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1. Introduction

This document summarizes published research regarding electrophysiology biomarkers pertaining to numerous cognitive conditions. It defines electroencephalography-derived metrics including qEEG, event-related potentials, and ECG, and details known clinical correlations based on over 600 scientific publications. Based on these clinical correlations, medical interventions are recommended.

Behavior Metrics

Every day, people must react to physical, emotional, and mental challenges. Behavior performance measures of reaction time, errors of omission (how often you miss information) and errors of commission (how often you make a mistake) are accurate measures of a person’s general ability to perform routine daily tasks effectively. As people naturally age, both their physical and cognitive abilities begin to decline. Performance measures provide an objective measurement of this decline.

Cardiac and Autonomic Function Metrics

Heart rate variability, frequency analysis, and spectral analysis are terms used to describe various parameters of the recorded electrocardiogram (ECG) that are meaningful in determining the patient’s state of cardiac and autonomic nervous system (ANS) function. HRV measures are deterministic of overall heart health and research has demonstrated the high correlation between HRV and myocardial infarct (Heart Attack) risk. HRV is also a strong indicator of stress level and autonomic resilience, and when measured HRV is depressed (e.g., < 75 in adults, <50 in older individuals) it can be a marker for sympathetic overdrive (too much of the “fight or flight” response) associated with anxiety, panic, sleep disorders, brain injury (e.g. concussion) and other related conditions.

Evoked Potentials (EPs)

Evoked Potentials (EPs) otherwise known as Event Related Potentials (ERPs) measure, to the millisecond, the brain’s speed of processing information (visual, auditory, physical, or electrical). This fast cognitive processing is what allows humans to receive billions of bits of information at a time, filter, and process this information in order to make decisions every second of every day. The temporal sensitivity of ERP testing can detect cognitive disruptions before they become noticeable in everyday life. ERP measures can indicate slowed physical reactions, slowed decision making, memory impairments, stress
disorders, and other known neurologic disorders. This metric is also important in determining brain speed in concussed athletes to ensure their brain reaction time returns to baseline.

Electroencephalogram (EEG)

The electroencephalogram (EEG) provides a robust measure of general brain function and overall brain health. The term EEG literally means “electrical” (electro) “brain” (encephalo) “writing” (gram). The neural activity measured by the EEG is responsible for all cognitive and planned movement functions and the orchestration of every human function. The EEG is able to detect abnormalities that occur due to normal and abnormal aging, mental diseases or disorders, brain insults from impact damage (e.g. concussion), toxins from the environment or substance abuse, or acute and chronic changes resulting from situational stressors.

Biofeedback

Biofeedback is a technique that is used to train people to achieve more control over their body’s central and autonomic nervous system functioning. Sensors, such as electrodes, are used to detect changes in metrics, like EEG brainwaves or heart rhythms, and computerized feedback then displays the subsequent changes in physiology to the individual. Over time, this computerized feedback helps people focus on making subtle changes in their body to achieve healthier mental, emotional, and overall physiological states. Biofeedback is completely painless and non-invasive.
2. Test Metric Definitions

2.1 Self- Assessment

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Test Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory</td>
<td>• Measures the patient’s ability to remember episodic events and semantic facts.</td>
</tr>
<tr>
<td>Executive &amp; Attention</td>
<td>• Measures the patient’s behavioral impulsivity, attention span, decision making, and focus.</td>
</tr>
<tr>
<td>Word Fluency</td>
<td>• Screens the patient’s ability to comprehend and produce language.</td>
</tr>
<tr>
<td>Affective</td>
<td>• Measures the patient’s recent emotional states.</td>
</tr>
<tr>
<td>Sensory</td>
<td>• Measures the patient’s day to day ability to perceive stimuli in the external environment.</td>
</tr>
<tr>
<td>Motor</td>
<td>• Screens the patient’s skeletal-muscular competency.</td>
</tr>
</tbody>
</table>

2.2 Behavior Metrics

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Test Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor speed/RT (Reaction Time)</td>
<td>• Motor speed is calculated by measuring the time it takes for the patient to respond to a target from the stimulus onset. It is a combination of central processing speed, stimulus interpretation, motor programming, and physical task execution.</td>
</tr>
<tr>
<td>RT (Reaction Time) Variance</td>
<td>• Reaction time variance is the patient’s ability to maintain a constant reaction time for each individual trial across testing. This indicates a patient’s sustained attention (concentration) and, therefore, measures the ability to maintain a consistent behavioral response during continuous and repetitive activity. Small variances imply sustained attention/concentration.</td>
</tr>
<tr>
<td>Omission</td>
<td>• Omission errors occur when a patient does not recognize a stimulus as a target. This test component measures selective (focused) attention and, therefore, high scores of omission reflect distractibility and difficulty focusing.</td>
</tr>
<tr>
<td>Commission</td>
<td>• Commission errors occur when the patient believes that the stimulus is a target when it actually is not. High commission scores indicate impulsivity and therefore, a lack of inhibition when paired with a fast reaction time. High commission errors paired with a slow reaction time indicate general inattention.</td>
</tr>
</tbody>
</table>
### 2.3 Cardiac and Autonomic Function

<table>
<thead>
<tr>
<th>Metric</th>
<th>Test Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate</td>
<td>• Heart rate refers to the speed of the heartbeat, usually quantified as beats per minute (bpm). It is a general measure of cardiovascular health. Low scores tend to indicate better physiological function.</td>
</tr>
<tr>
<td>QRS Duration</td>
<td>• QRS duration is the time it takes for the ventricles to depolarize. It is useful in diagnosing cardiac arrhythmias, conduction abnormalities, ventricular hypertrophy, myocardial infarction, electrolyte derangements, and other disease states.</td>
</tr>
<tr>
<td>SDNN (Autonomic Balance)</td>
<td>• SDNN is the standard deviation of the R-R peaks in the ECG waveform. It is indicative of autonomic balance. High SDNN scores indicate better heart health and ability to cope with stress. Low SDNN scores indicate reduced heart health and attenuated stress resilience.</td>
</tr>
<tr>
<td>Total Power</td>
<td>• Total Power is the variance of N-N intervals (artifact corrected ECG R-R interval) over the temporal HRV spectrum (&lt; 0.4 Hz). It is an estimate of overall heart rate variability and approximately equates to the SDNN time domain measure. Low total power is an indicator of reduced heart health and is a predictor of cardiac-related mortality.</td>
</tr>
<tr>
<td>VLF (Very Low Frequency)</td>
<td>• VLF is the amount of power in the very low frequency band of the HRV spectrum (&lt;.04 Hz). Several factors influence VLF power including physical, thermoregulatory, renin-angiotensin, endothelial, and parasympathetic nervous system activity. VLF is a measure of sympathetic tone and excess power indicates sympathetic overdrive and reduced heart health.</td>
</tr>
<tr>
<td>LF (Low frequency)</td>
<td>• LF is the amount of power in the low frequency band of the HRV spectrum (.04 Hz-.15 Hz) and is a measure of autonomic balance. When LF score is the largest of all other spectral scores, this indicates a healthy balance within the autonomic nervous system.</td>
</tr>
<tr>
<td>HF (High Frequency)</td>
<td>• HF is the amount of power in the high frequency band of the HRV spectrum (0.15 Hz-0.4 Hz) and is a measure of parasympathetic tone. Excess power often indicates increased fatigue, anxiety, burnout and excess stress.</td>
</tr>
</tbody>
</table>
## 2.4 Evoked Potentials

<table>
<thead>
<tr>
<th>Evoke Potential</th>
<th>Test Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visual</strong></td>
<td>• Measures visual processing efficiency</td>
</tr>
<tr>
<td><strong>Auditory</strong></td>
<td>• Measures auditory processing efficiency</td>
</tr>
<tr>
<td><strong>P3a</strong></td>
<td>• P3a is a positive-going, time-locked component of the larger ERP waveform that is associated with engagement of attention (focal orienting), stimulus recognition, and the processing of novelty stimuli.</td>
</tr>
<tr>
<td><strong>P3b</strong></td>
<td>• P3b is a positive-going, time-locked component of the larger ERP waveform that is associated with selective attention, information processing, and working memory. It is a well-researched measure used in dementia and other cognitive disorders.</td>
</tr>
<tr>
<td><strong>P3b Gradient</strong></td>
<td>• Measures the P3b slope across frontal and tempo-parietal lobes. It remains an experimental measure for differentiation between some dementia conditions.</td>
</tr>
</tbody>
</table>
# 2.5 Electroencephalogram (EEG)

<table>
<thead>
<tr>
<th>EEG Frequency Bands</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Delta</strong></td>
<td>2-4Hz. Infants and sleeping adults.</td>
</tr>
<tr>
<td><strong>Theta</strong></td>
<td>4-8Hz. Children and drowsiness.</td>
</tr>
<tr>
<td><strong>Alpha1</strong></td>
<td>8-10Hz. Resting rhythm in adults.</td>
</tr>
<tr>
<td><strong>Alpha2</strong></td>
<td>10-12Hz. Resting rhythms in adults</td>
</tr>
<tr>
<td><strong>Beta1</strong></td>
<td>12-19Hz. Active and alert states.</td>
</tr>
<tr>
<td><strong>Beta2</strong></td>
<td>19-30Hz.</td>
</tr>
<tr>
<td><strong>EMG</strong></td>
<td>Electromyography is a technique for evaluating and recording the electrical activity produced by skeletal muscles.</td>
</tr>
<tr>
<td><strong>Beta Spindles</strong></td>
<td>Synchronous activity in the beta range centered around a specific frequency such as 19-21Hz and is <strong>not</strong> the same as sleep spindles.</td>
</tr>
<tr>
<td><strong>Peak Frequency</strong></td>
<td>Individual posterior peak frequency from 5Hz to 13Hz.</td>
</tr>
<tr>
<td><strong>Theta:Beta Ratio</strong></td>
<td>Power ratio of 4-8Hz/13-21 Hz. A ratio used and recently cleared by the FDA to assess a common subtype of ADD/ADHD where there is excessive slow EEG content over the anterior cingulate.</td>
</tr>
</tbody>
</table>
3. Brain Function Maps

3.1 Surface EEG Functional Correlations

- Attention (logical)
  - Working memory (visual)
  - BA 9, 10, 11, 46

- Focus
  - Attention
  - Motivation
  - BA 6, 7, 8, 9, 10, 25, 33, 32,

- Attention (emotional-contextual)
  - Face and object processing
  - BA 9, 10, 11, 46

- Working memory
  - Impulsivity/Response inhibition
  - BA 6, 8, 9, 40, 43, 46

- Language production & comprehension
  - Working memory, selective attention
  - BA 38, 44, 45, 47, 46

- Short-term memory
  - Coordination
  - BA 1, 2, 3, 4, 6, 22, 41

- Language comprehension, reading
  - Long term memory
  - BA 4, 20, 21, 22, 38, 40, 41, 42, 43, 44

- Sensory processing
  - Information processing
  - Working memory
  - BA 20, 30, 36, 37, 39, 40, 41, 42, 47

- Verbal construction & comprehension
  - Verbal short-term memory
  - BA 7, 23, 31

- Verbal short-term memory
  - BA 39, 40

- Right visual field
  - Peak frequency
  - BA 17, 18, 19, 31, 37

- Left visual field
  - Peak frequency
  - BA 17, 18, 19, 31

- Impulse control/Impulsivity
  - BA 8, 9, 46

- Emotional processing
  - Sustained attention
  - BA 38, 44, 45, 47, 46

- Short-term memory
  - Anxiety
  - Sleep quality
  - BA 1, 2, 3, 4, 5, 6, 24, 25

- Non-verbal memory
  - Coordination
  - BA 1, 2, 3, 4

- Emotional regulation
  - Organization
  - BA 4, 20, 21, 22, 38, 39, 41, 42, 43

- Emotional awareness
  - Emotional comprehension
  - BA 20, 30, 36, 37, 39, 40, 41, 42

- Sustained attention
  - BA 40
3.2 Brodmann Areas Map
4. Clinical Correlations

4.1 Self-Assessments

<table>
<thead>
<tr>
<th>Brain Function Screener</th>
<th>Peer Reviewed Clinical Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Memory</strong></td>
<td>• Inattention/lack of focus 131</td>
</tr>
<tr>
<td></td>
<td>• Short or Long Term Recall 124 125</td>
</tr>
<tr>
<td></td>
<td>• Spatial and Temporal Orientation 135 136</td>
</tr>
<tr>
<td></td>
<td>• Procedural Memory 119 120</td>
</tr>
<tr>
<td></td>
<td>• Hindered Face Recognition 121 122 123</td>
</tr>
<tr>
<td></td>
<td>• Concussion/Brain Injury 117 118</td>
</tr>
<tr>
<td><strong>Executive &amp; Attention</strong></td>
<td>• Inattention/ Lack of Focus 131</td>
</tr>
<tr>
<td></td>
<td>• Impulsivity 131</td>
</tr>
<tr>
<td></td>
<td>• Frontal Lobe Dysfunction 126</td>
</tr>
<tr>
<td></td>
<td>• Concussion/Brain Injury 117 118</td>
</tr>
<tr>
<td><strong>Word Fluency</strong></td>
<td>• Hindered Language Processing 141 142 143 144</td>
</tr>
<tr>
<td></td>
<td>• Impaired Working Memory 141</td>
</tr>
<tr>
<td></td>
<td>• Concussion/Brain Injury 118</td>
</tr>
<tr>
<td><strong>Affective</strong></td>
<td>• Memory Complaints 132 133</td>
</tr>
<tr>
<td></td>
<td>• Affective And Mood Disturbance 132 133 134</td>
</tr>
<tr>
<td></td>
<td>• Concussion/Brain Injury 118</td>
</tr>
<tr>
<td><strong>Sensory</strong></td>
<td>• Hindered Sensory Processing 137 138 139</td>
</tr>
<tr>
<td></td>
<td>• Concussion/Brain Injury 118</td>
</tr>
<tr>
<td><strong>Motor</strong></td>
<td>• Motor Processing Deficiency 128 129</td>
</tr>
<tr>
<td></td>
<td>• Skeletal-Muscular Abnormality 128 129</td>
</tr>
<tr>
<td></td>
<td>• Concussion/Brain Injury 118</td>
</tr>
</tbody>
</table>

4.2 Behavior Metrics

<table>
<thead>
<tr>
<th>Brain Function Screener</th>
<th>Peer Reviewed Clinical Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motor speed/ Reaction Time</strong></td>
<td>• Cognitive or Motor Processing 127 128 129</td>
</tr>
<tr>
<td></td>
<td>• Hindered Visual Discrimination 130</td>
</tr>
<tr>
<td></td>
<td>• Concussion/Brain Injury 118</td>
</tr>
<tr>
<td><strong>Reaction Time Variance</strong></td>
<td>• Lack of focus/ sustained concentration 145 146 147</td>
</tr>
<tr>
<td></td>
<td>• Cognitive impairment 20</td>
</tr>
<tr>
<td></td>
<td>• Concussion/Brain Injury 118</td>
</tr>
<tr>
<td><strong>Omission</strong></td>
<td>• Inattention 148</td>
</tr>
</tbody>
</table>
4.3 Cardiac and Autonomic Function

<table>
<thead>
<tr>
<th>Metric</th>
<th>Peer Reviewed Clinical Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate</td>
<td>• Cardiac Health and General Fitness 58 60 61 2 62</td>
</tr>
<tr>
<td></td>
<td>• Anxiety (High HR) 54 50</td>
</tr>
<tr>
<td></td>
<td>• Stress (High HR) 54</td>
</tr>
<tr>
<td></td>
<td>• Chronic Pain (High HR)</td>
</tr>
<tr>
<td></td>
<td>• Overtraining Syndrome (high HR) 52</td>
</tr>
<tr>
<td></td>
<td>• Concussion/Brain Injury (high HR) 47 44 45 49 34</td>
</tr>
<tr>
<td></td>
<td>• Bradycardia (Low HR) 88</td>
</tr>
<tr>
<td></td>
<td>• Electrolyte Imbalance (Low HR) 88</td>
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<tr>
<td>QTc Interval</td>
<td>• Cardiac Health 2 48</td>
</tr>
<tr>
<td></td>
<td>• Anxiety 77</td>
</tr>
<tr>
<td></td>
<td>• Stress 51 54</td>
</tr>
<tr>
<td></td>
<td>• Mild Cognitive Impairment 6</td>
</tr>
<tr>
<td></td>
<td>• Concussion/Brain Injury 47 44 45 49 34</td>
</tr>
<tr>
<td></td>
<td>• Hypertension 63 77</td>
</tr>
<tr>
<td></td>
<td>• Hyperglycemia 89</td>
</tr>
<tr>
<td>QRS Duration</td>
<td>• Cardiac Health 97</td>
</tr>
<tr>
<td></td>
<td>• Ventricle Depolarization 97</td>
</tr>
<tr>
<td>SDNN (Autonomic Balance)</td>
<td>• Cardiac Health 73 78</td>
</tr>
<tr>
<td></td>
<td>• Stress 51 54 65 54</td>
</tr>
<tr>
<td></td>
<td>• Anxiety, PTSD 50 54</td>
</tr>
<tr>
<td></td>
<td>• Hyperglycemia 74 65</td>
</tr>
<tr>
<td></td>
<td>• Depression 46</td>
</tr>
<tr>
<td></td>
<td>• Chronic Pain</td>
</tr>
<tr>
<td></td>
<td>• Concussion/Brain Injury 44 45 34</td>
</tr>
<tr>
<td></td>
<td>• Affective and Mood Disorder 46 54</td>
</tr>
<tr>
<td></td>
<td>• Cognitive Impairment 1 5 6</td>
</tr>
<tr>
<td>Total Power</td>
<td>• Cardiac Health 52</td>
</tr>
<tr>
<td></td>
<td>• Vagal Activity and Balance 52</td>
</tr>
<tr>
<td></td>
<td>• Stress 51 54</td>
</tr>
<tr>
<td></td>
<td>• Overtraining Syndrome 52</td>
</tr>
<tr>
<td></td>
<td>• Affective and Mood Disorder 53</td>
</tr>
<tr>
<td></td>
<td>• Cognitive Impairment 1 5 6</td>
</tr>
<tr>
<td>VLF</td>
<td>• Sympathetic Over Arousal 62</td>
</tr>
</tbody>
</table>
### 4.4 Evoked Potentials

<table>
<thead>
<tr>
<th>Evoked Potentials (ERP Amplitudes)</th>
<th>Peer Reviewed Clinical Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>• Visual Processing 149 150 240</td>
</tr>
<tr>
<td>Auditory</td>
<td>• Auditory Processing 151 152</td>
</tr>
<tr>
<td>Attention/Vigilance (P300a)</td>
<td>• Inattention 99 103</td>
</tr>
<tr>
<td></td>
<td>• Focus 99</td>
</tr>
<tr>
<td></td>
<td>• Dopaminergic Deficiencies 105</td>
</tr>
<tr>
<td></td>
<td>• Frontal Lobe Dysfunction 105 112</td>
</tr>
<tr>
<td></td>
<td>• Memory Problems 105 104</td>
</tr>
<tr>
<td></td>
<td>• Cognitive Decline Due to Aging 100 103 101</td>
</tr>
<tr>
<td>Info Processing / Working Memory (P300b)</td>
<td>• Working Memory Deficiency 108 104</td>
</tr>
<tr>
<td></td>
<td>• Information Processing 110 113 114</td>
</tr>
<tr>
<td></td>
<td>• Temporal Lobe Dysfunction 104 105</td>
</tr>
<tr>
<td></td>
<td>• Parietal Lobe Dysfunction 112 105</td>
</tr>
<tr>
<td></td>
<td>• Inattention 106 107 103</td>
</tr>
<tr>
<td></td>
<td>• Focus 106 107</td>
</tr>
<tr>
<td></td>
<td>• Cognitive Decline Due to Aging 100 103 114</td>
</tr>
<tr>
<td>Midline Gradient</td>
<td>• Frontal Lobe Dysfunction 109</td>
</tr>
<tr>
<td></td>
<td>• Cognitive Dysfunction 109 100</td>
</tr>
<tr>
<td></td>
<td>• Working Memory 109 100</td>
</tr>
</tbody>
</table>
### 4.5 EEG Frequencies

<table>
<thead>
<tr>
<th>EEG Frequencies</th>
<th>Peer Reviewed Clinical Correlations</th>
</tr>
</thead>
</table>
| **Low Power (Global)**        | • Cognitive Decline Due to Aging 39  
• Alzheimer’s Disease 39, 197 |
| **Low Power (Slow Frequencies)** | • (reduced theta) Poor Episodic Memory Retrieval 98, 99  
• (reduced theta) Poor Verbal Working Memory 40, 98, 107 |
| **Low Power (Fast Frequencies)** | • (reduced alpha) Depression 199, 225  
• (reduced alpha) TBI, Concussion 199, 216, 217, 218, 219, 220  
• (reduced alpha) Anxiety Disorder 199, 212, 213  
• (reduced alpha) Cognitive Decline due to Aging, Alzheimer’s 197  
• (reduced alpha) Schizophrenia 199, 206, 207  
• (reduced alpha) Indicative of Autism in Adults 187  
• (reduced beta) Dementia 197, 200, 201, 202, 203  
• (reduced beta) Poor Working Memory 40, 98, 107  
• (reduced alpha and beta) ADHD in Children/Adolescents 199, 221, 222, 223  
• (reduced alpha and beta) Indicative of Alzheimer’s Disease (With Excess Power of Slow Frequencies) 39, 199, 200, 204, 205 |
| **High Power (Global)**       | • Mood Disorders 193, 199  
• Chronic Pain 192 |
| **High Power (Slow Frequencies)** | • Increased Slow Activity in Alzheimer’s Disease 39, 197, 200, 204, 205  
• (excess theta) Depression 199  
• (excess theta) Cognitive Decline Due to Aging 199  
• (excess theta) ADHD in Children and Adolescents 199, 224  
• (excess theta) TBI, Concussion 199, 216, 217, 218, 219, 220  
• (excess theta) Obsessive-Compulsive Disorder 199, 214, 215  
• (excess delta or theta) Dementia 197, 200, 201, 202, 203  
• (excess theta) Chronic Pain 192  
• (excess theta) Poor Visuo-Spatial Working Memory 98  
• Indicative of Degradation of Basal Ganglia and Substantia Nigra (Parkinson’s) 38  
• (excess theta) Typical for Genetically Distinct Sub-Groups of Autism Such as ‘Rett’ and ‘fragile X’ Syndromes 108 |
| **High Power (Fast Frequencies)** | • Mood Disorders Such as Depression and Bipolar Illness 39, 193, 199  
• (excess alpha) Obsessive-Compulsive Disorder 125  
• (excess beta) Schizophrenia 199, 208, 209  
• (excess beta) Autism 108 |
| **Theta-Beta Power Ratio**    | • (high ratio) Excessive Cortical Slowing in Frontal and Central Regions 199, 116, 237, 238, 239  
• (high ratio) Inattention/Lack of Focus 199, 116, 237, 238, 239  
• (high ratio) FDA Approved ADHD Diagnostic (Age < 30) 199, 116, 237, 238, 239 |
## 5. Interventions

### 5.1 Self-Assessments

<table>
<thead>
<tr>
<th>Brain Function Screener</th>
<th>Peer Reviewed Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Memory</strong></td>
<td>• tDCS (^{153,154,155})</td>
</tr>
<tr>
<td></td>
<td>• EEG Biofeedback (^{161})</td>
</tr>
<tr>
<td></td>
<td>• Cognitive Training (^{125,126})</td>
</tr>
<tr>
<td></td>
<td>• Medium Chain Triglycerides (^{168,169,170,171})</td>
</tr>
<tr>
<td></td>
<td>• Acetylcholinesterase Inhibitor (^{166,167})</td>
</tr>
<tr>
<td></td>
<td>• Subsymptom Threshold Exercise (Concussions) (^{47,180,181,232-235})</td>
</tr>
<tr>
<td></td>
<td>• Sleep (^{121,124})</td>
</tr>
<tr>
<td><strong>Executive &amp; Attention</strong></td>
<td>• EEG Biofeedback (^{97,156,157,158,159,160,162,236})</td>
</tr>
<tr>
<td></td>
<td>• Exercise (^{178,179,184,185,186})</td>
</tr>
<tr>
<td></td>
<td>• Cognitive training (^{125,126,236})</td>
</tr>
<tr>
<td></td>
<td>• Omega3 Fatty Acids (^{172,173,174,175,176,177})</td>
</tr>
<tr>
<td></td>
<td>• Subsymptom Threshold Exercise (Concussions) (^{47,180,181,232-235})</td>
</tr>
<tr>
<td></td>
<td>• Sleep (^{121})</td>
</tr>
<tr>
<td><strong>Word Fluency</strong></td>
<td>• Speech Therapy</td>
</tr>
<tr>
<td></td>
<td>• EEG Biofeedback (^{162,163})</td>
</tr>
<tr>
<td></td>
<td>• Subsymptom Threshold Exercise (Concussions) (^{47,180,181,232-235})</td>
</tr>
<tr>
<td></td>
<td>• rTMS (^{182,183})</td>
</tr>
<tr>
<td><strong>Affective</strong></td>
<td>• SSRI (^{91,92,93})</td>
</tr>
<tr>
<td></td>
<td>• tDCS (^{154})</td>
</tr>
<tr>
<td></td>
<td>• Exercise (^{94})</td>
</tr>
<tr>
<td></td>
<td>• Subsymptom Threshold Exercise (Concussions) (^{47,180,181,232-235})</td>
</tr>
<tr>
<td></td>
<td>• HRV Biofeedback (^{163,164})</td>
</tr>
<tr>
<td></td>
<td>• Sleep (^{67})</td>
</tr>
<tr>
<td><strong>Sensory</strong></td>
<td>• Occupational Therapy</td>
</tr>
<tr>
<td></td>
<td>• EEG Biofeedback (^{97})</td>
</tr>
<tr>
<td></td>
<td>• Subsymptom Threshold Exercise (Concussions) (^{47,180,181,232-235})</td>
</tr>
<tr>
<td></td>
<td>• Exercise (^{184,185,186})</td>
</tr>
<tr>
<td></td>
<td>• Sleep (^{67,121,124})</td>
</tr>
<tr>
<td><strong>Motor</strong></td>
<td>• Electrolytes</td>
</tr>
<tr>
<td></td>
<td>• Subsymptom Threshold Exercise (Concussions) (^{47,180,181,232-235})</td>
</tr>
<tr>
<td></td>
<td>• Physical Therapy</td>
</tr>
</tbody>
</table>
5.2 Behavior Metrics

<table>
<thead>
<tr>
<th>Brain Function Screener</th>
<th>Peer Reviewed Interventions</th>
</tr>
</thead>
</table>
| Motor speed/RT | • Physical Therapy  
• Subsymptom Threshold Exercise (Concussions)  
47 180 181 232-235  
• Exercise  
184 185  
• Nutritional Therapy |
| RT Variance | • Stimulant Medication 25  
• Subsymptom Threshold Exercise (Concussions)  
47 180 181 232-235  
• EEG Biofeedback  
156 157 158 159 160 162 236  
• Omega3 Fatty Acids  
172 173 174 175 176 177  
• Nutritional Therapy |
| Omission | • Stimulant Medication 25  
• Subsymptom Threshold Exercise (Concussions)  
47 180 181 232-235  
• EEG Biofeedback  
156 157 158 159 160 162 236  
• Omega3 Fatty Acids  
172 173 174 175 176 177 |
| Commission | • Stimulant Medication 25  
• Subsymptom Threshold Exercise (Concussions)  
47 180 181 232-235  
• Omega3 Fatty Acids  
172 173 174 175 176 177  
• EEG Biofeedback  
156 157 158 160 162 236 |

5.3 Cardiac and Autonomic Function

<table>
<thead>
<tr>
<th>Heart Metric</th>
<th>Peer Reviewed Interventions</th>
</tr>
</thead>
</table>
| Heart Rate | • Cardiology Assessment  
• HRV Biofeedback  
33 43 86  
• Omega3 Fatty Acids  
75 82 96  
• Exercise  
87 88 89  
• Cholinesterase Inhibitors (for fast HR)  
165  
• Beta Blockers (for fast HR)  
59 76  
• Coq10  
55  
• L-Theanine With GABA (for fast HR)  
85 |
| QTc Interval | • Omega3 Fatty Acids  
75 82 96  
• HRV Biofeedback  
33 43 86  
• Potassium Supplement  
• Beta Blockers  
59 76  
• QTc Assessment  
• Mexiletine (Class 1 Sodium Channel Blocker) |
| QRS Duration | • HRV Biofeedback  
33 43  
• Cardiology Assessment |
### INTerventions

#### SDNN (Autonomic Balance)
- HRV Biofeedback
- Omega3 Fatty Acids/Fish Oils 75 82 96 195
- Melatonin 66 70
- Magnesium Supplements 79
- Subsymptom Threshold Exercise (concussions) 47 180 181 232-235
- Gabapentin For Diabetic Patients 84
- Cholinesterase Inhibitors 165
- Sleep 67
- Oxytocin 39 42
- Beta blockers 195
- Benzodiazepines 195

#### Total Power
- HRV Biofeedback
- CoQ10 55
- Exercise 87 88 89
- Magnesium Supplements 79
- HRV Biofeedback 33 34 86
- Sleep 67
- Cholinesterase Inhibitor 165
- Oxytocin 39 42

#### VLF
- HRV Biofeedback
- Beta Blockers 59 76
- Sleep 67
- Aerobic Exercise 87 88 89

#### LF
- HRV Biofeedback
- Omega 3 Fatty Acids/ fish oils 75 82 96
- Melatonin 66 70
- Magnesium Supplements 79
- Dihydropiridines 90

#### HF
- HRV Biofeedback 33 43 86
- GABA 80 81
- Aerobic Exercise 87 88 89
- Melatonin 66 70
- Oxytocin 39 42
- (for high HF) Benzodiazepines 195
- Sleep 67
5.4 Evoked Potentials

<table>
<thead>
<tr>
<th>Evoked Potentials</th>
<th>Peer reviewed interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visual</strong></td>
<td>• Behavioral Optometry Referral</td>
</tr>
<tr>
<td><strong>Auditory</strong></td>
<td>• Consider Audiology or ENT Referral</td>
</tr>
<tr>
<td><strong>Attention/Vigilance (P300a)</strong></td>
<td>• Omega3 Fatty Acid 172 173 174 175 176 177</td>
</tr>
<tr>
<td></td>
<td>• Essential Fatty Acid/Arachidonic Acid 102</td>
</tr>
<tr>
<td></td>
<td>• Aerobic Exercise 103 178 179</td>
</tr>
<tr>
<td></td>
<td>• EEG Biofeedback 106 236</td>
</tr>
<tr>
<td><strong>Info Processing / Working Memory (P300b)</strong></td>
<td>• Omega3 Fatty Acid 172 173 174 175 176 177</td>
</tr>
<tr>
<td></td>
<td>• Essential Fatty Acid/Arachidonic Acid 102</td>
</tr>
<tr>
<td></td>
<td>• Aerobic Exercise 103 178 179</td>
</tr>
<tr>
<td></td>
<td>• EEG Biofeedback/ Slow Cortical Potential (SCP) Neurofeedback 106</td>
</tr>
<tr>
<td><strong>Midline Gradient</strong></td>
<td>• Omega3 Fatty Acid 172 173 174 175 176 177</td>
</tr>
<tr>
<td></td>
<td>• Essential Fatty Acid/Arachidonic Acid 102</td>
</tr>
<tr>
<td></td>
<td>• Aerobic Exercise 103 178 179</td>
</tr>
<tr>
<td></td>
<td>• EEG Biofeedback 106</td>
</tr>
<tr>
<td></td>
<td>• Vitamin B12</td>
</tr>
</tbody>
</table>

5.5 EEG Frequencies

<table>
<thead>
<tr>
<th>EEG Frequencies</th>
<th>Peer reviewed interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Power (Global)</strong></td>
<td>• EEG Biofeedback 194</td>
</tr>
<tr>
<td><strong>Low Power (Slow Frequencies)</strong></td>
<td>• EEG Biofeedback 197</td>
</tr>
<tr>
<td></td>
<td>• Modafinil (increases theta, decreases alpha) for Working Memory/Episodic Memory, Executive Function, Attention 226</td>
</tr>
<tr>
<td></td>
<td>• Donepezil (Aricept) for Alzheimer’s (increases delta) 226</td>
</tr>
<tr>
<td><strong>Low Power (Fast Frequencies)</strong></td>
<td>• EEG Biofeedback 194</td>
</tr>
<tr>
<td></td>
<td>• Stimulants 228</td>
</tr>
<tr>
<td></td>
<td>• Benzodiazepines (increase beta) 226 227</td>
</tr>
<tr>
<td></td>
<td>• Omega3 Fatty Acids for Autism 189</td>
</tr>
<tr>
<td></td>
<td>• Dextroamphetamine (Adderall) for ADHD (increases beta, decreases theta) 226</td>
</tr>
<tr>
<td></td>
<td>• Hyperbaric Oxygen Therapy (HBOT) for Autism 188</td>
</tr>
<tr>
<td></td>
<td>• Neuroleptic Medication for Schizophrenia (increases alpha, reduces beta) 199 208 209</td>
</tr>
<tr>
<td></td>
<td>• Vitamin B6 and Magnesium Supplements for Autism 189</td>
</tr>
<tr>
<td><strong>High Power (Global)</strong></td>
<td>• EEG Biofeedback 197</td>
</tr>
<tr>
<td><strong>High Power (Slow Frequencies)</strong></td>
<td>• MAO Inhibitors (decreases slower and faster frequencies) 228</td>
</tr>
<tr>
<td></td>
<td>• EEG Biofeedback 197</td>
</tr>
<tr>
<td></td>
<td>• Dextroamphetamine (Adderall) for ADHD (decreases theta, increases beta) 226</td>
</tr>
<tr>
<td></td>
<td>• Methylphenidate (Ritalin) for ADHD (decreases theta) 226</td>
</tr>
<tr>
<td></td>
<td>• Omega 3 Fatty Acids for Autism 189</td>
</tr>
<tr>
<td>INTERVENTIONS</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------------------------------------------------------------</td>
</tr>
<tr>
<td>• Hyperbaric Oxygen Therapy (HBOT) for Autism</td>
<td>188</td>
</tr>
<tr>
<td>• Vitamin B6 and Magnesium Supplements for Autism</td>
<td>189</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>High Power (Fast Frequencies)</th>
<th>• EEG Biofeedback</th>
<th>197</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• SSRI for Mood Disorders and Obsessive Compulsive Disorder</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td>• Neuroleptic Medication for Schizophrenia (decreases beta, increases alpha)</td>
<td>199 210 211</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Theta-Beta Power Ratio</th>
<th>• EEG Biofeedback</th>
<th>197 156 157 158 159 160 162 236 238 239</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Exercise</td>
<td>178 179 184 185 186</td>
</tr>
<tr>
<td></td>
<td>• Cognitive training</td>
<td>125 126 236</td>
</tr>
<tr>
<td></td>
<td>• Omega3 Fatty Acids</td>
<td>172 173 174 175 176 177</td>
</tr>
</tbody>
</table>
5.6 Heart Rate Variability (HRV) Biofeedback

Heart Rate Variability is the phenomenon of naturally occurring, beat-to-beat changes in heart rate. HRV is an important indicator of both physiological resilience and behavioral flexibility, reflecting an individual’s capacity to adapt effectively to stress and environmental demands. HRV Biofeedback (HRV BFB) is a technique for training the variability and dominant rhythms in heart activity. HRV BFB can train an individual to increase the percentage of total HRV power in specific frequency ranges. Based on various research studies, it is most optimal to increase HRV in the Low Frequency (LF) range (0.04 - 0.15 Hz). Low Frequency is most directly influenced and trained by breathing at a rate of about six (6) breaths per minute, known as the resonance frequency. Increasing HRV power in the LF range will strengthen an individual’s autonomic nervous system, providing an increased capacity for handling stress and everyday demands (Figure 1).

Figure 1: Heart Rate Variability training

HRV Biofeedback has empirical support for the following conditions:

- Depression
- PTSD
- Phobia
- Anxiety
- Stress
- Sleep
- Asthma
- Chronic muscle pain
- Hypertension
- Coronary artery disease
- Cardiac rehabilitation
- Congestive Heart Failure
- Performance Enhancement
- Headache
- Head Injury
- Post-Concussion Syndrome
5.7 Neurofeedback (EEG Biofeedback)

*Neurofeedback*, often referred to as EEG biofeedback, is a type of biofeedback in which individuals learn to improve their brain function. Neurofeedback helps promote the stability of brain waves, and consequently, brain functioning. Neurofeedback utilizes non-invasive sensors on the scalp to detect physiological signals from a person’s brain. Using computerized feedback (auditory and/or visual), individuals learn to increase or decrease the amplitude of certain brainwaves over time through the principles of classical and operant conditioning. As certain frequencies increase or decrease, the trainee gets feedback (auditory and/or visual) on their performance in meeting the training goals. This visual and auditory feedback is form of operant conditioning that re-trains brainwave patterns to improve self-regulation abilities. Neurofeedback does not involve surgery or medication, is painless, and has long lasting effects.

**Types of Neurofeedback (EEG Biofeedback)**

*Single Channel Neurofeedback*: a basic form of neurofeedback that trains a single EEG site at a time by locating the underlying deviations in electrophysiology. Usually the frontal (Fz) or central (Cz) electrodes are targeted, however it varies from patient to patient. This form of neurofeedback trains surface EEG amplitude. Feedback is given to the patient as certain brainwave patterns increase and/or others decrease. The training can be determined by a licensed physician utilizing QEEG maps as a guide (Figure 2).

*Multi-Channel Neurofeedback*: Multi-channel neurofeedback is a more sophisticated form of the single channel surface neurofeedback that allows you to train multiple EEG sites where deviant activity is noted at the surface of the brain. (Figure 3).

*Brodmann Area Neurofeedback*: LORETA neurofeedback is a more sophisticated form of neurofeedback that allows you to train the subcortical source of unhealthy brain activity, not just the surface locations it is identified. The source of this activity is identified according to Brodmann areas. LORETA neurofeedback trains Brodmann areas using all 19 EEG sites, often using real-time z-score values. Z score neurofeedback is a technique that uses a normative database to identify and target an individual’s specific area(s) of dysregulation (Figure 4).
Figure 2: Single Channel Neurofeedback

<table>
<thead>
<tr>
<th>Individual Posterior Peak Frequency</th>
<th>10.30 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theta : Beta Ratio</td>
<td>3.446</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eyes Open</th>
</tr>
</thead>
</table>

6Hz, 7Hz, 8Hz, 9Hz, 10Hz, 11Hz, 12Hz, 13Hz, 14Hz, 15Hz, 16Hz, 17Hz, 18Hz, 19Hz, 20Hz, 21Hz, 22Hz, 23Hz, 24Hz, 25Hz, 26Hz, 27Hz, 28Hz, 29Hz, 30Hz

6Hz, 7Hz
**Figure 3: Multi-Channel Neurofeedback**

<table>
<thead>
<tr>
<th>Individual Posterior Peak Frequency</th>
<th>10.30 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Theta : Beta Ratio</strong></td>
<td></td>
</tr>
<tr>
<td>2Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
</tr>
<tr>
<td>3Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
</tr>
<tr>
<td>4Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
</tr>
<tr>
<td>5Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
</tr>
<tr>
<td>6Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
</tr>
<tr>
<td>7Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
</tr>
<tr>
<td>8Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
</tr>
<tr>
<td>9Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
</tr>
<tr>
<td>10Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
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<tr>
<td>11Hz</td>
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<tr>
<td>12Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
</tr>
<tr>
<td>13Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
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<tr>
<td>14Hz</td>
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<tr>
<td>15Hz</td>
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</tr>
<tr>
<td>16Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
</tr>
<tr>
<td>17Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
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<tr>
<td>18Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
</tr>
<tr>
<td>19Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
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<td>20Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
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<td>21Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
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<tr>
<td>22Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
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<td>23Hz</td>
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<td>24Hz</td>
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<td>28Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
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<td>29Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
</tr>
<tr>
<td>30Hz</td>
<td>-3 -2 -1 0 1 2 3</td>
</tr>
</tbody>
</table>

**Eyes Open**

6Hz

7Hz
**Figure 4: Brodmann Area Neurofeedback**

<table>
<thead>
<tr>
<th>Region: Middle Temporal Gyrus</th>
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</thead>
<tbody>
<tr>
<td><strong>Brodmann Area (BA):</strong> 21</td>
<td></td>
</tr>
<tr>
<td><strong>Frequency:</strong> 3Hz (3.4 SD)</td>
<td></td>
</tr>
<tr>
<td><strong>Function:</strong> prosodic information processing[^190,191^]; auditory processing, categorization, rhythm, episodic memory, working memory, motor, face and object perception, balance[^190,191^]</td>
<td></td>
</tr>
<tr>
<td><strong>Secondary BA:</strong> 38</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Region: Middle Temporal Gyrus</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brodmann Area (BA):</strong> 21</td>
<td></td>
</tr>
<tr>
<td><strong>Frequency:</strong> 6Hz (-1.8 SD)</td>
<td></td>
</tr>
<tr>
<td><strong>Function:</strong> prosodic information processing[^190,191^]; auditory processing, categorization, rhythm, episodic memory, working memory, motor, face and object perception, balance[^190,191^]</td>
<td></td>
</tr>
<tr>
<td><strong>Secondary BA:</strong> 22</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Region: Medial Frontal Gyrus</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brodmann Area (BA):</strong> 10</td>
<td></td>
</tr>
<tr>
<td><strong>Frequency:</strong> 14Hz (-1.7 SD)</td>
<td></td>
</tr>
<tr>
<td><strong>Function:</strong> verbal construction, emotional decision making[^190,191^]; motor, memory recall, attention, executive function[^190,191^]</td>
<td></td>
</tr>
<tr>
<td><strong>Secondary BA:</strong> 32</td>
<td></td>
</tr>
</tbody>
</table>
Neurofeedback has empirical support for the following conditions:  

- ADD/ADHD, Learning & Developmental Disabilities  
- Addictive Disorders  
- Cognitive Decline Due to Aging  
- Anxiety  
- Autism & Asperger’s  
- Chronic Fatigue & Fibromyalgia  
- Cognitive Enhancement  
- Depression  
- Obsessive Compulsive Disorder  
- Peak Performance  
- PTSD  
- Pain & Headache  
- Sleep  
- Traumatic Brain Injury, Stroke & Com
### 6. Intervention Descriptions & Considerations

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Description</th>
<th>Side effects/contra-indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arachidonic Acid/Essential Fatty Acids</td>
<td>Arachidonic Acid (AA) is a polyunsaturated omega-6 fatty acid which is included in nutritious foods such as meat, eggs, peanuts, and fish, and is transmitted directly into the brain crossing the blood-brain barrier. AA is a major component of cell membranes, and therefore plays important roles in preserving physiological and psychological function. It’s also an important dietary component in support of the muscle anabolic processes. In the brain, AA helps to maintain hippocampal cell membrane fluidity and protects the brain from oxidative stress, while aiding in the growth and repair of neurons. Arachidonic acid may be effective in reducing the symptoms of and slowing the disease progress of Alzheimer’s.</td>
<td></td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>Benzodiapene is a psychoactive drug that enhances the effect of the inhibitory neurotransmitter gamma-amino butyric acid (GABA) resulting in sedative, sleep-inducing, anxiolytic, anticonvulsant, and muscle relaxant physiological states.</td>
<td>Withdrawals may occur after long-term use. Common side-effects include: drowsiness, dizziness, decreased alertness and concentration. Benzodiapenes may cause respiratory depression in susceptible individuals. Caution is required when prescribed to people with personality disorders and major depression. Individuals with a history of alcohol, opioid, and barbiturate abuse should avoid this drug.</td>
</tr>
<tr>
<td>Beta Blockers</td>
<td>Beta blockers target the beta receptors and act as antagonists. Beta receptors are found on cells of heart muscles, smooth muscles, airways, arteries, kidneys, and other tissues that are part of the sympathetic nervous system and lead to stress responses, especially when they are stimulated by epinephrine. Beta blockers inhibit the</td>
<td>Contraindicated patients with asthma, bradycardia, second or third degree heart block Side effects include fatigue, headache,</td>
</tr>
<tr>
<td>NeuronRead</td>
<td>Clinician’s Manual</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td><strong>INTERVENTION DESCRIPTIONS &amp; CONSIDERATIONS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NeuroRead</strong></td>
<td>Clinician’s Manual</td>
<td></td>
</tr>
<tr>
<td>binding of epinephrine thus weakening stress hormone effects.</td>
<td>upset stomach, constipation, diarrhea, dizziness</td>
<td></td>
</tr>
<tr>
<td><strong>Calcium</strong></td>
<td>The most abundant mineral in the body, calcium is required for vascular contraction and vasodilation, muscle function, nerve transmission, intracellular signaling, and hormonal secretion. It is also stored in bones and teeth where it supports their structure and function.</td>
<td></td>
</tr>
<tr>
<td><strong>Cholinesterase Inhibitors</strong></td>
<td>Acetylcholinesterase is an enzyme that degrades acetylcholine after it has been released into the synapse. Therefore, the inhibitors act as an agonist for acetylcholine and perpetuate its biochemical effects on the body.</td>
<td></td>
</tr>
<tr>
<td><strong>CoQ10</strong></td>
<td>CoQ10 is used by cells to produce energy for cell growth and maintenance. It also functions as an antioxidant. This coenzyme has been used as treatment for heart failure, cancer, muscular dystrophy, and periodontal disease. It is also said to boost energy and speed recovery from exercise. Patients with liver problems and sleep issues should avoid using CoQ10.</td>
<td></td>
</tr>
<tr>
<td><strong>D3</strong></td>
<td>Vitamin D promotes calcium absorption, modulates cell growth, regulates neuromuscular and immune functions, and reduces inflammation. It is also required for bone growth and bone remodeling. Blood levels (25-hydroxy vit.D3) are thought to be within healthy limits above 50 mg/mL but some find that above 75 mg/mL is optimal. Not recommended for use in patients with heart failure. Side effects include edema, flushing, headache, dizziness, and reflex tachycardia</td>
<td></td>
</tr>
<tr>
<td><strong>Dihidropyridines</strong></td>
<td>Dihydropyridines are calcium blockers used in the treatment of hypertension.</td>
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<tr>
<td><strong>EEG-Biofeedback</strong></td>
<td>EEG biofeedback uses displays of electroencephalography (EEG) to illustrate brain activity and teach self-regulation.</td>
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<td><strong>Folic Acid</strong></td>
<td>Folic acids are forms of the water-soluble vitamin B9. This vitamin is essential for numerous bodily functions. It is not synthesized endogenously and must therefore be supplied through the diet to meet daily requirements. Humans need folate to synthesize DNA, repair DNA, and methylate DNA as well as to act as a cofactor in several biological reactions. It is also important for cell division and producing healthy red blood cells.</td>
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<tr>
<td><strong>GABA</strong></td>
<td>GABA (γ-aminobutyric acid) is the major inhibitory neurotransmitter in the central nervous system. It has been shown to have a stress-reducing effect in humans and a tranquilizing effect on patients with sleeplessness. Hypotension, bradycardia</td>
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and depression. GABA has a beneficial influence on cardiac physiology.

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<tr>
<th>Interventions</th>
<th>Description</th>
<th>Considerations</th>
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<tr>
<td><strong>Gabapentin</strong></td>
<td>Gabapentin is an anticonvulsant and is often used in adults to treat nerve pain caused by herpes virus, shingles, restless leg syndrome, and seizures. It was initially synthesized to mimic the chemical structure of GABA, but is not believed to act on the same brain receptors. A possible mechanism of action includes interaction with voltage-gated calcium channels.</td>
<td>Most common side effects in adult patients include dizziness, fatigue, weight gain, drowsiness, and peripheral edema. Long-term use and subsequent rapid termination may provoke a withdrawal syndrome.</td>
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<tr>
<td><strong>HRV-Biofeedback</strong></td>
<td>HRV biofeedback involves entraining the patient’s breathing rate to the frequency at which the amplitude of HRV is maximized. The resonant frequency in humans occurs between .075-12 Hz. On average, resonance frequency is .092 Hz (approximately 5.5 breaths per minute).</td>
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<td><strong>Hyperbaric Oxygen Therapy (HBOT)</strong></td>
<td>HBOT involves inhaling pure oxygen in a pressurized room. In this room, the air pressure is raised up to three times higher than normal. Under these conditions, lungs can gather a much higher concentration of oxygen.</td>
<td>Hypotension, bradycardia</td>
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<td><strong>L-Theanine</strong></td>
<td>L-Theanine is an amino acid contained in green tea leaves that is known to block the binding of L-glutamic acid to glutamate receptors in the brain. It has been reported to reduce blood pressure and inhibit the excitatory effects of caffeine. L-Theanine’s antagonistic role against the excitation of the glutamatergic phenotype suggests that it plays a role in reducing stress induced excitation of sympathetic activity.</td>
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<td><strong>Magnesium</strong></td>
<td>The fourth most abundant mineral in the body, magnesium helps maintain normal muscle and nerve function, keeps heart rhythm steady, supports a healthy immune system, and keeps bones strong. It also regulates blood sugar levels, promotes normal blood pressure, and is involved in energy metabolism and protein synthesis.</td>
<td>Antacids and laxatives that contain magnesium, tetracycline antibiotics, loop and thiazide diuretics</td>
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<td><strong>Melatonin</strong></td>
<td>Melatonin levels allow for the entrainment of the circadian rhythms of several biological functions. Additionally, melatonin is a wide-spectrum antioxidant that can easily cross cell membranes. Studies have shown its effectiveness in improving HRV, as a treatment for circadian rhythm disorders, and preventing neuronal death caused by exposure to the amyloid beta protein in Alzheimer’s disease.</td>
<td>Not recommended for patients with hypotension and autoimmune disorders</td>
</tr>
<tr>
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<td>Description</td>
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<td><strong>Mexiletine</strong></td>
<td>Mexiletine is a type of anti-arrhythmic medicine used to treat arrhythmias of the heart or excessively irregular heartbeats. It decreases action potential duration by shortening the repolarization phase (by blocking sodium channels).</td>
<td>Side effects include dizziness, heartburn, nausea, nervousness, trembling, and unsteadiness. Mexiletine is not recommended for those with epileptic seizures, heart attacks, heart block, severe heart failure, hypotension, liver problems.</td>
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<td><strong>Omega-3/Fish Oils</strong></td>
<td>Refers to three groups of fatty acids ALA, EPA, DHA found in plant oils and marine oils. The body needs to extract these fatty acids exogenously from our diet. Studies show that EPA and DHA can help lower triglycerides and blood pressure, reducing the risk of heart attack, stroke, and death from heart disease. Additionally, omega-3 fatty acids may help with other medical conditions such as depression, ADHD, Alzheimer’s/dementia, and asthma.</td>
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<td><strong>Oxytocin</strong></td>
<td>Oxytocin is a hormone and neurotransmitter that is released during social interaction and contact. Its receptors are widely distributed in regions of the brain associated with emotional processing and stress responsivity.</td>
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<td><strong>rTMS</strong></td>
<td>Repetitive transcranial magnetic stimulation (rTMS) utilizes a non-invasive electromagnet placed on the scalp that generates magnetic field pulses that stimulate a small area on the surface of the brain. The electromagnetic currents cause either depolarization or hyperpolarization in functional groups of neurons. rTMS has been used to treat various neurological and psychiatric disorders including depression, chronic migraines, Parkinson’s Disease, and hallucinations.</td>
<td>Very rare occurrence of induced seizures</td>
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<td><strong>Stimulant Medications</strong></td>
<td>Stimulants are psychoactive drugs which induce temporary improvements in either mental or physical functions or both. Examples of these kinds of effects may include enhanced productivity, alertness, wakefulness, mental acuity, and locomotion.</td>
<td>Hypertension, anxiety, high blood pressure, beta spindles</td>
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<td><strong>Serotonin Reuptake Inhibitors (SSRI)</strong></td>
<td>SSRIs are a class of compounds that are typically used as antidepressants in the treatment of depression, anxiety, and some personality disorders. They act as serotonin agonists by inhibiting its reuptake into the presynaptic cell, thereby increasing the level of serotonin in the synaptic cleft available to bind to the receptors. SSRIs have also been used for the treatment of strokes.</td>
<td>Side effects include nausea, nervousness, agitation, dizziness, reduced sexual desire, drowsiness, insomnia, weight gain or loss,</td>
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| Vitamin B12  | Vitamin B6  | Vitamin B-Complex  | Headache, dry mouth, vomiting, diarrhea  
| Headache, dry mouth, vomiting, diarrhea  
| Young adults under 25 may experience an increase in suicidal thoughts or behavior  

**Vitamin B12:**

Vitamin B12 is a water-soluble vitamin with a pertinent role in the normal functioning of the brain and nervous system, and for the formation of blood. It is involved in metabolism, fatty acid synthesis, and energy production. Humans cannot produce B12, so it must be supplied by the diet. Those with anemia, whose intrinsic factors of the stomach are destroyed, often have a vitamin B12 deficiency. Besides anemia, it has also been used clinically to protect against age related brain atrophy, impaired cognitive function, and Alzheimer’s Disease.

**Vitamin B6:**

Vitamin B6 is a water-soluble vitamin that is naturally present in many foods, added to others, and available as a dietary supplement. As a coenzyme, B6 is mostly concerned with protein metabolism. It also plays a role in cognitive development, gluconeogenesis, immune function, and hemoglobin formation. Vitamin B6 deficiency is associated with anemia, EEG abnormalities, dermatitis, depression, confusion, and weakened immune function.

**Vitamin B-complex:**

Vitamin B-complex refers to all the known essential water soluble vitamins except for vitamin C including, B1, B5, B6, biotin, folic acid, B12. Vitamin B-complex is used to treat many conditions such as anxiety and ADHD. Additionally, vitamin B-complex vitamins are used to augment athletic performance.
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