Behavioral Medicine Associates, Inc.
4820 West 77th Street, Suite 135
Edina, Minnesota 55435
952.844.0619
Facsimile: 952.844.0628
E-mail: information@qeeg.com

Quantitative EEG Report and IVA continuous performance test, binocular screening

Patient name: Xxx

DOB: DD/MM/YYYY

Referral: self

Date of recording: DD/MM/YYYY

Date of report: DD/MM/YYYY

Problem: migraines, concussive head injury in motor vehicle accident, trouble with sleep, organization, distractibility, finding words, productivity, reading comprehension, spelling.

Procedure:

1. An initial one hour clinical interview was conducted by Elizabeth M. Nash, MA, LMFT, AT-R. History questionnaires were completed and medical records were requested.
2. A test of attentiveness and response control, the Intermediate Variables of Attention (IVA) continuous performance task. The IVA measures errors of inattention (missed targets), commission (responses to non-target stimuli), hyperactivity (extraneous responses), reaction times, variability and stamina of response times to both auditory and visual targets. A "1" or a "2" is presented either on the screen or as speech by the computer. The goal is to press a mouse button quickly when the "1" is presented. The main scores produced are Auditory and Visual Response Control Quotients and both Auditory and Visual Attention Quotients, as well as Full Scale Response Control and Full Scale Attention quotients. The quotients are age and sex normed and are designed like IQs, with a mean of 100 and S.D. of 15. Full Scale Response Control is a composite of auditory and visual scores for Prudence (avoiding reacting to the non-target 2's), Consistency (the standard deviation of the mean reaction time) and Stamina (maintaining the first-half reaction time into the second half of the test). Full Scale Attention Quotient is a composite of Vigilance (hitting the button when target 1's occurred), Focus (the standard deviation of the middle 50% of reaction times) and Speed (the mean reaction time). Separate Response Control and Attention Quotients are also generated separately for Auditory and Visual modalities, along with subscale scores for the individual measures like Vigilance, Focus and Speed.
3. A visual screening was conducted which detects common developmental visual disorders, measuring fusion/fusion reserves and stereopsis by presenting binocular images with gradually increasing degrees of spatial separation in both convergent and divergent directions The problem often causes complaints of sore eyes when doing a lot of close visual work, like reading. Poor convergence also usually decreases reading speed and comprehension. Limited divergence will also diminish optimal sports

performance by limiting accurate depth perception. If findings are not within normal limits, the problem can be reduced or eliminated with vision therapy.

4. 19 channels of digital EEG were recorded with a NeuronSpectrum-3 19 channel EEG recording system using a Lycra cap which carried the electrodes in the standard International 10-20 System montage of electrode positions. Sampling was at 200 samples per second with 16 bit amplitude resolution and impedances were maintained below 10 KOhms. Eye blink and movement artifacts were removed prior to examining the data with the Neuroguide eyes closed and eyes open reference databases (R. Thatcher, Ph.D., appliedneuroscience.com). Five minute recordings were made for each of the following conditions: eyes open, reading, listening, writing and drawing. Eyes closed recordings were made before and after the eyes open/task recordings and were also 5 minutes each. The eyes closed recording was repeated at the end of the session to allow us to determine stability and test-retest reliability.

RESULTS: Information in this section is from interview, questionnaires and objective assessments.

BACKGROUND:

Xxx lives with [clinical information]. He enjoys [clinical information]. However, mentally he's not able to work full days from "brain fog" (a very common complaint of people with serious concussions) and struggles with organization.

On DD/MM/YYYY, Xxx was at a stop while driving during rush hour on Highway ### when he was rear-ended by a large SUV and pushed into the car in front of his. He was not unconscious and suffered no retrograde or anterograde amnesia. However, since the accident he has short term memory issues, "brain fog," trouble "getting phrases out" and can't think as fast as he used to. He "crashes" after about 4 hours of work and has trouble thinking at a high level. He has trouble reading. He is more irritable.

On a short symptom checklist of symptoms that happen twice a week or more, Xxx noted his mind going blank, difficulty making decisions and difficulty concentrating. Emotionally, Xxx noted loss of interest in things, loss of sexual desire or interest and thoughts of ending his life. Physically, Xxx noted headaches, dry mouth, tight jaw, shakiness, cold feet/hands, faintness or dizziness and weakness in parts of his body.

Xxx described his childhood as [clinical information]

Xxx described his academic performance in grade school and high school as [clinical information]. Socially, he [clinical information].

. He's now employed as [clinical information]. He enjoys [clinical information]. However, mentally he's not able to work full days from "brain fog" (a very common complaint of people with serious concussions) and struggles with organization.

On a short symptom checklist of symptoms that happen twice a week or more, Xxx noted his mind going blank, difficulty making decisions and difficulty concentrating. Emotionally, Xxx noted loss of interest in things, loss of sexual desire or interest and thoughts of ending his life. Physically, Xxx noted headaches, dry mouth, tight jaw, shakiness, cold feet/hands, faintness or dizziness and weakness in parts of his body.

Xxx described his childhood as [clinical information]

Xxx described his academic performance in grade school and high school as [clinical information]. Socially, he [clinical information].

TBI Checklist

Xxx also completed a survey with 30 symptoms typical of mild traumatic brain injury. The items are rated 0 – 100 points, with "0" indicating no problem and "100" indicating a very severe problem with that symptom in the past month. This gives an accurate, analog assessment of the person's experience of the severity of each of the symptoms. Also, simply adding all the scores together gives a convenient measure of the global severity of the person's complaints. Xxx's ratings were as follows:

Problems organizing	80	Dizziness	50
Headaches	50	Vomiting	0
Nausea	0	Ears ringing	5
Blurred vision	30	Seizures	0
Tired, lethargic	50	Memory problem	70
Amnesia for the accident	0	Confusion	95
Disoriented (gets lost)	10	Slowed thinking	95
Distractible	100	Disturbed sleep	0
Irritable	60	Sensitive to noise/light	50
Depressed feelings	85	Temper outbursts	30
Mood swings	50	Difficulty concentrating	95
Anxious/scared	0	Trouble finding words	95

Impatient	75	Forgetful, losing things	50
Anxious/scared	0	Overloaded by too much	
Angry much of the time	8	going on	100
Unconscious after injury	N/A	Other	-

MEDICAL HISTORY: Xxx describes [clinical information]

FAMILY HISTORY (relevant to diagnosis): [clinical information]

MENTAL STATUS: In the initial interview Xxx was pleasant and cooperative, with normal eye contact. Attention and memory were grossly intact. Affect was somewhat anxious, but appropriate to the situation. There was no evidence of a thought disorder. Xxx was well groomed, showed no unusual mannerisms and was oriented to situation, time, place and person. Speech was of normal rate and flow. Intelligence appears above average and Xxx is verbally skilled.

SUBSTANCE USE/ABUSE: No history of illegal substance use, very rare alcohol use, daily caffeine.

RESULTS OF OBJECTIVE TESTS:

IVA: (with medication) Xxx's performance was mildly impaired, with Full Scale Response Control Quotient = 83, and Full Scale Attention Quotient = 87. Full Scale Response Control is a composite of auditory and visual scores for Prudence (avoiding reacting to the non-target 2's), Consistency (the standard deviation of the mean reaction time) and Stamina (maintaining the first-half reaction time into the second half of the test). Full Scale Attention Quotient is a composite of Vigilance (hitting the button when target 1's occurred), Focus (the standard deviation of the middle 50% of reaction times) and Speed (the mean reaction time).

Visual Prudence was low, Q = 78, indicating visual distractibility. Auditory Consistency was low, Q = 86, indicating high reaction time variability. Auditory Stamina was low, Q = 77, indicating slowing of auditory reaction times in the second half of the test. Auditory Speed (mean reaction time) was slow, Q = 83. Visual Speed was even slower, Q = 73. Auditory Focus (the variability of the middle 50% of scores) was low, Q = 83; Visual Focus was low average, Q = 92.

Part of the test was designed to assess sustained attention and contained relatively few targets. These scores were average for auditory but very impaired for visual: Sustained Auditory Attention Quotient = 97. Sustained Visual Attention Quotient = 69.

Interpretation: None of these low scores would be expected in someone with Xxx's level of professional achievement. Attention not well sustained for auditory and visual targets. There was indication also of visual distractibility.

Binocular screening results: Xxx attained 10 prism diopters convergent and 10 p.d. divergent on the six card set of fixed demand Bernell tranaglyphs. He had intermittent suppression of the right eye image. These are red/green "3-D" images with increasingly wide separations between the left and right eye image, requiring increasing amounts of "fusion reserves" in the visuomotor brain systems. Optimal fusion is 30 p.d. convergent/18 p.d. divergent.

Interpretation: Xxx's convergent fusion to close objects is impaired enough to produce headaches, slowed reading and diminished comprehension when having to do a lot of reading or screen work. This condition is called "convergence insufficiency" and is common after concussions. It is also a developmental condition that can be present, undetected, since childhood. Divergent fusion is more mildly impaired, reducing long distance depth which prevents optimal sports performance.

Our screening does not test for more complex visual issues, only basic convergent and divergent fusion and stereopsis ("3-D" perception).

EEG analysis

Quantitative EEG seeks to understand the causes of behavioral, cognitive and emotional difficulties by examining the rhythmic electrical activity of the brain. EEG is analyzed first by looking at the actual electrical waves that are detected at each of the 19 recording electrodes. There are patterns that are common and "normal" and there are patterns the eye can see that are not normal and are associated with inattention, cognitive problems or even anxiety. The EEG is not examined from the standpoint of detecting organic brain disorders or diseases; rather we are interested in patterns that may be concomitants of abnormal cognitive or emotional states. Brain electrical rhythms are also analyzed with the Neuroguide normative lifespan database, which lets us see how the averaged EEG in each recording condition compares to the average EEG for the patient's age group; this is the "quantitative" part of the process. There are some terms to know when reading the statistical part of the report:

Explanation of terms in the statistical analysis of the EEG: "Power" refers to the size of the waves at each frequency. The more brain cells (neurons) that are oscillating together at a given frequency, the larger the rhythms that appear in scalp recordings. Generally, the faster rhythms (beta, high beta) occur when smaller groups of cells are more activated. The

fast waves are normally rather small. The slower rhythm of alpha (8 – 13 waves per second or "Hertz", abbrv. "Hz") occurs when large groups of cells are "idling" but are awake and ready to do something. The slower rhythms (delta, theta) when in proper proportion act to synchronize the excitability levels of widespread groups of neurons. When delta/theta becomes very large, however, it is an indicator of lower levels of excitement and regional – or whole brain – "sleepiness". "Relative power" refers to the percentage of the total power of the EEG signal accounted for by each frequency. In the "z-score topographic maps", below, each recording electrode is represented as a dot on the head map. Z-scores are signed (+ = above the mean, - = below the mean) standard deviations from age-means. A z-score of +1.96 or more means the feature being measured is very unusual in the population and likely to be causing problems of some sort. Orange to red indicates 2 – 3+ standard deviations above age-norm means, while the darker blue means 2 – 3+ standard deviations below the mean.

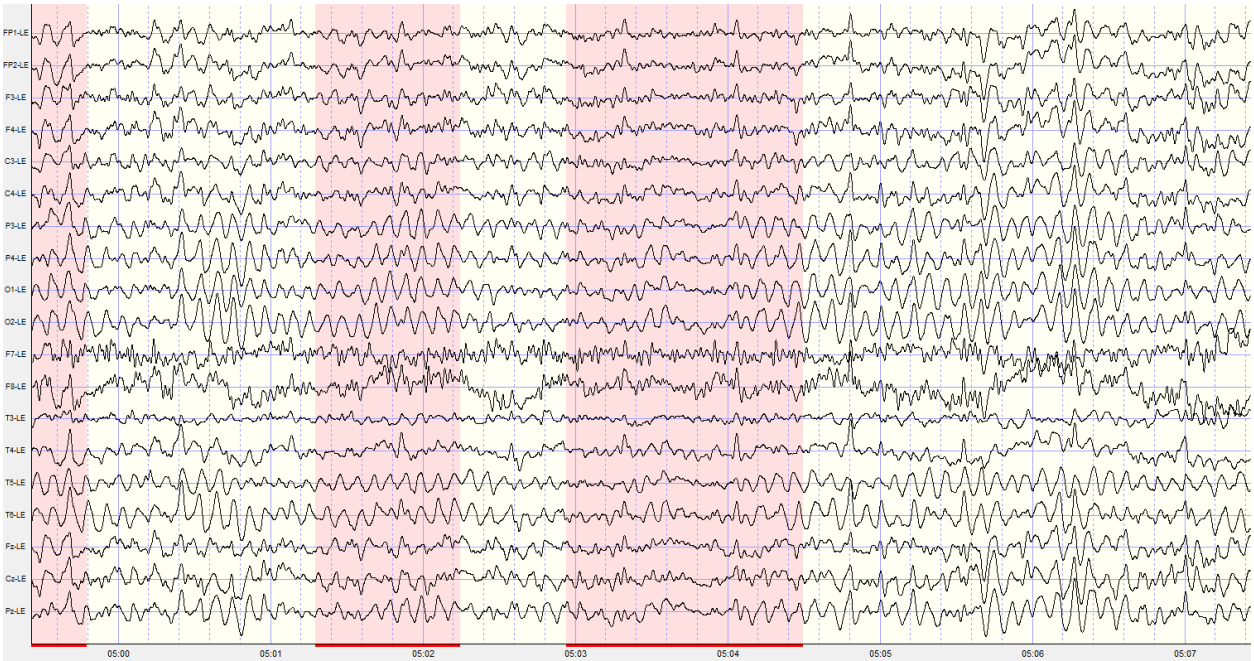
Another reflection of the functionality of regions of brain is the coherence and phase lag of electrical rhythms between pairs of recording electrodes. Coherence is a mathematical calculation that reflects the degree of coupling between two brain regions. Phase lag refers to the degree that signals from two recording electrodes "lead" or "lag" behind each other. Coherence and phase measurements together reflect the functional connectivity of brain regions. Abnormally high or abnormally low connectivity is a concomitant of impaired function in the region. When this occurs in frontal/prefrontal regions, executive control is impaired. Executive control includes voluntary focus of the attention, impulse control, and delay of gratification, organization, planning and remembering priorities. When poor functional connectivity occurs in the highly automatic sensory processing regions in the back of the brain (visual, auditory, somatosensory, long term memory recall), deficits in learning, comprehension and memory occur.

In the topographic z-score maps later in this report, elevated coherence or phase lag is shown by red lines connecting recording sites. Blue lines show less than normal coherence or phase lag. The thicker lines mean greater deviation from normal.

Raw Data: The EEG was marked by no unusual electrical abnormalities that would require neurological evaluation. Ophthalmologic evaluation (if not already done) is required to assure basic medical eye health. There were abnormal lateral slow rolling eye movements during the eyes closed and to some degree during the eyes open recording.

The following screen capture shows a representative 8 second segment of Xxx's eyes closed EEG recording at 50 uV screen display, linked ear references (the voltage at each

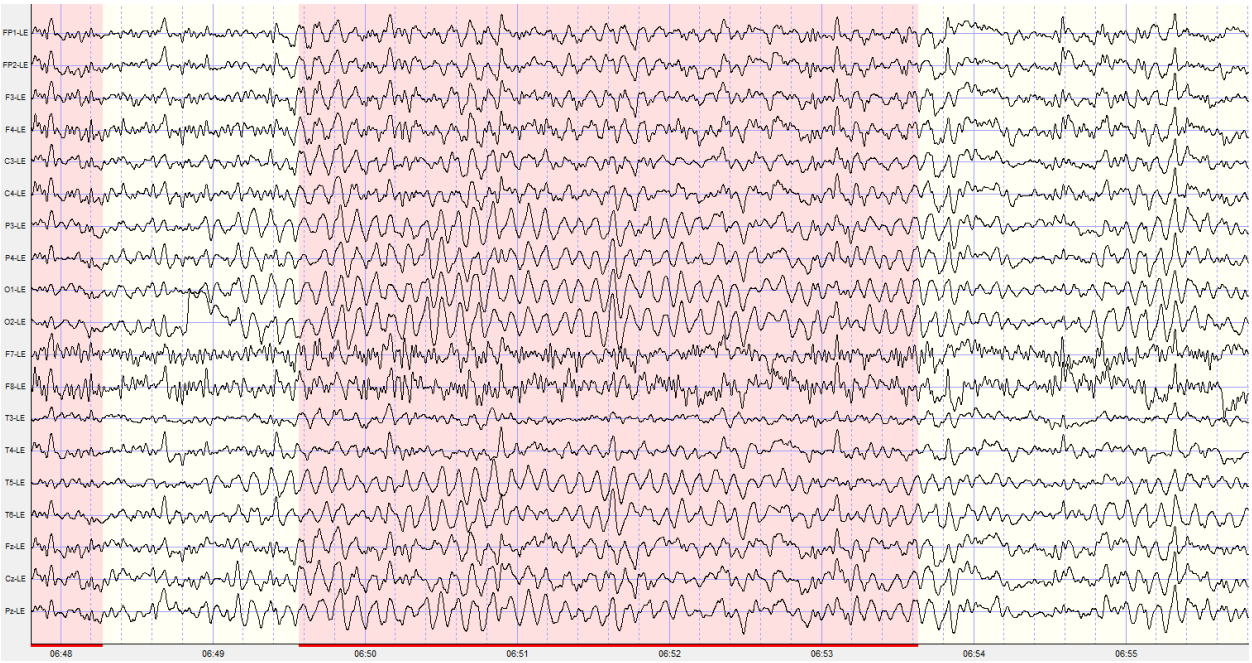
scalp electrode is compared to the voltage at the ear lobes). Pink highlighted areas were free of artifact and used for statistical analysis.



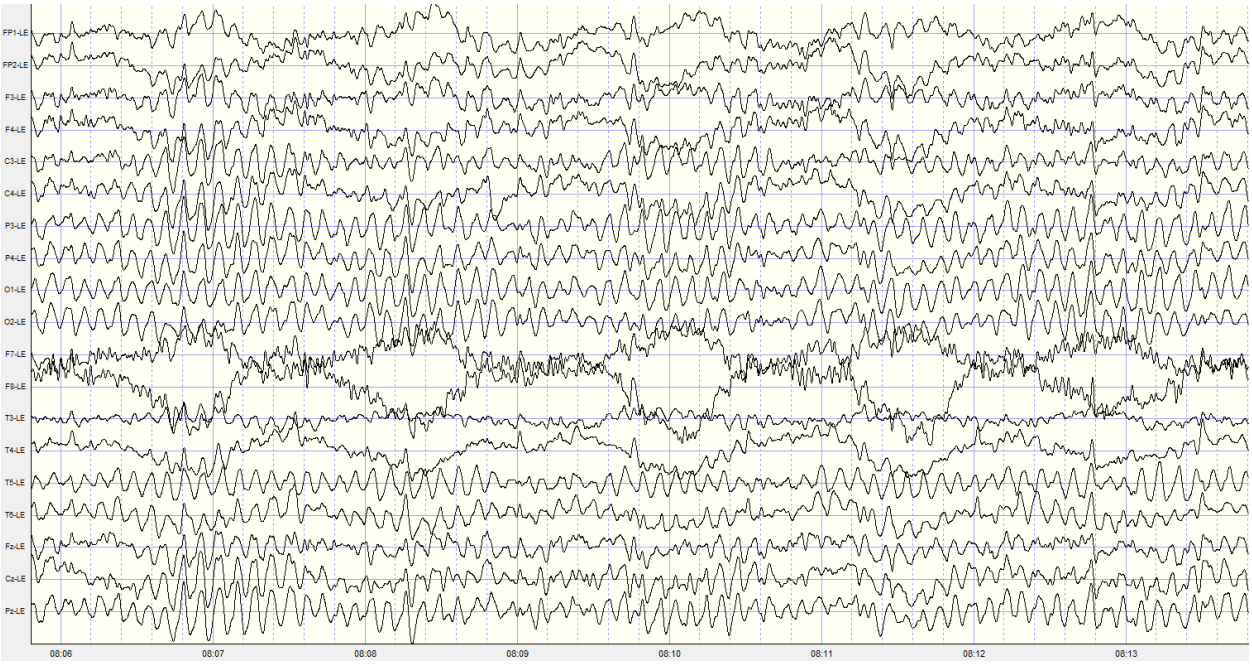
The large, very rhythmic, sinusoidal waves are "alpha" waves (the middle channels at about 10 Hz) and this normally appears in long trains throughout the eyes closed record. There muscle tension (the "buzzy" look on two channels) on lead next to the eyes. At times low frequency alpha emerged over prefrontal regions:

Behavioral Medicine Associates, Inc.
4820 West 77th Street, Suite 135
Edina, Minnesota 55435

952.844.0619
Facsimile: 952.844.0628
E-mail: information@qeeg.com

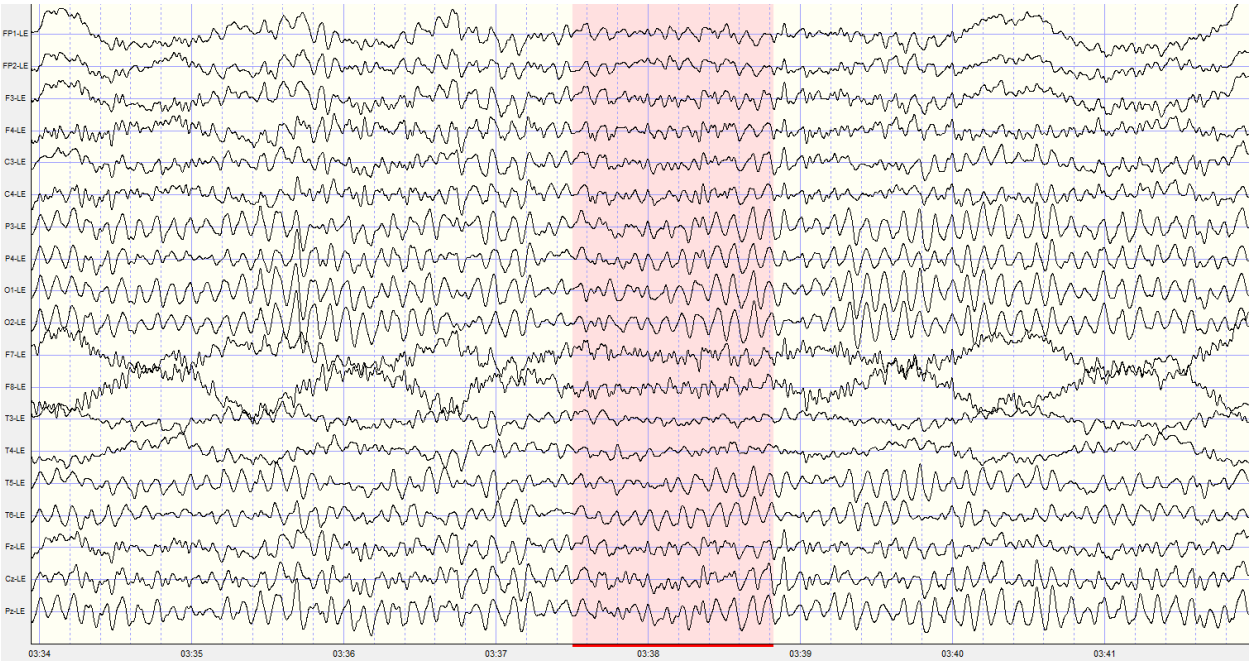


There was nearly continuous lateral eye movement and often vertical eye movement. Much of the data couldn't be used because of the large lateral eye movements:

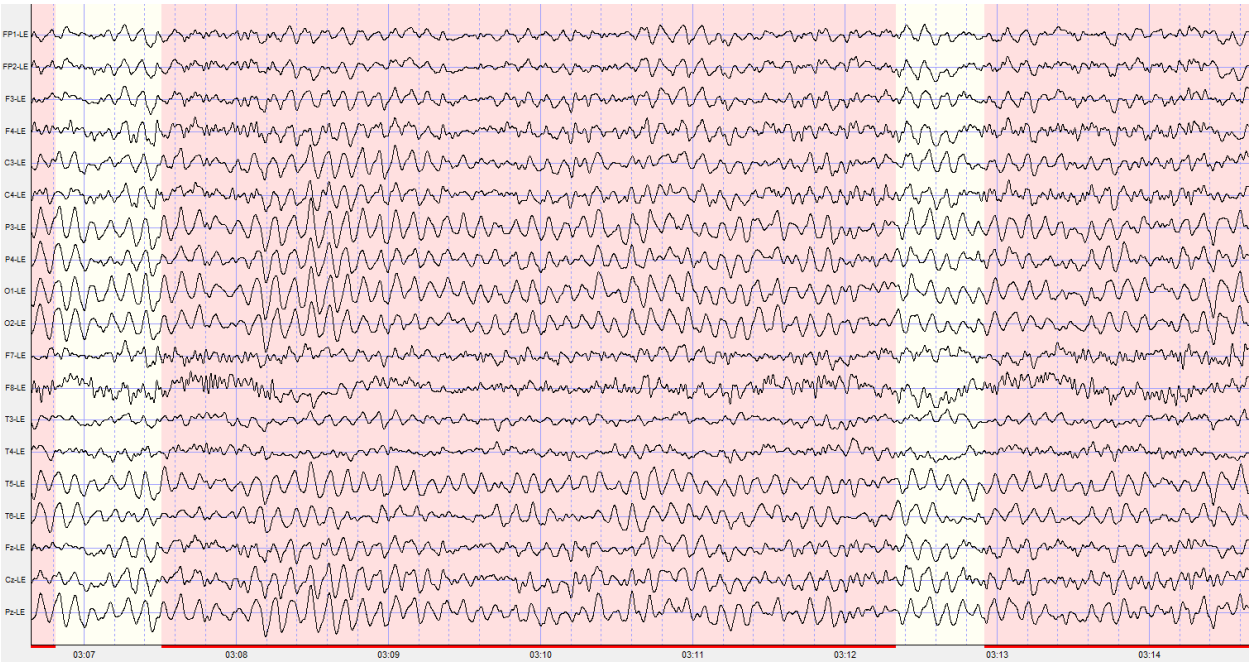


1.5 minutes of data was selected for later analysis.

In the second eyes closed recording Xxx showed much the same pattern, with frequent lateral eye movements:



At times the eye movements subsided and there were longer periods during which one can see the EEG more clearly:

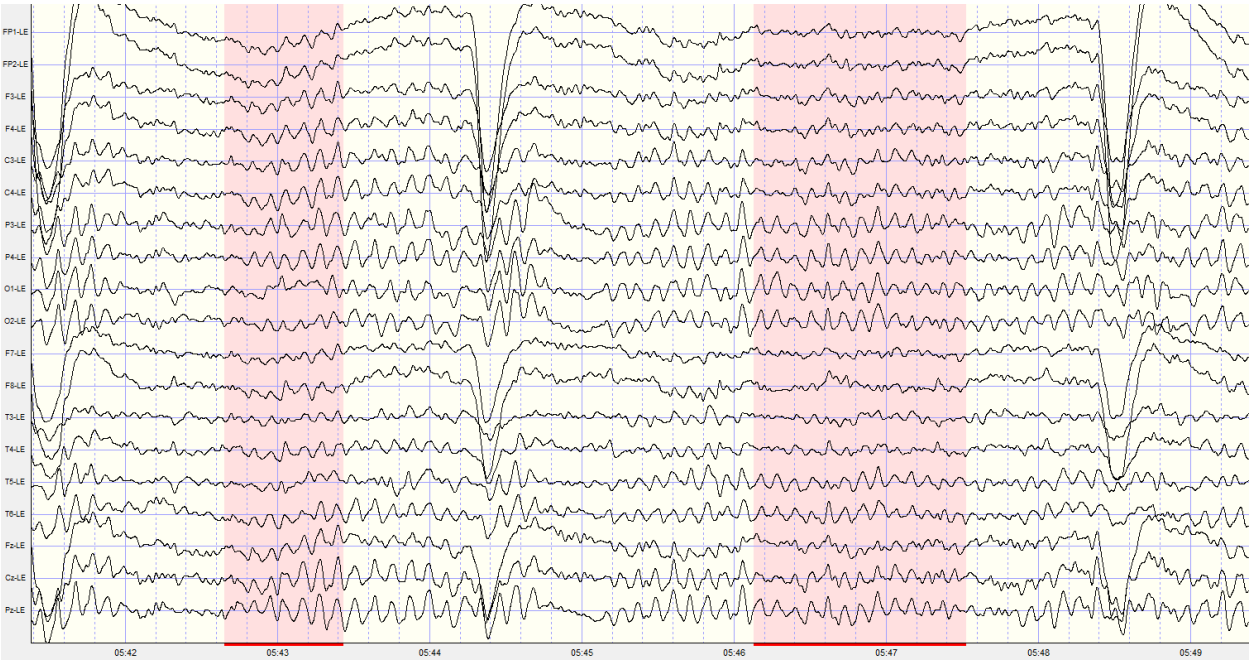


When the eyes are open and during tasks, the alpha rhythm should mostly disappear. This is called "alpha blocking" and it reflects the brain's resources being used for processing what is being attended to. The following is a sample of Xxx's eyes open EEG:

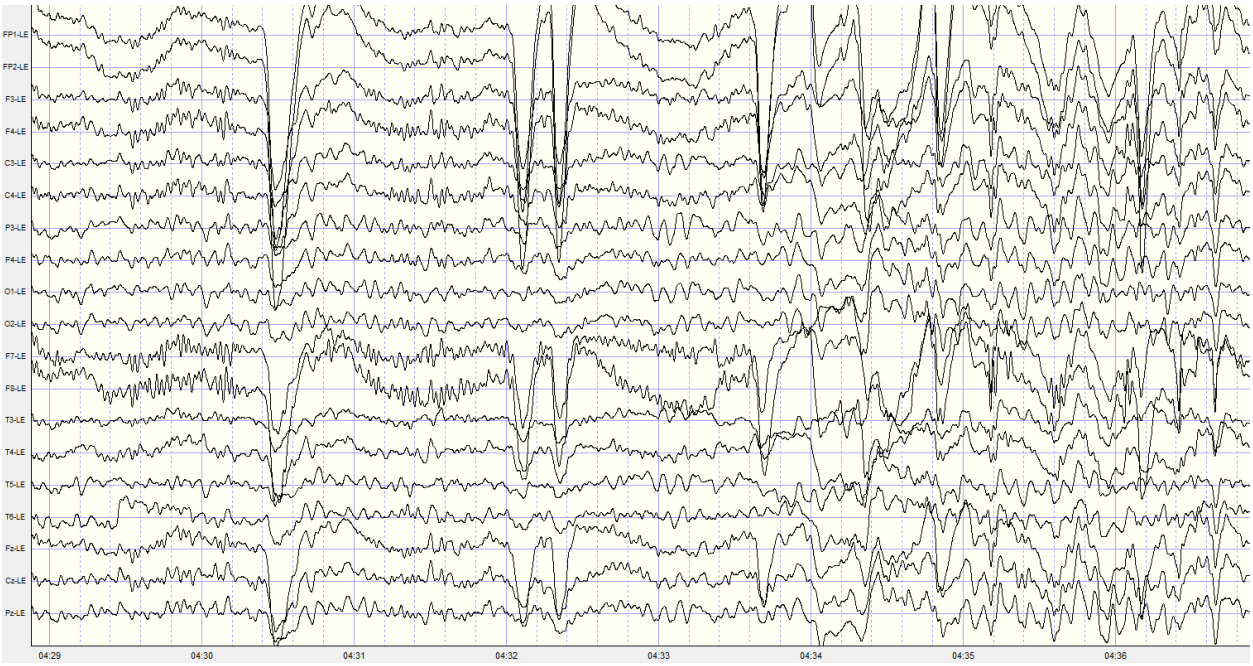
Behavioral Medicine Associates, Inc.
4820 West 77th Street, Suite 135
Edina, Minnesota 55435

952.844.0619
Facsimile: 952.844.0628
E-mail: information@qeeg.com

There was mostly average alpha blocking, although at times there were outbreaks of alpha, consistent with lapses of attention, shown here:

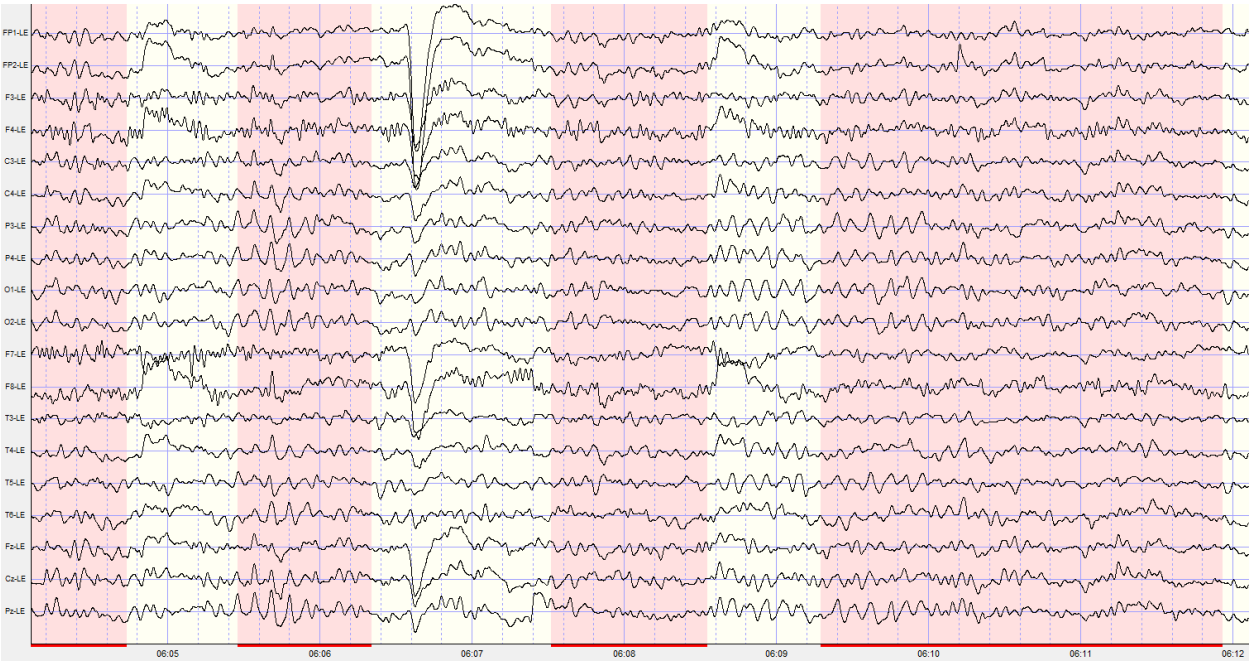


There was often excessive blinking, illustrated here:



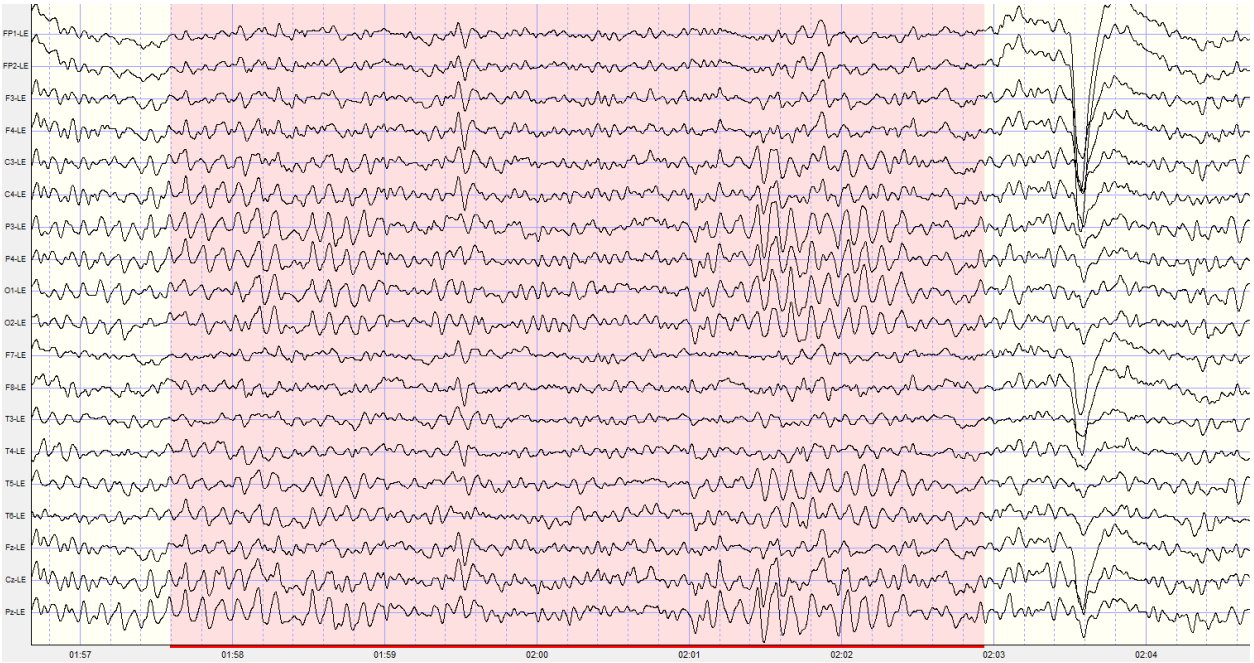
During tasks one expects even less alpha than during eyes open recording, because the demand of the task is expected to cause allocation of more neurons to detailed processing requiring brief, fast, high frequency processing networks to be established. This normally

results in a fully "desynchronized" appearance in the EEG. The following image is a representative sample of Xxx's EEG during reading:

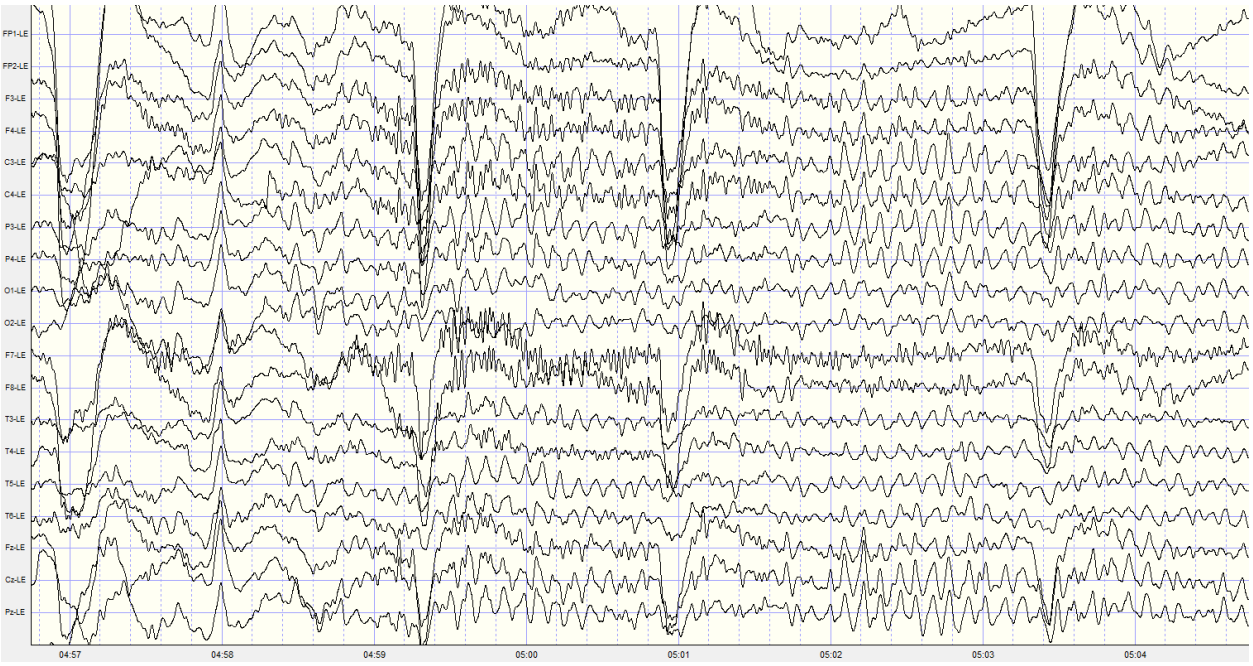


During reading there was incomplete alpha blocking. Eye movements, normally seen as "opposite-going" artifacts on the leads next to the eyes (F7 & F8), were somewhat irregular and not too well-formed, with the right eye moving more than the left and "hanging" briefly (seen as the flattening right after the sharp upward waves on the F8 channel).

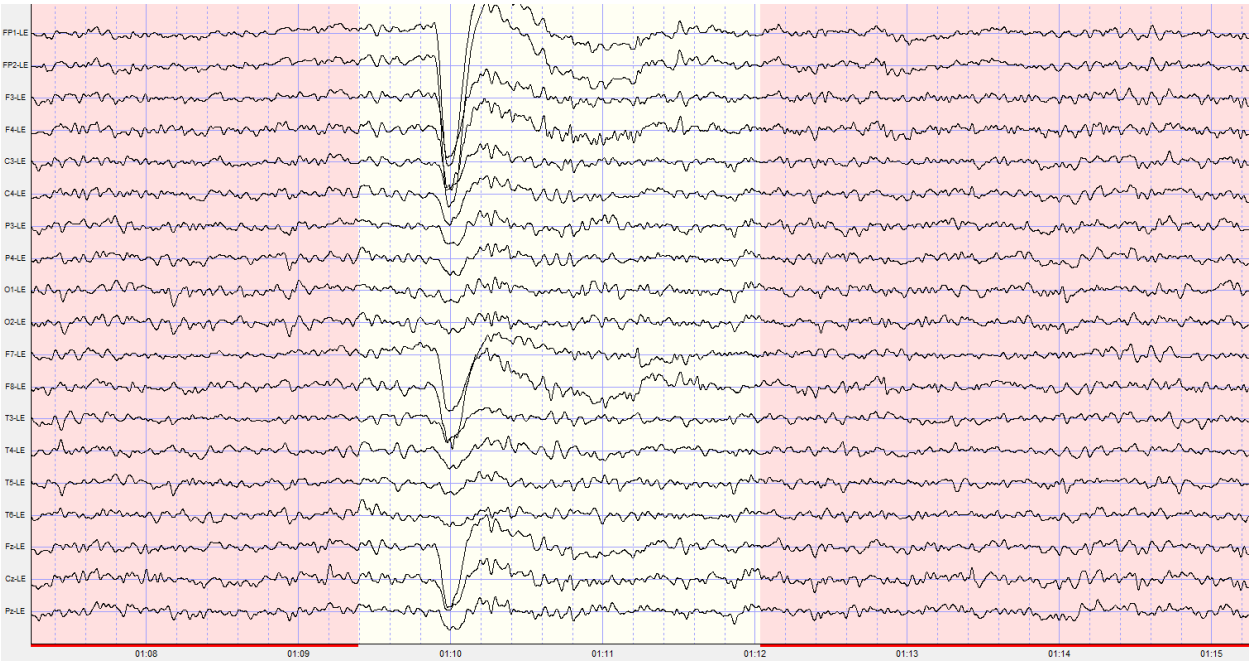
During listening there very poor alpha blocking:



Much of the data during listening was not usable for statistical analysis because of excessive blinking:



During writing there was strong alpha blocking and much less blinking and muscle tension:



During drawing there was full alpha blocking, with average delta power but low power at the higher frequencies, with little blinking or muscle tension:

Interpretation of the raw EEG data

The eyes closed EEG showed normal posterior alpha rhythms, but with some excess frontal alpha consistent with executive function difficulties, likely not pre-existing given the premorbid history of strong academic and professional performance. There was persistent muscle tension (EMG) artifact on the leads next to the eyes and very frequent slow, rolling lateral eye movements consistent with a problems in the brain system controlling eye movements. Alpha blocking, which indicates allocation of cortical processing resources to tasks, was incomplete during eyes open, reading and listening tasks. The alpha during listening was quite continuous. Excessive alpha like this during tasks indicates failures of attention and accounts for Xxx's complaints of problems with distractibility and concentration. This is consistent with Xxx's self-report of trouble tracking client conversations. The excessive blinking is consistent with anxiety, probably from the difficulty of focusing the attention.

During reading the inconsistent eye movements indicate the likelihood of problems tracking during reading, producing slowed reading with lower comprehension. The full alpha blocking and lower blink rates during writing and drawing indicate these active output tasks activate Xxx's cognitive resources and these tasks are probably much easier for him (based on the lower blink rate, less muscle tension) than passive listening or reading.

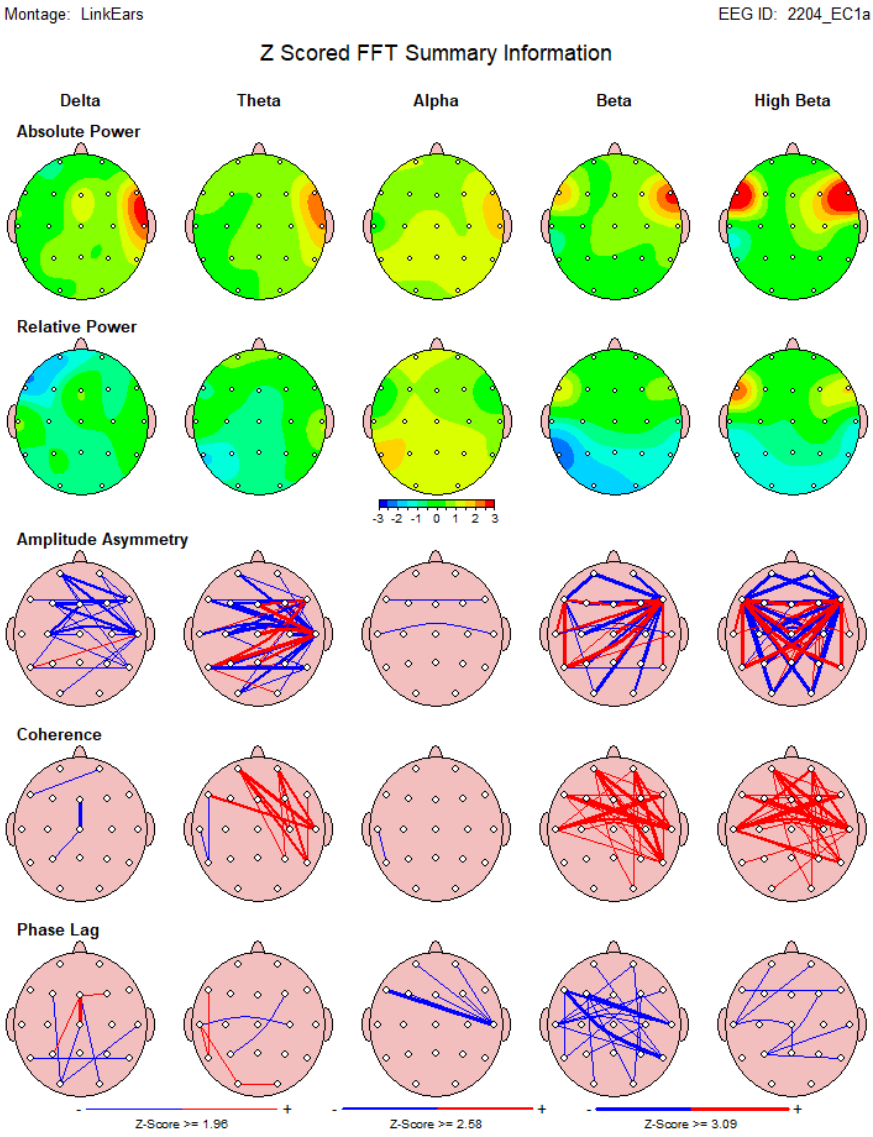
Statistical analysis of the EEG:

Artifacts from eye and head movements were carefully removed by visual inspection during the editing process. It was not possible to get data with no muscle tension artifact. Elevations in frontal high beta or abnormalities in high beta coherence or phase in frontal regions may reflect the presence of these artifacts. The eyes closed data was examined with the eyes closed Neuroguide database; the eyes open and all task data was examined with the Neuroguide eyes open database. Age and sex normed Z-score maps were used to assess deviations from age/sex norms for power, coherence and phase.

Behavioral Medicine Associates, Inc.
4820 West 77th Street, Suite 135
Edina, Minnesota 55435

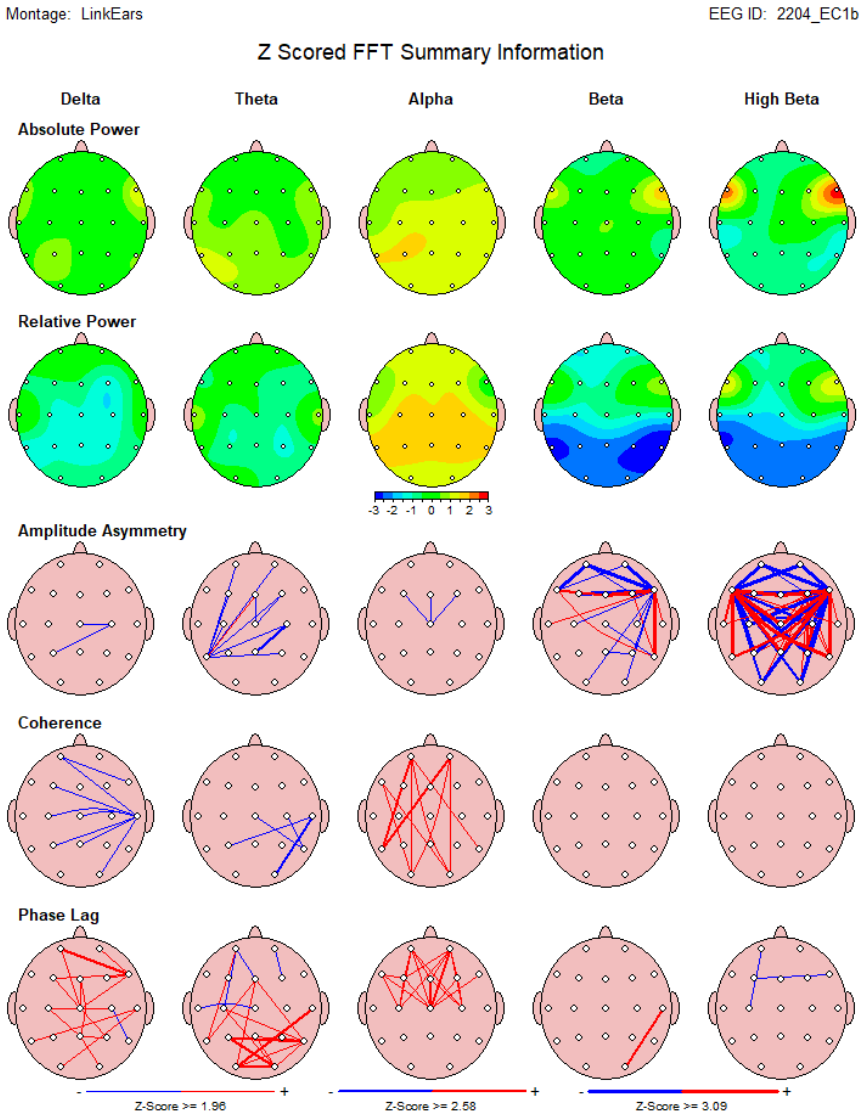
952.844.0619
Facsimile: 952.844.0628
E-mail: information@qeeg.com

Eyes Closed Recordings:



Behavioral Medicine Associates, Inc.
4820 West 77th Street, Suite 135
Edina, Minnesota 55435

952.844.0619
Facsimile: 952.844.0628
E-mail: information@qeeg.com



1. There is elevated power in alpha in the parietal association areas and right temporal regions. The first recording showed elevated right lateral frontal delta and theta, which normalized in the second recording. The lateral frontal beta/high beta power elevation is artifact of muscle tension. There was somewhat diminished high beta power in posterior regions; some of the extent of this may have been masked by the frontal EMG artifact. The strong asymmetries are mostly the result of eye movement or EMG artifact.
2. There is low coherence in delta and theta affecting temporal regions. There was prefrontal – frontal – right temporal hypercoherence in theta, beta and high beta in the

first recording. This normalized in the second recording, but extensive anterior-posterior hypercoherence emerged in alpha in the second recording.

3. Phase lags were variable, with longer phase findings in the second recording in delta, theta and alpha.

4. Thatcher's mild Traumatic Brain Injury discriminant analysis was positive in both recordings, with .90 and .975 probability of TBI and mild to moderate impairment predicted:

Behavioral Medicine Associates, Inc.
4820 West 77th Street, Suite 135
Edina, Minnesota 55435

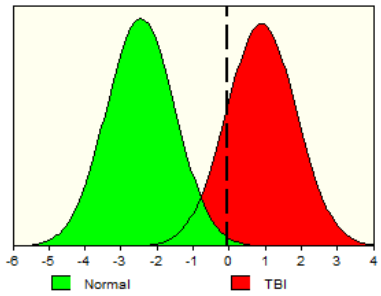
952.844.0619
Facsimile: 952.844.0628
E-mail: information@qeeg.com

Montage: LinkEars EEG ID: 2204_EC1a

Traumatic Brain Injury Discriminant Analysis*

TBI DISCRIMINANT SCORE = -0.10 TBI PROBABILITY INDEX = 90.0%

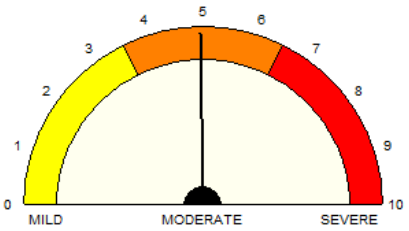
The TBI Probability Index is the subject's probability of membership in the mild traumatic brain injury population. (see Thatcher et al, EEG and Clin. Neurophysiol., 73: 93-106, 1989.)



			RAW	Z
FP1-F3	COH	Theta	89.50	0.97
T3-T5	COH	Beta	61.33	0.74
C3-P3	COH	Beta	82.70	0.67
FP2-F4	PHA	Beta	-0.09	-1.05
F3-F4	PHA	Beta	0.32	-0.13
F4-T6	AMP	Alpha	-40.40	-0.48
F8-T6	AMP	Alpha	-12.84	1.26
F4-T6	AMP	Beta	54.96	1.62
F8-T6	AMP	Beta	123.94	4.72
F3-O1	AMP	Alpha	-102.11	-0.74
F4-O2	AMP	Alpha	-96.31	-0.52
F7-O1	AMP	Alpha	95.97	-0.24
F4-O2	AMP	Beta	47.51	1.87
P3	RP	Alpha	66.35	0.88
P4	RP	Alpha	63.66	0.69
O1	RP	Alpha	75.30	1.04
O2	RP	Alpha	74.06	0.88
T4	RP	Alpha	40.83	-0.07
T5	RP	Alpha	73.17	1.51
T6	RP	Alpha	59.78	0.30

TBI SEVERITY INDEX = 4.93

This severity score places the patient in the MODERATE range of severity.



			RAW	Z
FP1-C3	COH	Delta	62.58	0.87
FP1-FP2	COH	Theta	91.62	1.10
O1-F7	COH	Alpha	18.50	-0.71
O2-T6	COH	Alpha	88.32	0.88
P3-O1	COH	Beta	82.26	0.86
FP1-T3	PHA	Theta	-2.34	-0.11
T3-T4	PHA	Theta	2.51	-1.12
O1-F7	PHA	Alpha	-34.35	1.46
F7-F8	PHA	Alpha	-0.19	-1.34
T5-T6	PHA	Beta	1.53	-0.20
C3-F7	AMP	Delta	-39.79	-3.02
FP2-F4	AMP	Delta	-19.71	-0.36
C4-F8	AMP	Delta	-88.10	-5.08
O1-O2	AMP	Theta	-22.77	-1.57
P3-F7	AMP	Alpha	80.27	-0.50
FP2-P4	AMP	Alpha	-86.52	-0.23

The TBI Severity Index is an estimate of the neurological severity of injury. (see Thatcher et al, J. Neuropsychiatry and Clinical Neuroscience, 13(1): 77-87, 2001.)

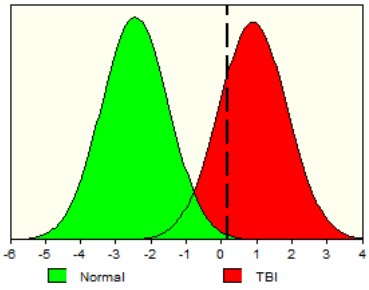
***Statement of Indications of Use:**
The Discriminant Analysis and Severity Index are to be used by experienced and qualified professionals for the post-hoc statistical evaluation of the human electroencephalogram (EEG). The Discriminant Analysis and Severity Index are to be viewed as an adjunct to the evaluation of the patient, and they do not serve as a primary basis for a diagnosis. Warning: Inclusion criteria of a history of traumatic brain injury and greater than 13 years of age must be adhered to.

Montage: LinkEars EEG ID: 2204_EC1b

Traumatic Brain Injury Discriminant Analysis*

TBI DISCRIMINANT SCORE = 0.15 TBI PROBABILITY INDEX = 97.5%

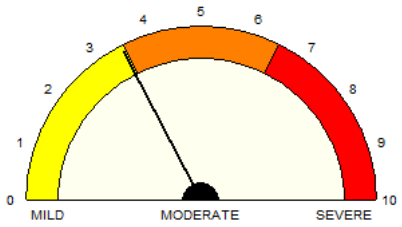
The TBI Probability Index is the subject's probability of membership in the mild traumatic brain injury population. (see Thatcher et al, EEG and Clin. Neurophysiol., 73: 93-106, 1989.)



			RAW	Z
FP1-F3	COH	Theta	86.50	0.52
T3-T5	COH	Beta	63.66	0.92
C3-P3	COH	Beta	78.69	-0.10
FP2-F4	PHA	Beta	-0.04	-1.25
F3-F4	PHA	Beta	0.02	-1.18
F4-T6	AMP	Alpha	-69.24	-1.14
F8-T6	AMP	Alpha	-101.92	-0.81
F4-T6	AMP	Beta	51.88	1.51
F8-T6	AMP	Beta	72.67	3.24
F3-O1	AMP	Alpha	-129.48	-1.26
F4-O2	AMP	Alpha	-118.21	-0.88
F7-O1	AMP	Alpha	152.07	1.06
F4-O2	AMP	Beta	9.73	0.86
P3	RP	Alpha	73.28	1.38
P4	RP	Alpha	75.99	1.63
O1	RP	Alpha	77.79	1.22
O2	RP	Alpha	79.97	1.29
T4	RP	Alpha	51.44	1.03
T5	RP	Alpha	74.33	1.61
T6	RP	Alpha	75.04	1.43

TBI SEVERITY INDEX = 3.49

This severity score places the patient in the MILD range of severity.



			RAW	Z
FP1-C3	COH	Delta	52.51	0.03
FP1-FP2	COH	Theta	88.19	0.54
O1-F7	COH	Alpha	48.89	1.59
O2-T6	COH	Alpha	91.34	1.26
P3-O1	COH	Beta	82.63	0.91
FP1-T3	PHA	Theta	-3.92	0.48
T3-T4	PHA	Theta	85.39	2.16
O1-F7	PHA	Alpha	-31.94	1.37
F7-F8	PHA	Alpha	-0.69	-0.82
T5-T6	PHA	Beta	4.25	0.99
C3-F7	AMP	Delta	-26.87	-2.56
FP2-F4	AMP	Delta	21.39	0.80
C4-F8	AMP	Delta	-73.58	-4.51
O1-O2	AMP	Theta	25.43	1.58
P3-F7	AMP	Alpha	146.60	1.26
FP2-P4	AMP	Alpha	-129.89	-1.23

The TBI Severity Index is an estimate of the neurological severity of injury. (see Thatcher et al, J. Neuropsychiatry and Clinical Neuroscience, 13(1): 77-87, 2001.)

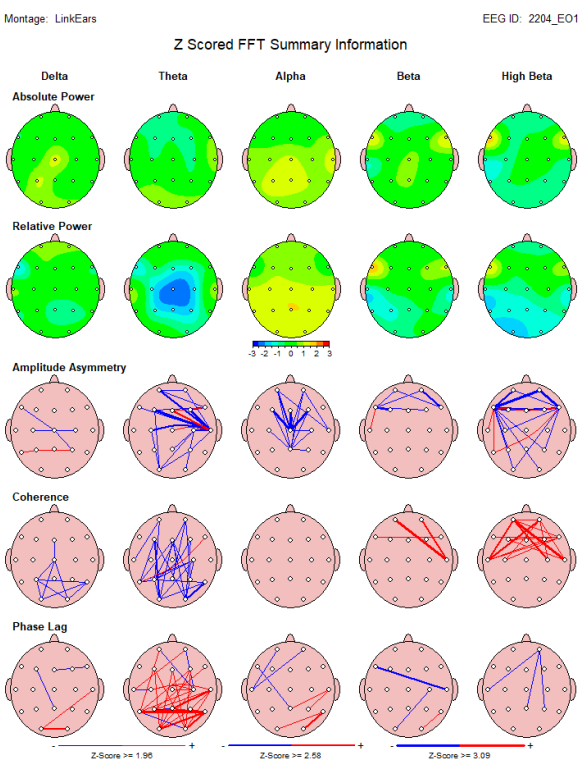
***Statement of Indications of Use:**
The Discriminant Analysis and Severity Index are to be used by experienced and qualified professionals for the post-hoc statistical evaluation of the human electroencephalogram (EEG). The Discriminant Analysis and Severity Index are to be viewed as an adjunct to the evaluation of the patient, and they do not serve as a primary basis for a diagnosis. Warning: Inclusion criteria of a history of traumatic brain injury and greater than 13 years of age must be adhered to.

Interpretation of eyes closed data

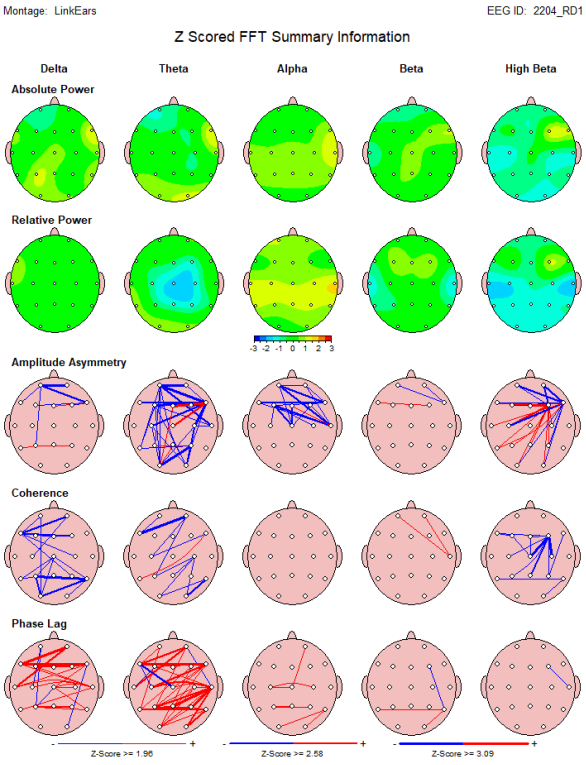
1. Eyes closed recordings give the best view of the brain's "default" state, the state toward which the brain moves when not under immediate task demand.
2. There was a change in state between the two recordings, with the second one showing altered coherence relative to the first, when Xxx may have been more relaxed.

3. Diminished beta/high beta power in common after mild brain injuries and reflects injury to the cortex.
4. The elevated alpha power is not clinically significant in the eyes closed state.
5. The coherence and phase abnormalities reflect alterations (decreases) in "functional connectivity" and often result from mild brain injuries. Diffuse axonal injury – stretching and tearing of white matter nerve tracts – causes problems with the precision synchronization of neuronal networks that is necessary to normal cognitive function.
6. The significant TBI discriminant scores indicate Xxx's eyes closed EEG bears significant resemblance to the EEGs seen in a group of 175 adults with documented TBI. The severity scores are based on predicting neuropsychological test scores from a combination of quantitative MRI and EEG data. These scores are consistent with Xxx's cognitive and functional complaints.

Eyes open



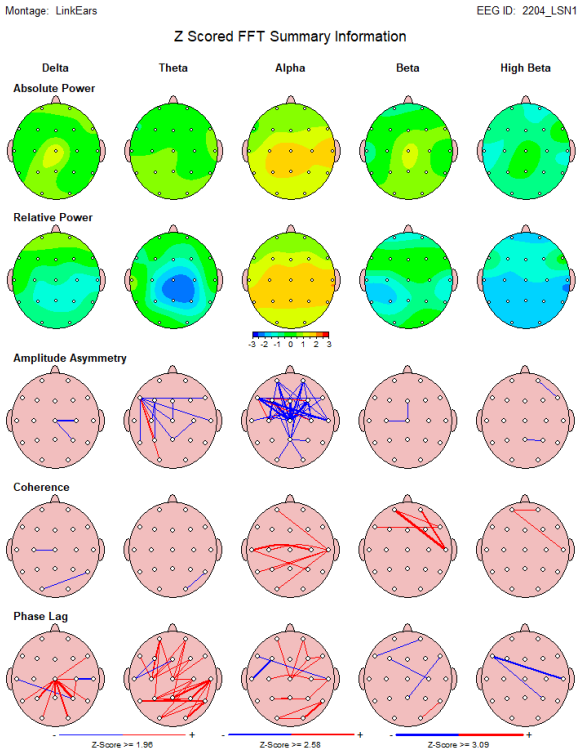
Reading



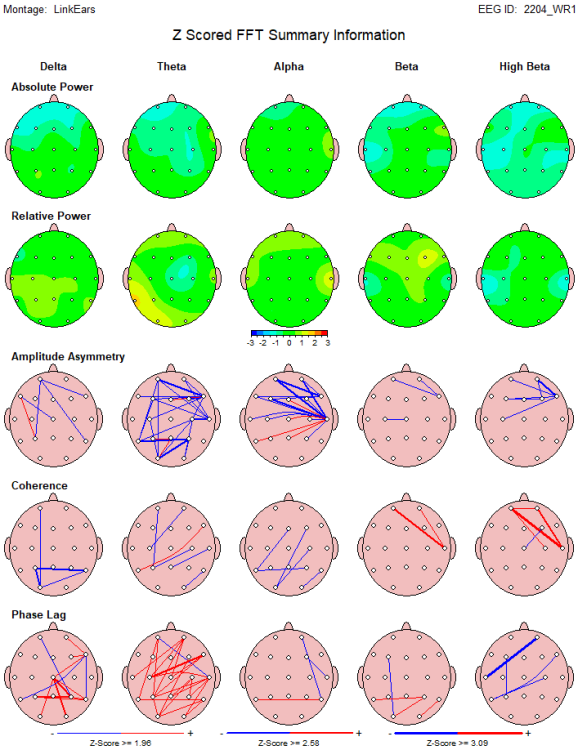
Behavioral Medicine Associates, Inc.
4820 West 77th Street, Suite 135
Edina, Minnesota 55435

952.844.0619
Facsimile: 952.844.0628
E-mail: information@qeeg.com

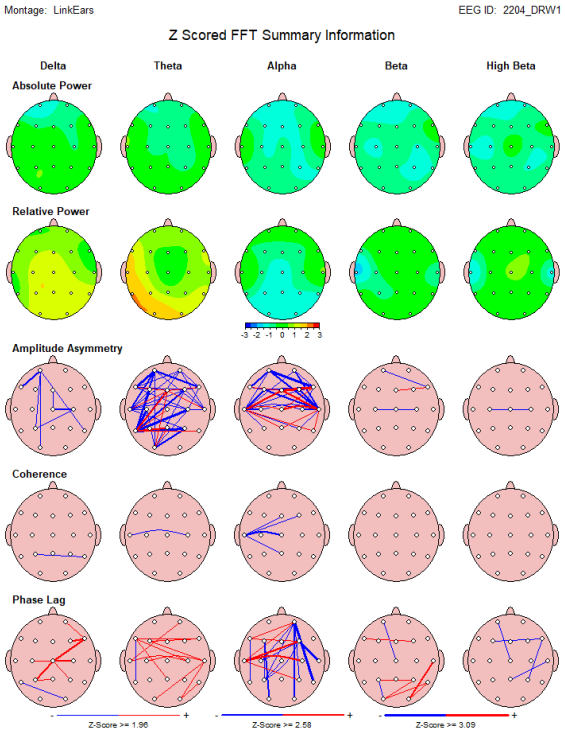
Listening



Writing



Drawing



1. There is elevated alpha power in the parietal region during eyes open and listening. This normalizes during the other tasks. Only drawing showed strong alpha blocking.
2. There is diminished power in beta and/or high beta in all conditions.
3. There are coherence abnormalities that vary in the different task conditions. Delta and theta hypocoherence is the biggest concern. Hypercoherence in beta/high beta is fairly persistent in the right prefrontal – temporal region, except during drawing. EMG artifact produced the hypocoherence and probably masked hypercoherence in that region during reading.
4. Phase lags were generally long across tasks and frequency bands.

Interpretation of task condition data

1. The eyes open resting state and to a greater degree the state that ensued during listening reflects perceptual and automatic cognitive association regions (the parietal lobes) failing to allocate resources. This results in gaps in attention, mind wandering and distractibility. This may represent "primary" ADHD, inattentive type, since failures of alpha blocking are common in adult patients with this syndrome. However, the concussion in this accident likely exacerbated this condition and disrupted learned adaptations Xxx would have developed across his life span. This large a failure in alpha blocking would not be expected in a successful businessman doing detailed professional work, listening carefully to associates and clients and creating rigorous long term plans with them prior to this accident.
2. The diminished beta/high beta power is common in people with concussions and/or acceleration/deceleration injuries and reflects diminished activation of the cortical neuronal networks.
3. The coherence and phase abnormalities are consistent with a mild brain injury. The hypercoherence in the high frequencies reflects reduced differentiation of function in the right frontal (executive) region and this may cause problems with "getting the big picture" on a cognitive level. On an emotional level this might cause reactivity and a feeling of being easily overwhelmed. The delta/theta hypocoherence affects the frontal – central – parietal connections and in combination with the long phase lags produces diminished functional connectivity that will interfere with one's normal sense of mental quickness and ability to automatically handle one's normal cognitive challenges.

4. The generally long phase lags indicate slowed conduction velocities and are consistent with a sense of diminished cognitive speed and perhaps with low energy.

ICD-10 Diagnoses

Note that these are labels for patterns of complaints and that they do not map well onto brain physiology. Various brain physiologies can cause very similar behavioral, emotional and cognitive symptoms. Both the International Classification of Disease and the Diagnostic and Statistical Manual of the American Psychiatric Association use diagnostic labels that are at best labels for patterns of complaints. Much of scientific medicine has abandoned symptom-based diagnosis in favor of descriptions of the physiological abnormalities that actually cause the symptoms.

Post-concussion syndrome, F07.81

ADHD, inattentive type, by history, F90.0. I note that further exploration of Xxx's history would be necessary to confirm this diagnosis; significant symptoms have to have been present early on and must not be related to other problems, e.g., childhood adversity (bullying, parental discord) or other medical disorders.

Xxx is being treated for depression and he appears to have some depression and anxiety. These symptoms are hard to separate out from PCS, so provisionally I'd diagnose Adjustment Disorder with depressed mood, F43.21 to note the likely association of depression with life events ranging from a difficult marriage to the recent disability from the motor vehicle accident.

Recommendations

1. Neurofeedback can be used to train for better alpha blocking during eyes open and during listening. That normally improves attention. Stabilizing and normalizing the coherence in prefrontal – frontal – parietal – occipital connections should improve the "brain fog" and quicken mental processing. The low coherence in delta and theta during eyes open and reading in the posterior cortex is a particular target, since this region does the automatic visual processing and automatic associations between what one already knows and new input from visual experience.
2. We do basic vision therapy as part of our sessions and this usually normalizes binocular control by but depending on what is causing the poor binocular control we may or may not be able to ameliorate it with our basic methods. Xxx has significant findings in this area; we usually can correct this by coupling vision therapy with neurofeedback by 20 sessions. If not, we'd refer to a developmental optometrist. Given the abnormal eye

movements I'd suggest an immediate evaluation with an ophthalmologist or neuro-ophthalmologist to make sure there are no physical/medical problems with the eyes, eye muscles or optic nerve.

3. Xxx should be very cautious about using any prescription or over-the-counter medication that has anticholinergic effects. A wide range of sleep medicines (including alprazolam), antidepressants and OTC allergy medications have known anticholinergic effects that have been strongly associated with cognitive impairment, particularly in older people as described in several recent publications in the British Journal of Medicine and the Internal Medicine Journal of the American Medical Association. Allegra (fexofenadine) has very low anti-cholinergic effects, so I will use only that for allergies. Further information on this can be found by doing a Google Scholar for "anticholinergic burden dementia."

4. Nutrition also needs to be addressed, specifically getting a good protein-rich meal to start the day and getting complex carbohydrates (vegetables, whole grains) in meals, avoiding processed meats and foods. I also suggest an omega-3 supplement, since it is likely for any standard American diet not to provide sufficient omega-3 fatty acids and these are commonly deficient in people with ADHD, depression and anxiety. Omega-3's are powerful anti-inflammatories and benefit gene and neurotransmitter regulation. People taking "blood thinners" for heart conditions or who are anticipating surgery or have any tendency toward excessive bleeding should consult with their physician before using omega-3 supplements, since omega-3s have a mild anti-coagulant effect. For adults 2000 mg combined EPA and DHA is suggested. About the best concentrate I've found is Nature Made brand 1400 mg fish oil capsules, each with 1000 mg of EPA + DHA. Omega-3s are also in foods, particularly organic eggs, nuts and "fatty" fish (anchovies, bluefish, herring, mackerel, salmon (wild has more omega-3s than farmed), sardines, sturgeon, lake trout, and tuna). One also wants adequate Vitamin B-12, SAM-e, folic acid, magnesium, zinc, Vitamin C and Vitamin D. Particularly during the winter, Vitamin D levels may need to be supplemented. The physician might want to test Vitamin D levels, since individuals vary a lot in terms of how much they get from food or from the sun, and how well they store it. Xxx could also consider Jarrow's Neuro Optimizer which contains a number of substances that promote normal memory function, including acetyl l-carnitine, phosphatidylcholine, phosphatidylserine and alpha lipoic acid that have been associated with memory improvement in research. Xxx's personal physician should approve of any supplements Xxx is taking or considering.

5. Physical activity (aerobic and resistance training) helps reduce reactivity to stress, feels good, and helps promote deeper sleep, so this is recommended several times a week at a level Xxx tolerates.

6. Good sleep hygiene should be followed, meaning sleeping in a cool, thoroughly dark room, having a regular bed-time routine, and not worrying, reading, watching TV or doing work in bed. If not asleep in roughly 20 minutes Xxx should get out of bed and do something quiet until very drowsy, then get back in bed. This is repeated until sleep onset is within 20 minutes. For middle of the night awakenings or difficulty falling back asleep it is often helpful to do a deep relaxation activity like watching the breath come and go, contemplate the warmth of one's feet, or simply saying the word "one" over and over again until asleep. Sometimes "telling yourself a dream" works nicely, because most awakening occurs during the dream phase and this is disrupted by the awakening. One should never expose oneself to light in the middle of the night, since this will disrupt the sleep phase. The brain "sets its clock" by the wake-up time, so it is important to have a regular, steady wake-up time. It is best not to expose the eyes to a lot of bluish light in late evening, so minimizing computer and TV exposure in the later evening is a good idea. Computers can use a utility like f.lux (available free at http://stereopsis.com) to automatically cut the color temperature of the screen each day at sunset. IOS and Windows 10 now have this function built in to the screen display software, but it has to be deliberately invoked and set. Many people simply get too little sleep duration; 7.5 - 8 hours is needed.

7. The high dose of DDDDDD Xxx takes may be reducing his sleep efficiency; DDDDD has a long half-life and some of it will be active during his sleep period. His physician should be consulted about this. The other two medications should also be discussed ongoing with Xxx's physician, since both may produce some unwanted side effects, including feeling a bit slowed or foggy. They're helpful medications for blood pressure and migraines, respectively, but may not be playing well with his post-concussional symptoms.

John K. Nash, Ph.D., L.P.
Sr. Fellow, BCIA, Board Certified Neurofeedback
Diplomate (Licensed), International QEEG Certification Board