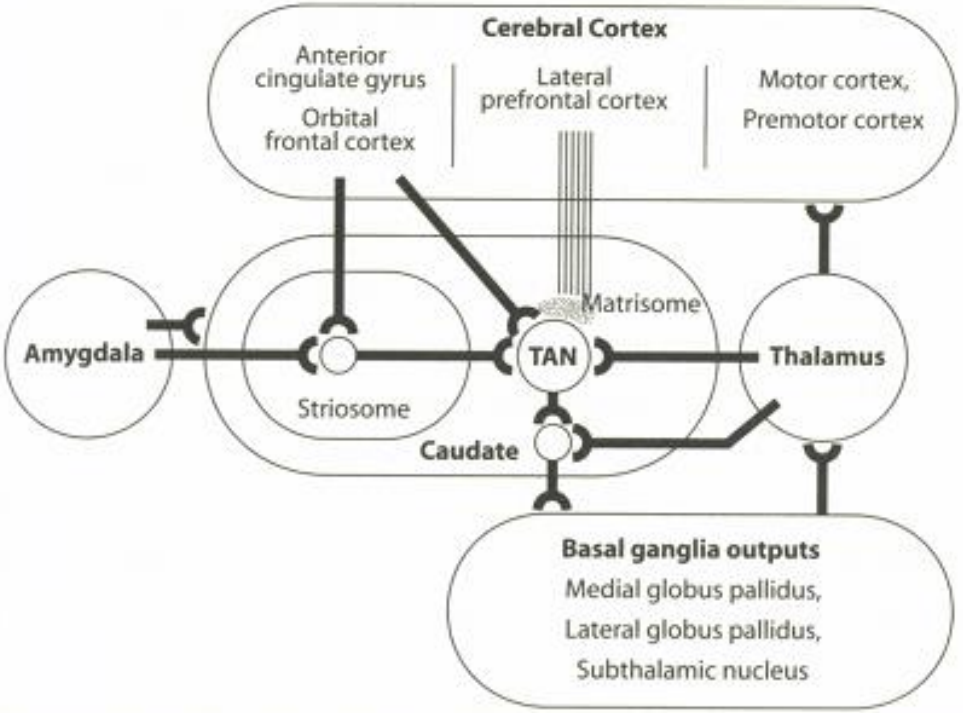


Figure 2: Cells in the caudate known as tonically active neurons (TANs) tend to be found between striosomes and matrisomes. Striosomes are areas where information from an emotion-processing part of the brain, the amygdala, reaches the caudate; matrisomes are clumps of axon terminals where information from the thinking, reasoning cerebral cortex reaches the caudate. By virtue of their position, TANs can integrate emotion and thought. They fire in a characteristic pattern when the brain senses something with positive or negative emotional meaning. Cognitive-behavioral therapy may change how TANs respond to OCD triggers.

Schwartz & Begley, 2002

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

TECHNICAL REPORT

The Lifelong Effects of Early Childhood Adversity and Toxic Stress

abstract

FREE

Advances in fields of inquiry as diverse as neuroscience, molecular biology, genomics, developmental psychology, epidemiology, sociology, and economics are catalyzing an important paradigm shift in our understanding of health and disease across the lifespan. This converging, multidisciplinary science of human development has profound implications for our ability to enhance the life prospects of children and to strengthen the social and economic fabric of society. Drawing on these multiple streams of investigation, this report presents an ecobiodevelopmental framework that illustrates how early experiences and environmental influences can leave a lasting signature on the genetic predispositions that affect emerging brain architecture and long-term health. The report also examines extensive evidence of the disruptive impacts of toxic stress, offering intriguing insights into causal mechanisms that link early adversity to later impairments in learning, behavior, and both physical and mental well-being. The implications of this framework for the practice of medicine, in general, and pediatrics, specifically, are potentially transformational. They suggest that many adult diseases should be viewed as developmental disorders that begin early in life and that persistent health disparities associated with poverty, discrimination, or maltreatment could be reduced by the alleviation of toxic stress in childhood. An ecobiodevelopmental framework also underscores the need for new thinking about the focus and boundaries of pediatric practice. It calls for pediatricians to serve as both front-line guardians of healthy child development and strategically positioned, community leaders to inform new science-based strategies that build strong foundations for educational achievement, economic productivity, responsible citizenship, and lifelong health. *Pediatrics*

Jack P. Shonkoff, MD, Andrew S. Garner, MD, PhD, and THE COMMITTEE ON PSYCHOSOCIAL ASPECTS OF CHILD AND FAMILY HEALTH, COMMITTEE ON EARLY CHILDHOOD, ADOPTION, AND DEPENDENT CARE, AND SECTION ON DEVELOPMENTAL AND BEHAVIORAL PEDIATRICS

KEY WORDS
ecobiodevelopmental framework, new morbidity, toxic stress, social inequalities, health disparities, health promotion, disease prevention, advocacy, brain development, human capital development, pediatric basic science

ABBREVIATIONS
ACE—adverse childhood experiences
CRH—corticotropin-releasing hormone
EBD—ecobiodevelopmental
PFC—prefrontal cortex

Toxic Stress
Adverse Childhood Experiences (ACE)

- "From strong, frequent of prolonged activation of the body's stress response system in the absence of the buffering protection of a supportive adult relationship."
- Child Abuse
- Neglect
- Parental Substance Abuse
- Maternal Depression

Shonkoff & Garner, 2011, American Academy of Pediatrics

Health Effects of Toxic Stress

- Diminished Immune Function
- Inflammatory Process
- Neural Excitotoxicity
- Telomere Shortening- Early Aging
- Abnormal Fat Deposits
- Arterial Degradation

Toxic Stress Degrades Cognitive Abilities

Childhood Trauma & Adult Emotional Trauma

- General Cognitive
- Linguistic Abilities
- Socio-emotional Skills
- Developmental Landmarks
- Decision-making
- Working & Short Term Memory
- Behavioral Self Regulation
- Mood and Impulse Control

Shonkoff & Garner, 2011, American Academy of Pediatrics

How Stress Effects Structure and Function of the Brain

- Hypertrophy of Amygdala
- Hypertrophy of Orbital Frontal Cortex
- Reduced Hippocampal Function
- Reduced Medial PFC Function
- Neuronal Death
- Degradation of Neuronal Connections

Hypersensitivity to Stress

Reduced Socio-emotional Contextual Evaluation

Degradation of Memory Function

Loss of Top Down Control and Increased Impulsivity

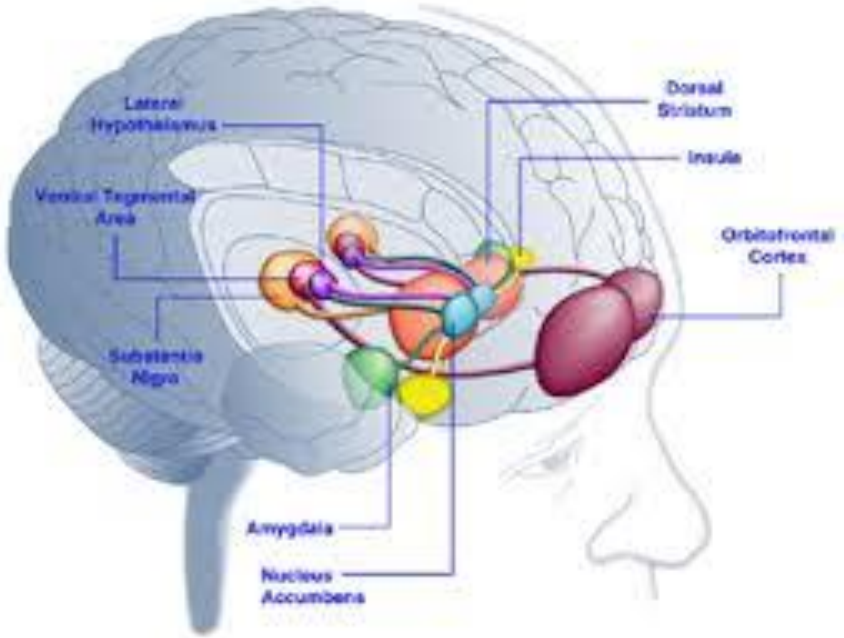
Loss of Cognitive Resources

Loss of Cognitive Function

Shonkoff & Garner, 2011, American Academy of Pediatrics

Fear and Arousal

Exposure To Toxic Stress Enhances Fear Response

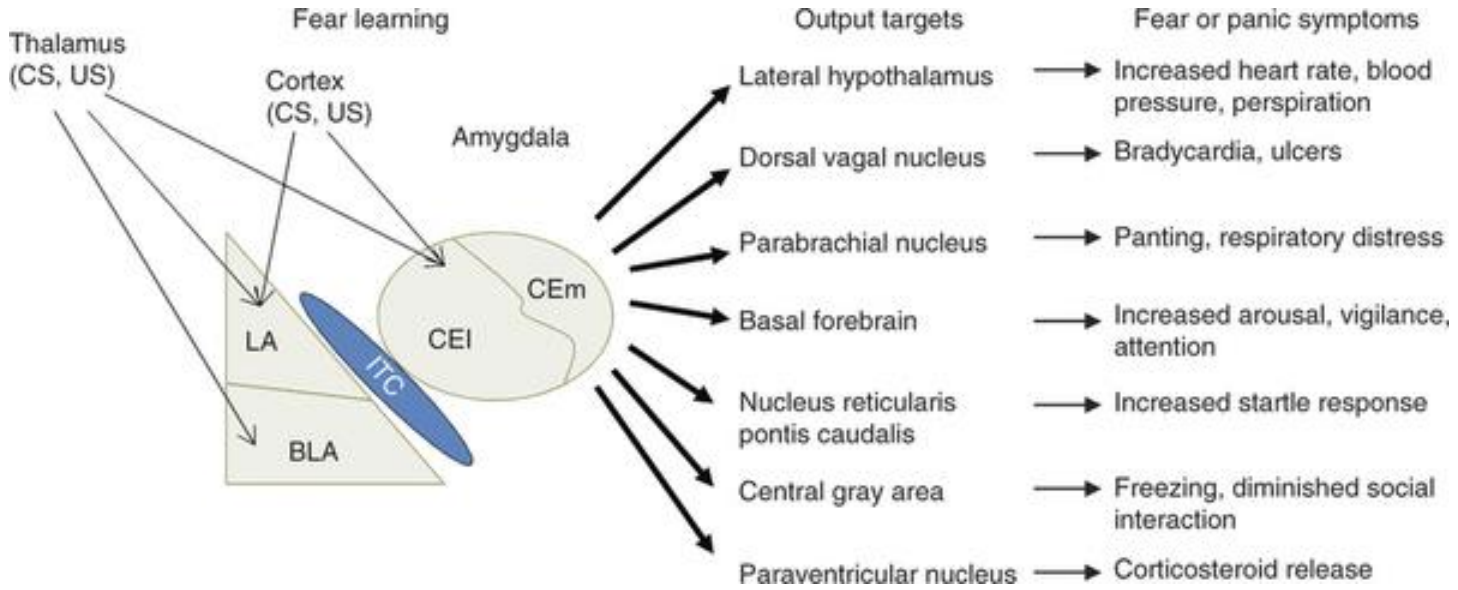


The amygdala modulates activity in the hypothalamus through the ventral amygdalofugal pathway

The Amygdala & The CNS

- The amygdala has direct control over hypothalamic, somatic, endocrine and brain stem functions.
- It indirectly precipitates immune system suppression through gluccocortical levels.

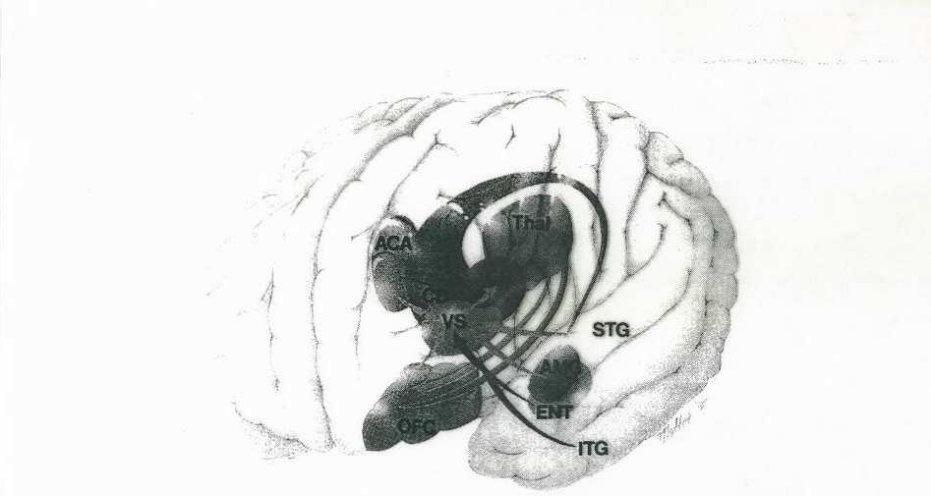
Extensive trauma can generate periodic recurrent paroxysmal activity in the amygdala.
It is an important survival mechanism



Emotion- Memory- Attention

The Three Frontal Circuits

- Chronic Anxiety generates excess cortisol which degrades hippocampal function.
- Loss of hippocampal function degrades ST Memory
- Loss of ST memory undermines sustained attention.

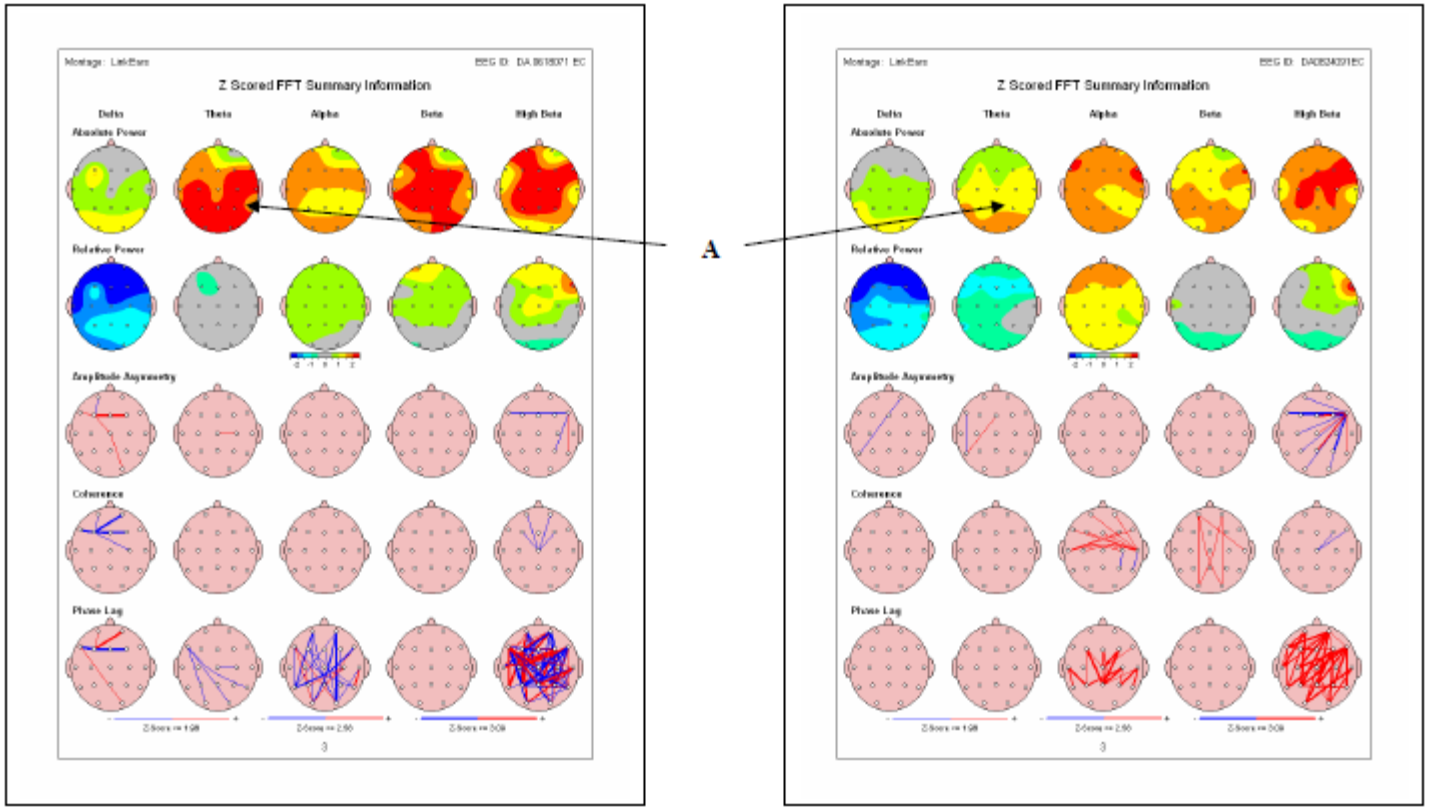


Orbital Frontal
Dorsolateral
Anterior Cingulate

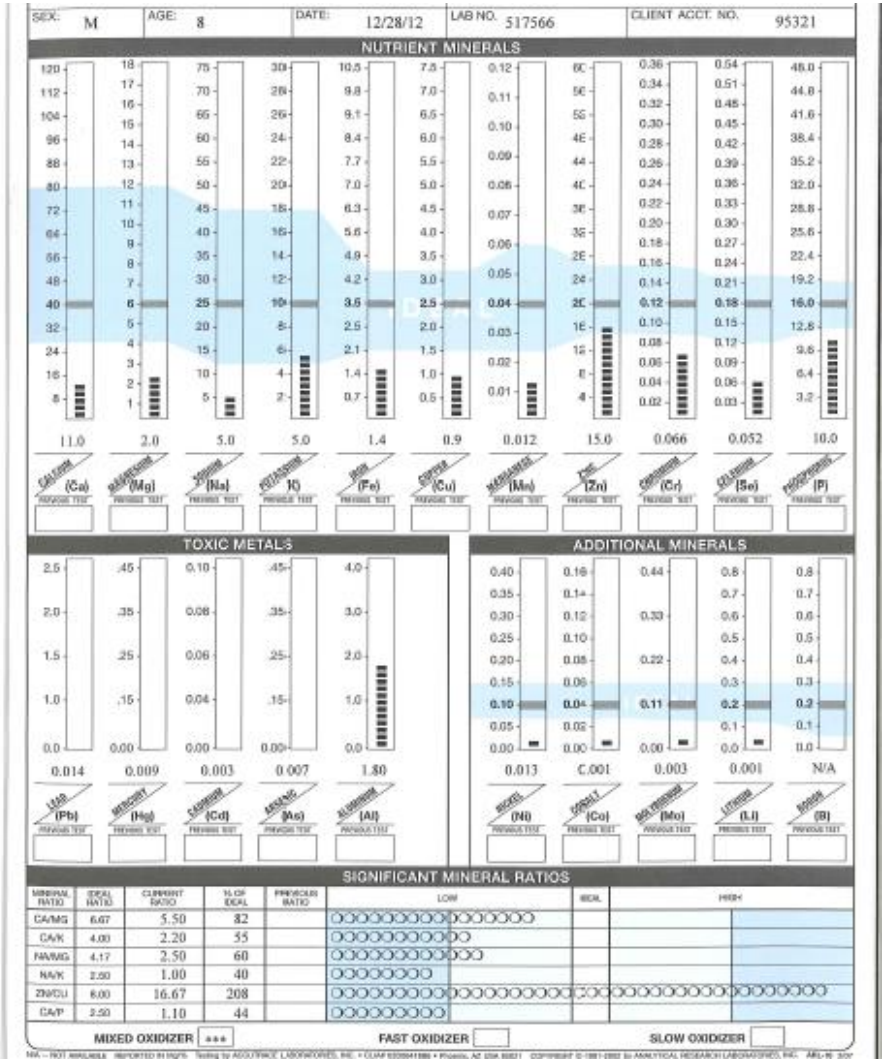
Trans-generational Behavior
The Silent Process

- Parenting style alters RNA (Posner & Peterson, 2012).
- Behavior can be transmitted through genes (Shonkoff & Garner, 2011).
- EEG is 80-90% heritable (Zietsch et al, 2007).

Gluten & Slow Wave
Pre Post Gluten Map



8 Year Old: ASD/ ADHD



SEX: M	AGE: 8	DATE: 12/28/12	LAB NO. 517566	CLIENT ACCT. NO. 95321

NUTRIENT MINERALS

(Ca)	(Mg)	(Na)	(K)	(Fe)	(Cu)	(Mn)	(Zn)	(Cr)	(Se)	(P)
11.0	2.0	5.0	5.0	1.4	0.9	0.012	15.0	0.066	0.052	10.0

TOXIC METALS

(Pb)	(Hg)	(Cd)	(As)	(Al)
0.014	0.009	0.003	0.007	1.80

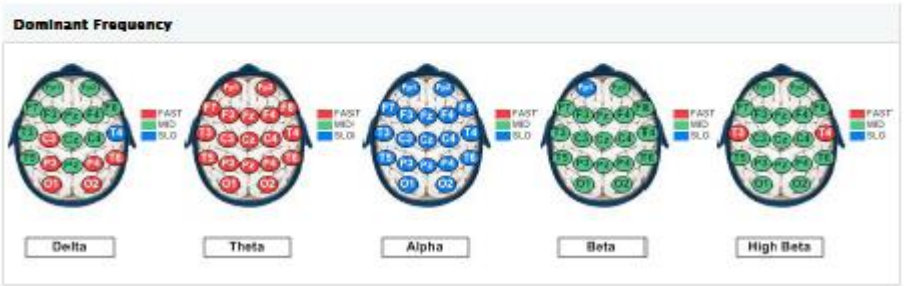
ADDITIONAL MINERALS

(Ni)	(Co)	(Mo)	(Li)	(B)
0.013	C.001	0.003	0.001	N/A

SIGNIFICANT MINERAL RATIOS

MINERAL RATIO	IDEAL RATIO	CURRENT RATIO	% OF IDEAL	PREVIOUS RATIO	LOW	IDEAL	HIGH
CA/MG	6.67	5.50	82				
CA/K	4.00	2.20	55				
NA/MG	4.17	2.50	60				
NA/K	2.50	1.00	40				
ZN/CU	8.00	16.67	208				
CA/P	2.50	1.10	44				

MIXED OXIDIZER *** FAST OXIDIZER SLOW OXIDIZER



Note: Elevated Theta, Alpha, Delta
Slowed Alpha Dominant Frequency
Frontal Connectivity Abnormality

8 Year Old Metabolics

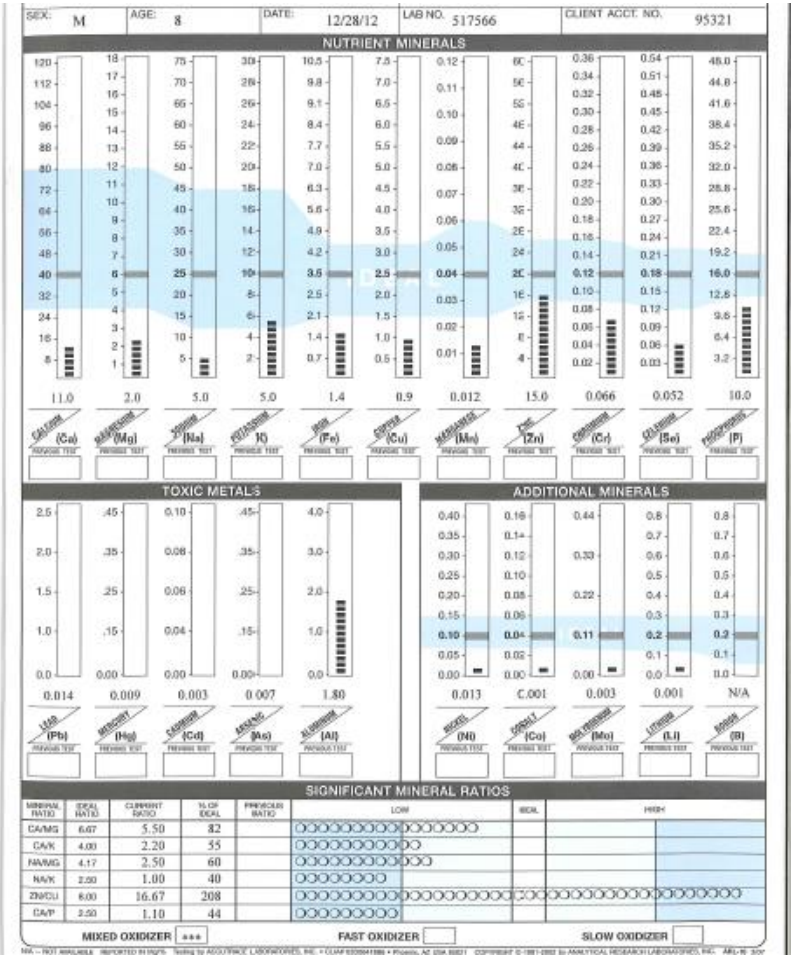
Metabolic Analysis

Score	Metabolic Category	Symptoms Reported
7	Blood Sugar	Crave Sweets Irritable with missed meals Agitation
6	Gall Bladder	Reddened Skin Dry or flaky skin Food intolerances Itchy Skin
4	Thyroid (hypo)	Fatigue Cold all the time
3	Gastrointestinal	Food intolerances Diarrhea Constipation
2	Liver	Fatigue Loss of Appetite Diarrhea
2	Kidney	Fatigue
2	Cardio-Vascular	Fatigue
1	Adrenals	Fatigue
1	Somatic	Restless Legs

MetaMetrix Lab Test Findings:
IgG4 Tested Positive for Egg
Intestinal Hyperpermeability
Oxidative Stress

RX
Given Glutithione and B6 with Dietary Restrictions

8 Year Old: Hair Analysis Details



Very low readings overall:
Electrolyte Imbalances
Poor Eliminator, Digestive Issues

"Four Lows:" First four categories low
Indicates exhausted system
Difficulty breaking down protein,
Adrenals at 60% function

Sodium low

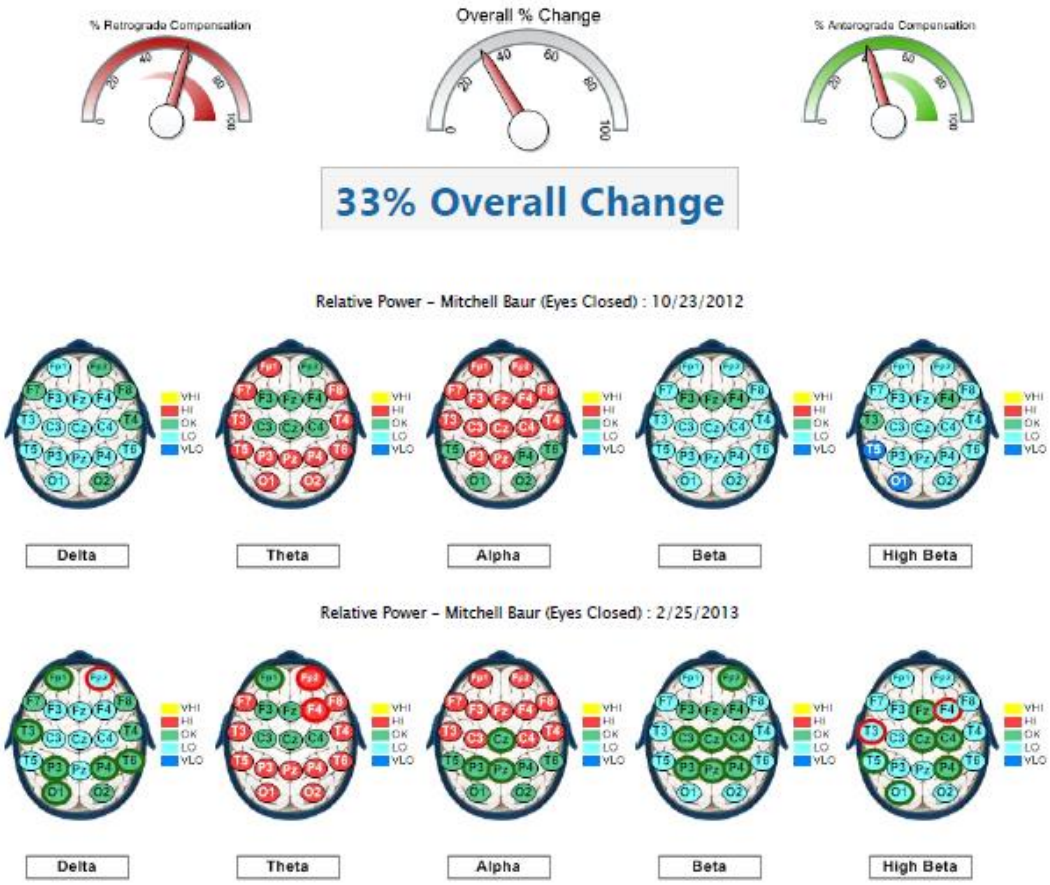
Zinc/copper Imbalance
Indicates Thyroid Regulation Problem
Selenium Low- needed for T3-T4 Conversion

Chromium low
Blood Sugar Regulation Problem

8 Year Old: Pre Post Map

30 Sessions
Improved Sleep
Better Concentration
Emotional Stabilization

Temporary Suspension of NFB to focus on metabolics.



NOTE: Pre-Post Maps Do Not Have To Turn All Green To Have Significant Changes In Symptoms!