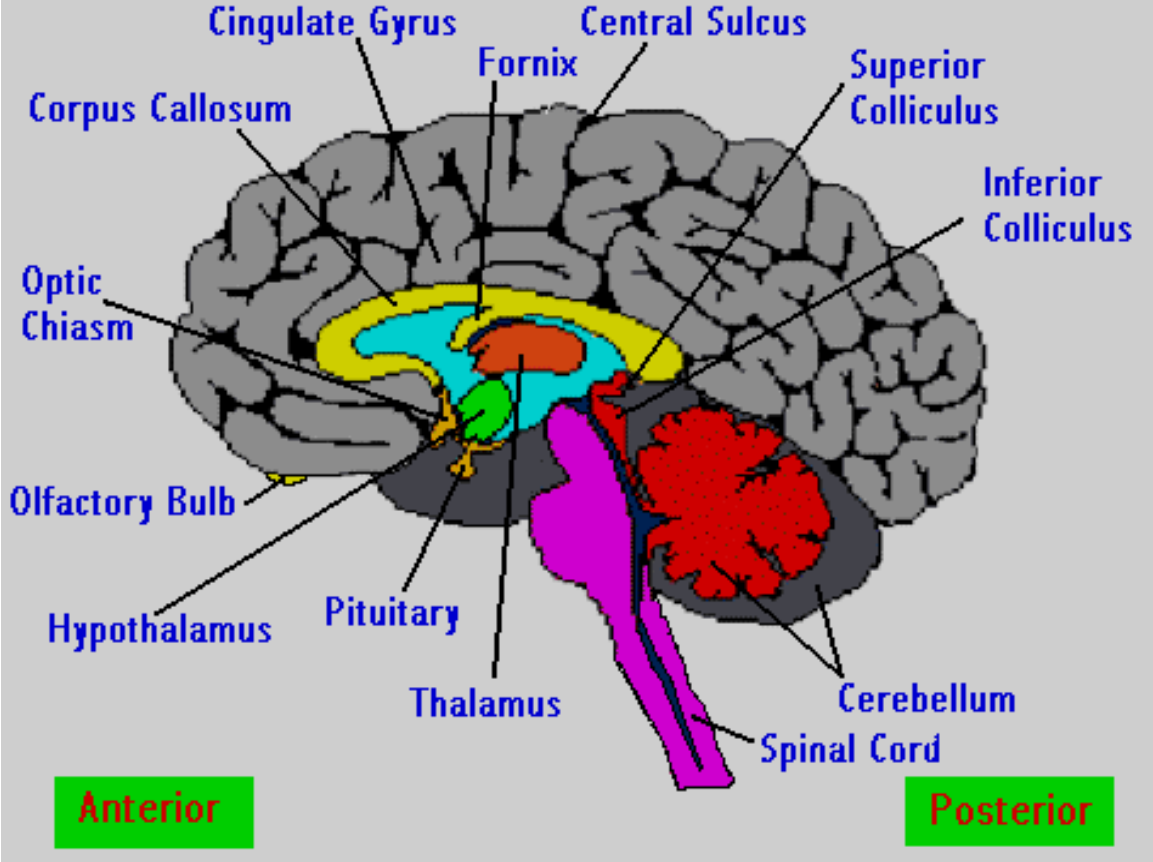

Cheat Sheet for Neurofeedback

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Cheat Sheet of the Brain – Synthesis for Neurofeedback

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LEFT HEMISPHERE OF THE BRAIN	RIGHT HEMISPHERE OF THE BRAIN
Dominant hemisphere **Analyzes** – reduces a complex concept or process into its individual components. Detail oriented. **Thinks sequentially** – i.e. one word after another, one note after another. **Thinks linguistically** – perceives, comprehends, stores in memory, formulates and expresses. **Thinks logically**, good at math and analytical reasoning. Verbal memories. Men are stronger with spatial abilities using both sides of the brain; directions, maps or puzzles Beta tends to be higher Theta roughly equal left & right	**Synthesizes** – takes components and combines them into an integrated whole. Experiences the process in its entirety. **Thinks spatially/holistically** – putting puzzles together, hearing the musical chord. Intuition and insight. **Perceives, comprehends and expresses visual and auditory social cues** – reading faces, remembering places, creating facial expressions, comprehending and creating vocal intonation. Creativity, empathy, early self-concept. **Experience and express emotion** – anger, rage, anxiety. Mood regulation emotional – contextual. Alpha tends to be higher

Specificity to sites is slightly misleading – these are best guesses and all functions are a result of the interaction of many areas. The typical site is differentially engaged in 40% of behavioral domains.

Prefrontal Cortex Fp1, Fz, Fp2

Executive functioning – establishes goals, inhibits information extraneous to the goal directed planning process, plan and make decisions, working memory. Prefrontal lobes have connections to the amygdala. Self-regulation, initiation, social-emotional behavior in

social context, recognition and production of expression of language (prosody)

Decrease in left prefrontal activation may reflect depressive experience where increase in right prefrontal activation may reflect anxieties.

Prefrontal lobes have neuronal networks leading to the amygdala.

Autonomic Nervous System regulation

Attends to internal and external stimuli,

Determines the amount of attention that will be distributed among competing stimuli.

Supervisory Attentional System - Sustained attention.

Motor Control and Programming

Calls up memory and utilizes it

Ability to inhibit behavior appropriately in complex social contexts

Delayed gratification

Mental flexibility

Understanding the concept of past, present and future.

Provide awareness of what is rewarding and pleasurable

Regulation of emotions (modulate and inhibit impulses)

Organising, creative, problem solving

Ability to learn from experience. Reality testing

Development of personality

Attachment, conscience, empathy

Fz – frontal eye fields, motor, focus and action observation.

(Fpz – emotional inhibition, modulation of emotional (sensitivity) and behavioral responses, motivation/attention.)

Fp1 & F3 – logical, detailed attention, the organization of responses (like a conductor), semantics	Fp2 & F4 – emotional/contextual attention

Fp1 - verbal retrieval. Visual working memory, verbal analytical and approach behaviors	Fp2 - Face and object processing, gestalt and context, episodic memory (when overactive may correlate with irritability, impulsivity, tactless, manic and panic behavior)

Frontal Lobes

Higher executive functions

Attentional gating. Decision making. Problem solving, memory, social awareness, character, motivation, planning, judgment.
Frontal lobes are responsible for immediate and sustained attention, social skills, emotions, empathy, time management, working memory, moral fiber or character, executive planning and initiative. They identify problems and may send them to other parts of the brain for resolution.

The brain is not just a cognitive processing organism; it is also the seat of our conscience. Emotions, morals and social self cannot be isolated to frontal lobe activities; other deeper structures are also involved. There is a relationship between the frontal lobe and the amygdala. The frontal cortex is responsible for the brains most complex processing and has the heaviest projections to the amygdala, and the two combine to form a network that is the social brain.

F3 & F7 - Approach behavior, engagement, interest, mood regulation, processing of positive emotional input, conscious awareness. Frontal mirror neuron system – empathy and intention of others. F3 – judgment, planning, sustain attention, inhibition of responses, verbal episodic memory retrieval, problem solving, sequencing, deducing facts to conclusions. F7 - Creates and controls output of spoken and written language, visual and auditory working memory, selective attention Broca's area (word retrieval,	F4 & F8 - Avoidance behavior, withdrawal, impulse control (important links to the amygdala). Emotional tone variations (motor aprosodia) F4 – inductive creative, inductive emotional, metaphorical thinking, short-term retrieval of spatial-object memory, vigilance, selective and sustained attention. F8 – spatial and visual working memory, gestalt, sustained attention, conscious facial emotional processing, prosody Empathy conscience. Feeling sense of right and wrong. Emotional gating. Vigilance area.

semantics, verbal understanding, speech) Divided and selective attention	Apprehension, disinterest Sustained and selective attention Processing of anger, rate, anxiety, fear. Regulation of aggressive and sexual impulses

C3, Cz, C4 Central Strip

The sensory and motor cortices run parallel to each other and are divided by the central sulcus. The two cortices combined are called the sensorimotor cortex.
The sensory cortex alone is the primary somatosensory cortex or the somatosensory cortex: spatial discrimination and the ability to identify where bodily functions originate. Responsible for both the external senses of touch, temperature, pain and the internal senses of of joint position, visceral state and pain.

The primary motor cortex may be called just the motor cortex - conscious control of all skeletal muscle movements. Skillful movements and smooth repetitive operations such as typing, playing musical instruments, handwriting, the operation of complex machinery and fluid speaking. It is the hub and switching station between voluntary muscles of the body and the brain.

Cz – somato-sensory association cortex (? Hub of affective limbic system).

Sensory-motor functions, short term memory

Awareness of body, body position, body movement, co-ordination of sensory input with motor output.

Gross motor activity, walking, throwing a ball

Fine motor movements – pen skills, needle threading, typing, speaking.

C3 – hand and digits (with F3 – handwriting and inhibit or execute action), audition, happiness,	C4 – cognition of music, reasoning/decision making and emotional/feeling, and in addition, disrupts the process of basic body

syntax	signaling, happiness & sadness

The Sensorimotor cortex not only divides the anterior from the posterior, but they also serve as a junction that coordinates movement that is also in part guided by sensations.

Temporal Lobes T3 & T4

Auditory Association cortex; phonetics, letters to sound, grasping the whole picture vs. sensing everything in fragments (may be dysfunctional in autism), episodic memory, emotional valence and regulation (temper). Without clear left hemisphere dominance, dyslexia and stuttering may occur. Because women have up to 30% more interhemispheric connections, they manage dyslexia better and understand interpersonal emotions better.

T3, T5 (left) Wernicke's – comprehension both verbal and reading visual perception of what an object is processing integration and perception of auditory input comprehension of auditory and visual perception (reading and word recognition) long term memory – auditory (verbal) and visual linguistic perception and comprehension "Inner voice" positive mood	T4, T6 (right) – conscious emotional and physical awareness (insula), sense of direction visual memory & visualization, categorization sound voice intonation perception, music facial recognition spatial and facial perception - social cues T4-T6 Central Strip (Temporal-Parietal junction RHS – copying emotional tones, comprehension – innuendo & nuance, non-verbal memory visual perception of what an object is (object recognition) symbol recognition long Term memory emotional content (anxiety) due to proximity to amygdala and hippocampus

Parietal Lobes P3,Pz, P4

Organization, integration, and synthesis of auditory, visual perception, and kinesthetic inputs, orientation, cognitive processing and attention.

The parietal lobes solve the problems that the frontal lobes conceptualize. Labeled the "association cortex".

Pz - Integrating somato-sensory information with posterior visual perceptions, working memory

Posterior parietal cortex - sense of direction, Balint's syndrome...the client cannot attend to multiple objects simultaneously, can't shift attention from one location to another, or perhaps one sensory modality to another.

Parietal and Occipital – procedural memory

Posterior Pz may involve long term memory, sensory integration and some quick decisions in crisis situations.

Parietal spindling beta reflects sensory hypersensitivity or sensory defensiveness, auditory, visual and kinesthetic.

P3 - Language processing, integration of self, logical reasoning and memory, imagination, spelling and short term memory, math calculations, naming objects, complex grammar, sentence construction and math processing (right side body awareness)	P4 - Visual-spatial sketch pad, image and spatial processing, facial decoding, integration with environment, spatial memory, perhaps dysfunction effects self-concern, map orientation, knowing the difference between right and left, self in space, music, body image, physical act of dressing. (left side body awareness)

Occipital Lobes O1, Oz, O2

Visual association cortex. Visual processing, procedural memory, dreaming, visual perception.

Visual field, helps to locate objects in the environment, see colors and recognize drawings and correctly identify objects, reading, writing and spelling.

Increased activation of the occipitals may reflect brain stem issues (cerebellum and involutional body movement)

Because the occipital lobe borders on the parietal and temporal lobes, EEG abnormalities in posterior locations in those two lobes, often extend into occipital lobe regions

Oz – Hallucinations

O1 - memory encoding with semantic tasks	O2 - perception, vision, color (somewhat shape and motion)

IMPORTANT FUNCTIONS VIA LOBES AND SITES - TRAINING IMPLICATIONS

Frontal Lobes

Behaviors and symptoms:

Oppositional defiant and antisocial behaviors. This behavior may parallel excessive EEG slowing, and inadequate CBF throughout other prefrontal areas as well-especially Fp1 and Fp2.

Clients with excessive fear as a result of trauma, anxiety, and neglect may have an overactive amygdala.

Training along the anterior dorsal Fz and ventral Fpz may have an impact on social behavior and moral fortitude (dysfunction shows as irresponsible behavior, lack of appropriate affect, euphoria in some and incorrect expectation in others).

Training in the right prefrontal cortex may lead to a reduction in fear as well as create a sense of calm and well being.

Checking for prefrontal lobe problems often involves testing. Even without testing, look for: clients appear to be in a fog, unable to concentrate. They get into trouble in school or with community authorities. They may be fearful, have difficulty with ethical or moral issues, lack empathic ability, or lack social skills. Difficulty in completing administrative tasks, unmotivated, disconnected. Inattention, poor planning or judgment, slow reaction time, lack of social awareness and poor impulse control.
Negative, depressed or anxious...check out frontal asymmetries.

SENSORY MOTOR CORTEX C3, C4, Cz

Behaviors and symptoms:

Training along the SMR is implied for stroke, epilepsy, paralysis, ADHD, and disorders of sensory motor integration.

Clients who have difficulty seeing the logical sequence of cognitive tasks may benefit from neurofeedback training along the LH sensory cortex (C3). Training along the RH sensorimotor cortex (C4) may invoke feelings, emotions or calmness.

Temporal Lobes

If "hot" avoid training initially due to issues of reactivity (sensitivity to external or internal input, emotion)

Behaviors and symptoms:

Left mid-temporal zone problems could reflect difficulties in keeping up a conversation.

Right temporal lobe problems may reflect inability to recognize intricate rhythmic melodies; appreciation for music.

Mid-temporal extending into the hippocampal lobes ...episodic memory, such as functional tasks; remembering to pay the bills, fill the gas tank, where the keys are, how to play baseball, where glasses, etc.

Because of the temporal lobes proximity to the amygdala, it could result in angry or aggressive behavior.

EEG slowing in the temporal lobes is often associated with concussions since head injuries, regardless of the site of the impact, often involve scraping of the temporal lobes along the inner part of the sharp, bony, middle fossa. Problems with temporal lobe slowing are the most common type of EEG abnormality.....major pathology changes in aging, anoxic conditions, head injury, and many other etiologies found in the temporal lobe, especially in the depth of this lobe the amygdala and hippocampus.

Cerebral Blood Flow in the temporal lobes (especially R) for subjects with anxiety and panic disorder. Mild anxiety increases CBF; severe anxiety reduces CBF values and cerebral metabolism.

Parietal Lobes

Behaviors and symptoms:

Clients may have more car accidents because they cannot attend to both sides of the visual field. May have difficulty playing computer games which require a left to right scanning process. Draw pictures and the left of the picture seems to have something missing...may be a deficit in right parietal lobe.

Difficulty following directions to the office, failure to recognize a simple tune, can't remember faces, easily gets turned around and gets lost...then look at the parietal lobe as well as the right posterior temporal lobe.

Ask client to write a few sentences. Draw a simple picture, play " monkey see, monkey do", do a few simple math or word problems. How well do they perform? How accurate is the picture? How difficult is it to follow hand and body movements? How easy were problems solved, or not at all?

OCCIPITAL

Behaviors and symptoms:

Difficulty with visual memories and accurate reading require accurate vision. Traumatic memories that accompany visual flashbacks are often processed in the occipital lobes.
Visual agnosia....inability to perceive and draw complete objects.
Simultaneous agnosia....inability to see multiple objects at the same time.

Problems with writing...cannot trace the outline of an object, or join the strokes together during writing, if they see the pencil point they lose the line, or if they see the line they can no longer see the pencil point. Difficulty coloring or other visual spatial activities.
(Also consider posterior parietal lobes for visual spatial problems).

Adults who have strokes or TBI

Clients who have PTSD may benefit from training in the occipital lobes. There is a unique connection between the visual cortex and the

amygdala related to PTSD. Practitioners often place sensors on the visual cortex when doing deep states training.

DEEPER BRAIN STRUCTURES - FUNCTIONS

The Limbic System

This is power-packed with function even though it is only about the size of a walnut. It sets emotional tone, controls motivation and drive, holds emotional memories. The female limbic system is larger relative to the size of the brain than is the male.

Hypothalamus

One of the busiest parts of the brain. It is mainly concerned with homeostasis. It regulates hunger, thirst, pain response, pleasure, sex drive, sleep, the ANS and thus control of the hormonal system. It activates the fight or flight system.

Amygdala

Provides emotional content to language, intonation, sound of voice, social emotion, guilt, shame. Detection, judgment (evaluation & magnitude) of fear, sadness (not happiness). Dysfunction shows as social disinhibition. Stores unconscious memories. Mediates depression and hostility/aggression.

Hippocampus (beneath the temporal lobes)

Short and long term auditory and visual (emotional) memory conscious (LH). Sound-voice intonation, memory, and spatial-facial memory (RH).

Septal Nucleus

This acts in conjunction with the hypothalamus and hippocampus particularly in relation to internal inhibition and the exerting of quieting and dampening influences on arousal and limbic system functioning.

Cingulate Gyrus (Fpz, Fz, Cz, Pz)

Being able to shift ones attention from one subject to another. Mental flexibility. Executive functions. Adapting within changing circumstances/seeing options. Being co-operative in a social context.

Anterior cingulate gyrus - the HUB affect/emotional regulation and limbic system control. Mental flexibility, cooperation, attention, helps the brain to shift gears, and the young child to make transitions, helps the mind to let go of problems and concerns, helps the body to stop ritualistic movements and tics, helps contribute to the brain circuitry that oversees motivation, the social self and the personality. Is closely aligned with the amygdala. Here, imagination, motor learning, fear and pain.

Posterior cingulate gyrus....closely aligned with parahippocampal cortices and shares in the memory making process, provides orientation in space, as well as eye and sensory monitoring services. The division between the anterior and posterior is generally considered to be at Cz.

Training at the vertex, Cz, influences three cortices simultaneously, somatosensory, motor and cingulate.....the cingulate is concerned with emotion/feeling, attention and working memory. They interact so intimately that they constitute the source for the energy of both external action (movement) and internal action (thought, animation, and reasoning).

The "hot" cingulate means it is overactive and causing problems such as OCD, ADD/ADHD and Tourette's syndrome.

ADD/ADHD - the disorder can manifest itself with, or without hyperactivity. Components include inattention, distraction, hyperactivity and impulsivity. Several different brain localities may be suspect when assessing ADD/ADHD. The cingulate gyrus and the anterior medial region may be the first place to look.

Flexibility and "Inflow".

Thalamus

Connects sensory organs to areas of primary sensory processing – eyes to visual cortex of the occipital lobe. Ears to primary auditory cortex of the temporal lobe. Body sensation and position to primary somato- sensory cortex of the Parietal lobe. Connects the cerebellum to the motor strip. Sets overall tone or level of excitation for the entire cerebral cortex. Virtually all inputs ascending to the cerebral cortex are funneled through the thalamic nuclei - the gateway to the cortex.

Reticular Activating System

This is the centre in the brain. It is the key to "turning on the brain" and seems to be the centre of motivation. Keeps the brain alert, awake and receptive to information.
It serves as a point of convergence for signals from the external world and the internal environment.
The R.A.S. is the centre of balance for the other systems involved in learning, self-control or inhibition.

Brain Wave Frequencies:

Fast waves are not synchronous – engaged with the world.

Gamma brainwaves are very fast EEG activity above 30 Hz. Although further research is required on these frequencies, we know that some of this activity is associated with intensely focused attention and in assisting the brain to process and bind together information from different areas of the brain.

Gamma is measured between (36 – 44) Hz and is the only frequency group found in every part of the brain. When the brain needs to process simultaneous information from different areas, its hypothesized that the 40 Hz activity consolidates the required areas for simultaneous processing. A good memory is associated with well-regulated and efficient 40 Hz activity, whereas a 40 Hz deficiency creates learning disabilities. When trained it improves memory, language and effortlessness in learning.

Gamma (40 Hz): Subjective feeling states: thinking; integrated thoughts, learning.
Associated tasks & behaviors: high-level information processing, "sensory binding." Physiological correlates: associated with information-rich task processing.

Beta brainwaves are small, relatively fast brainwaves (above 13–30 Hz) associated with a state of thinking, mental, intellectual activity and outwardly focused sustained concentration. This is basically a ''bright-eyed, bushy-tailed'' state of alertness. Activity in the lower end of this frequency band (e.g., the sensorimotor rhythm, or SMR at Cz) is associated with relaxed attentiveness. If someone is exceptionally anxious and tense, an excessively high frequency of beta brainwaves

may be present in different parts of the brain, but in other cases this may be associated with an excess of inefficient alpha activity in frontal areas that are associated with emotional control. If beta is deficient, either all over or in small areas, the brain may have insufficient energy to perform tasks at peer group standards.

Beta activity is fast activity. It reflects desynchronized active brain tissue. It is usually seen on both sides in symmetrical distribution and is most evident frontally. Beta should be higher on the left than on the right. Increased beta asymmetry in the right hemisphere is indicative of anxiety. Beta hyper-coherence may indicate anxiety, panic attacks, and test anxiety. It may be absent or reduced in areas of cortical damage. It is generally regarded as a normal rhythm. It is the dominant rhythm in those who are alert or anxious or who have their eyes open. Beta fast is the state that most of brain is in when we have our eyes open and are listening and thinking during analytical problem solving, judgment, decision making, processing information about the world around us. Dominant frequency beta may indicate that there is excess norepinephrine. Increased beta alone is often indicative of withdrawal from social interaction (when theta and alpha are lower). Increased beta at Fp2 and F3 simultaneously can be indicative of the patient hiding all feelings and emotions (flat affect may be seen). Increased beta and decreased alpha in frontalis is indicative of agitation, being controlled by anxiety, feeling overwhelmed, and impulsivity with explosiveness.
The beta band has a relatively large range, and has been divided into low, midrange and high.

Low Beta (13-15) Hz: Could be called hi alpha, formerly "SMR":(Sensory Motor Rhythm when at C3, Cz, or C4). The alpha wave of the motor system, maximum when body is still.
Subjective feeling states: relaxed yet focused, integrated.
Associated tasks & behaviors: low SMR can reflect "ADD", lack of focused attention Physiological correlates: is inhibited by motion; restraining body may increase SMR

Midrange Beta (15-18) Hz: Subjective feeling states: thinking, aware of self & surroundings; Associated tasks & behaviors: mental activity; Physiological correlates: alert, active, but not agitated. Localized activity where work is being done, asynchronous.

High Beta (above 18 Hz): Muscle artifact can intrude here. You tend to inhibit hi beta to decrease artifact.

Subjective feeling states: alertness, agitation, problem solving,

anxiety, worrying, rumination, mental effort.
Associated tasks & behaviors: mental activity, e.g. math, planning, etc.
Physiological correlates: general activation of mind & body functions.

Beta hypercoherence – stress, "traffic jam," overwhelmed, can't process activated networks.

Beta hypocoherence – immobilized.

Beta Wave Indicators:

Area	Indicator	Indicator	Indicator	Indicator	Indicator
Frontal	Anxiety Impulsivity (being controlled by anxiety and feeling overwhelmed), and impulsivity with explosiveness , Mood shifts	Pain	Emotional hyper-vigilance and controlling, passive and/or avoidant personality Insomnia Person hides all feelings and emotions (flat affect may be seen)	Fear (increased frontal beta) Aggression (decreased frontal beta)	Increased beta in frontal areas and on the right hemi (the brain is running too fast) may indicate anxiety, OCD, mania and worry
Temporal	TBI			Anger Irritability	
Global	Anxiety ADD Insomnia (insomnia often reveals LoBeta at 5.1/4.5)	Insomnia Muscle tension Headaches	Self-regulation problems		OCD
Posterio	Anxiety	Fibromyalgi	Ruminatio		OCD

r	disorder(s) Rumination	a	n Trauma		Ruminatio n

Slow waves are synchronous.

Alpha brainwaves (8–12 Hz) are slower and larger. Alpha is generated from resonance between the thalamus and the cortex. They are generally associated with a state of relaxation, peacefulness and alertness. Activity in the lower half of this range represents to a considerable degree the brain shifting into an idling gear, relaxed and a bit disengaged, waiting to respond when needed. If people merely close their eyes and begin picturing something peaceful, in less than half a minute there begins to be an increase in alpha brainwaves. These brainwaves are especially large in the back third of the head. EEG investigations of alcoholics (and the children of alcoholics) have documented that even after prolonged periods of abstinence, they frequently have lower levels of alpha and theta brainwaves and an excess of fast beta activity.

Alpha waves will peak around 10 Hz. Good healthy alpha production promotes mental resourcefulness, aids in the ability to coordinate mentally, enhances overall sense of relaxation and fatigue. In this state you can move quickly and efficiently to accomplish whatever task is at hand.

When Alpha predominates most people feel at ease and calm. Alpha appears to bridge the conscious to the subconscious. It is the major rhythm seen in normal relaxed adults - it is present during most of life especially beyond the thirteenth year when it dominates the resting.

Alpha rhythms are reported to be derived from the white matter of the brain. The white matter can be considered the part of the brain that connects all parts with each other.

It is a preferred state for the brain and occurs whenever a person is alert (it is a marker for alertness and sleep), but not actively processing information. Alpha waves are strongest over the occipital (back of the head) cortex and also over frontal cortex.

He traumatized brain idles too fast (in the beta direction), or too slowly (in the theta direction). If excessive alpha coherence is present, the brain may be locked up in alpha and be hard to speed up or slow down. Low alpha may be indicative of anxiety, PTSD, or short-term memory impairment. (Low alpha increases cortisol in the brain, which

affects the hippocampus and thus short-term memory). Alpha should be higher in the right hemisphere than in the left hemisphere. Alpha asymmetry and locally increased alpha are indicative of depression. With an eyes-closed map, the normal dominant frequency should be alpha. When the dominant frequency is at 11-12 Hz, it is faster than normal; slower than normal from 8-9 Hz and when 9.5-10.5 Hz it is considered normal. Slow (or low) alpha can be indicative of metabolic problems, toxin-related issues, bipolar disorder/depression, and substance abuse (i.e., marijuana use/abuse). Increased fast alpha in the posterior may indicate emotional rumination.

Alpha has been linked to extroversion (introverts show less), creativity (creative subjects show alpha when listening and coming to a solution for creative problems), and mental work. When your alpha is with in normal ranges we tend to experience also good moods, see the world truthfully, and have a sense of calmness. Alpha is one of the brain's most important frequencies to learn and use information taught in the classroom and on the job. You can increase alpha by closing your eyes or deep breathing or decrease alpha by thinking or calculating. Alpha-Theta training can create an increase in sensation, abstract thinking and self-control. Alpha allows us to shift easily from one task to another. Too much alpha in the right frontal cortex may be associated with defiance in children while a similar amplitude in the left frontal cortex may be associated with a depressed mood state.

Subjective feeling states: relaxed, not agitated, but not drowsy; tranquil, conscious

Associated tasks & behaviors: meditation, no action
Physiological correlates: relaxed, healing

Sub band low alpha: (8-10)Hz: inner-awareness of self, mind/body integration, balance

Sub band high alpha: (10-12)Hz: healing, mind/body connection.

If Alpha is blunted or absent, clients cite poor retention of info and/or poor short-term memory. When Alpha response is non-existent or negative then suspect the possibility of traumatic stress.

When Alpha response is negative at both Cz and O1, suspect emotional trauma.

In most severely emotionally distressed fibromyalgia patients, the QEEG show relatively little Alpha activity and the greatest Alpha power in the group with the least emotional distress (and pain). The more severe fibromyalgia patients, i.e. those with the greatest psychological distress and pain, are most likely those with a history of significant

emotional trauma.

Alpha Wave Indicator:

Area	Indicator	Indicator	Indicator	Indicator
Frontal	Depression (alpha asymmetry with more alpha on the left than right) Lack of motivation Lack of right alpha – social withdrawal	Decreased alpha is indicative of impulsivity, being controlled by anxiety, feeling overwhelmed, and impulsivity with explosiveness	ADD Attentional problems	Pain and anxiety
Global	Increased alpha on the left may indicate emotional shutdown	Depression Metabolic issues Substance abuse	Parkinson's may include alpha slowing	Person's energy level is low (esp. when delta is low)
Posterior	Depression, passivity, and avoidant personality	Trauma, PTSD		Fibromyalgia (depressed alpha)

Theta (4–8 Hz) activity generally represents a more daydream like, fantasy prone rather spacey state of mind that is associated with mental inefficiency. At very slow levels, theta brainwave activity is a very relaxed state, representing the twilight zone between waking and sleep. When theta is high, the brain is working overtime to recruit resources (perhaps because there is a lack of nutritive resources available). Generally, when there is increased theta, there may be increases in delta and alpha (all slower waves). Having increased theta and beta is like driving with the brakes on (the brain does not run smoothly).

Persons with Attention-Deficit Hyperactivity Disorder (ADD, ADHD), head injuries, stroke, epilepsy, developmental disabilities, and often chronic fatigue syndrome and fibromyalgia tend to have excessive slow waves (usually theta and sometimes excess alpha) present. When an

excessive amount of slow waves are present in the executive (frontal) parts of the brain, it becomes difficult to control attention, behavior, and/or emotions. Such persons generally have problems with cognitive processing, concentration, memory, controlling their impulses and moods, or hyperactivity. They have problems focusing and exhibit diminished intellectual efficiency. Theta is generated through the thalamo-cortical path and reflects resources used in the body, pulled into the brain when needed. Check out one's diet and exercise/health issues. Elevated theta in the posterior of the brain tends to be associated with feelings of calm and well-being.

Theta activity is classified as "slow" activity. It is seen in connection with creativity, intuition and daydreaming and is a repository for memories, emotions, and sensations. Theta waves are strong during internal focus, hyper-vigilance, meditation, prayer, and spiritual awareness. It reflects the state between wakefulness and sleep. Relates to subconscious.

It is abnormal in awake adults but is perfectly normal in children up to 13 years old. It is also present during sleep. Theta is believed to reflect activity from the limbic system and hippocampus regions.

Theta is observed in anxiety, behavioral activation and behavioral inhibition. When the theta rhythm appears to function normally it mediates and promotes adaptive, complex behaviors such as learning and memory. Under unusual emotional circumstances, such as stress or disease states, there may be an imbalance of three major transmitter systems, which results in aberrant behavior. Excessive theta and delta have a slowing effect and the brain is underactive. Lack of blood flow to the brain increases theta and delta waves.

Subjective feeling states: intuitive, creative, recall, fantasy, imagery, creative, dreamlike, switching thoughts, drowsy

Associated tasks & behaviors: creative, intuitive; but may also be distracted, unfocused
Physiological correlates: healing, integration of mind/body.

Theta/Beta Ratios: (greater than 3:1 - constitutes a slow-wave disorder. The normal theta/beta ratio is 2:1 (i.e., theta 8.7 over beta 11.07 = .79 or too much beta). The largest theta/beta ratios are found at Cz or Fz; the smallest theta/beta ratios are found in the temporal lobes. The normal theta/beta ratio at Cz is 1.6:1, and at Fpz is 1.5:1. A high theta/beta ratio is a signature of ADHD. Deficiencies suggest inefficiency in self-quieting, general anxiety, self-medicating and/or

distraction oriented behaviors, burnout, depression or poor sleep quality, self-designated alcoholics. When the ratio is too high, look for interpersonal detachment with qualitative aspects of autistic or Asperger's behavior. Look to equalize frontal lobe activity and reduce the theta/beta ratio in the occipital area of the grain.

Theta Wave Indicators:

Area	Indicators	Indicators	Indicators	Indicators	Indicators
Frontal	ADHD/ADD Anxiety	Impulsiveness/ Impulse Control D/O Lack of inhibitory control (when theta is higher on the right front and right hem.)	Foggy headed/L.D. (Unable to grasp concepts, ideas, information)	Emotional: PTSD Depression/Over-whelmed Emotions shut down	Disorganization (when theta is higher on the left front and left hemi)
Temporal			Language processing problems Short-term memory problems	Emotional processing problems	
Global		Decreased delta/theta globally may indicate a person is low energy (esp. when alpha is high)		Emotional processing problems	Trouble with accessing emotional information. Retrieval problems
Posterior	Pain and anxiety. Decreased theta may indicate attentional problems.	OCD/ Perseveration (hard time letting go)	L.D. reading comprehension problems		

Delta brainwaves (.5–3.5 Hz) are very slow, high-amplitude (magnitude) brainwaves and are what we experience in deep, restorative sleep. In general, different levels of awareness are

associated with dominant brainwave states. Delta measures do not give clear diagnostic indications. Delta brainwaves will also occur, for instance, when areas of the brain go ‘‘off line’’ to take up nourishment, and delta is also associated with learning disabilities. If someone is becoming drowsy, there are more delta and slower theta brainwaves creeping in, and if people are somewhat inattentive to external things and their minds are wandering, there is more theta present. Often present with learning difficulties.

ADD tends to show high amplitude delta slow waves, excessive theta or a locked in alpha state. Excessive alpha and beta is the brain’s most reliable signature for depression. Depression may show high alpha or beta, excessive coherence problems or poor inter-hemisphere communication.

The lowest frequencies are delta and are generated from the brain stem and cerebellum. These are less than 4 Hz and occur in deep sleep and in some abnormal processes also during experiences of "empathy Delta waves are involved with our ability to integrate and let go. It reflects unconscious mind. Delta is normally the dominant rhythm in infants up to one year of age and it is present in stages 3 and 4 of sleep. It tends to be the highest in amplitude and the slowest waves. We increase Delta waves to decrease our awareness of the physical world. We also access information in our unconscious mind through Delta. Complex problem solving.

Peak performers’ decrease Delta waves when high focus and peak performance is required. However, most individuals diagnosed with Attention Deficit Disorder, naturally increase rather than decrease Delta activity when trying to focus. The inappropriate Delta response often severely restricts the ability to focus and maintain attention. It is as if the brain is locked into a perpetual drowsy state. Parietal delta (P4) affects association and cortex/processing. A delta deficit is indicative of problems with working memory.

Subjective feeling states: deep, dreamless sleep, non-REM sleep, trance, unconscious.
Associated tasks & behaviors: lethargic, not moving, not attentive
Physiological correlates: not moving, low-level of arousal.

Delta Wave Indicators:

Area	Indicator	Indicator	Indicator	Indicator	Indicator
Frontal	TBI	L.D.	Dementi	Parkinson’	Decreased Delta may indicate

			a	s	short-term memory problems
Temporal	TBI	Language Processing Problems			Short-term memory problems
Global	TBI				Emotional processing problems/ADHD/list acquisition problems
Posterior		L.D.			

Biofeedback is the process of learning to control physiological functions by the use of instrumentation. Biological signals are fed to trainees with the goal of gaining mental control over subconscious biological processes. Biofeedback is a self-regulation skill and always rewards the trainee. Trainees learn best when the challenge matches their ability to learn. Training that is too easy or two difficult usually fails to produce change.

When brain-maps are consistently blue (hypo-arousal), the body is winning the battle for resources. When the brain-maps are consistently red, there is heightened stimulation.

Absolute Power – the brainpower available within a particular frequency at each site. The amplitude/strength of the frequency. Microvolts squared.

Relative Power – whether a particular frequency is overpowering other vital frequencies. In proportion to other bands. Distribution of power. Percentage of total power in each channel.

Mean Frequency – average frequency reflects if the bandwidth is within normal operating ranges. Example, alpha should peak around 10hz, and when it peaks at 9.5 hz, individuals may complain of fatigue, being error prone or simply misunderstanding vital input information.

Asymmetry – whether the brain waves between the various parts of the brains are balanced (difference in magnitude between two sites). Excessive activity may indicate an overtiring of brain cells. Insufficient activity may suggest neurons are not firing sufficiently to maintain proper function.

Coherence – How stable the phase relationship is between two sites. The degree of interaction or communication, shared information, between brain sites. Who's talking to whom? The inner self-talk reflecting connecting and disconnecting different parts of the brain to accomplish tasks. A measure of synchronization between activity in two channels.

Hypercoherence: when brain sites are not functioning in efficient interdependent fashion, but rather have too much "cross-talk". Excessive coherence tends to indicate two or more areas of the brain being overly connected or locked together. Too rigid, and this also occurs when the brain builds new neural connections. The brain has become overly dependent on these centers and is not efficiently processing and executing information resulting in poor day-to-day performance. Hypercoherence requires cortical organization while hypocoherence does not.

Hypocoherence: This is called poor inter-site interaction and is associated with diminished cognitive efficiency. Deficient coherence is a sign that the brain is not able to efficiently connect cortical areas to perform specific tasks. Insufficient differentiation inhibiting effective inter-site communication. Learning disabilities may show either hyper or hypo-coherence while serious TBI classically show excessive coherence. This is often found with brain injury, after which clients experience stereotypical, perseverative and inflexible behavior and cognitive processing.

A full Q is required to assess hypocoherence (!)

Phase – reflects how many of the brain's functions are timed events, the energy from one part of the brain arriving at the right moment to perform a task. Excessive phase mean the signals arrive too early (meaning a slowing of connections) while deficiency means they arrive too late. This is a measure of the temporal relationship between two signals. A locking and unlocking of signals. EEG waves are electromagnetic waveforms that move from positive to negative voltage. If two wave forms shift from positive to negative at exactly the same rate, they are in phase. Two wave forms that shift at the opposite rate are out of phase. Areas of the brain that emit consistently in-phase signals are doing so because they are communicating and processing the same information. Consequently,

they are referred to as coupled.

Bandwidth microvolt normative distributions at Cz:

Bandwidth	Eyes Closed	Eyes Open
Alpha (8-12 Hz)	16.6 mvl	9.3 mvl
Theta (4-8 Hz)	12.4 mvl	10.7 mvl
Beta (13-21 Hz)	8.1 mvl	6.4 mvl
SMR (12-15 Hz)	5.1 mvl	4.4 mvl
Theta to beta ratio	1.6:1	1.8:1

Normal amplitude of beta tends to be higher than or equal to high beta, while the normal amplitude of theta tends to be greater than delta. Theta is still highest at Pz (EO).

Contributions from Soutar & Longo ("Doing Neurofeedback")

Drug Effects on the EEG:

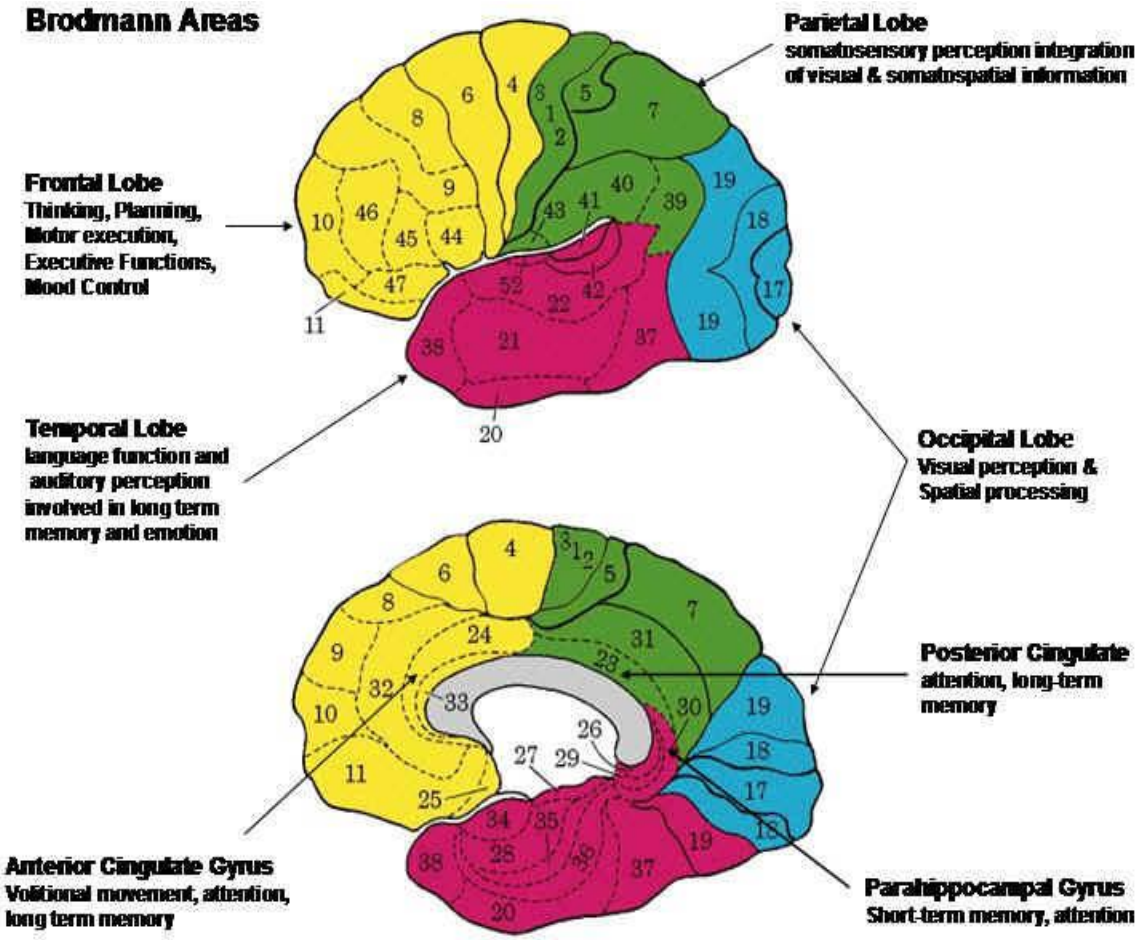
Table 9: Drug Effects on EEG

Family	Drugs	Purpose	EEG Impact
Neuroleptics	Haldol, Prolixin, Thorazine, Mellaril	Sedative	Increase delta, theta and beta above 20 Hz and decrease alpha and beta below 20 Hz.
Neuroleptics	Seroquel, Risperdal, Geodone	Non-sedative and antipsychotic medications	Decrease alpha and increase beta in general.
Anxiolytics	Valium, Halcion, Librium, Dalmane	Anxiety relief	Decrease alpha and increase beta, especially 13-20 Hz beta
Benzodiazepines	Valium, Xanax, and Ativan	Anxiety, panic relief	Decrease alpha and increase 20-30 Hz beta
SSRIs	Prozac, Paxil, and Zoloft	a class of antidepressants used in the treatment of depression, anxiety disorders, and some personality disorders.	Decrease in frontal alpha and a mild increase in 18-25 Hz beta.
MAO Inhibitors	Marplan, Parnate, Eldepryl	Antidepressant	Tendency to increase 20-30 Hz beta while decreasing all other frequencies
Tricyclic antidepressants	Imipramine and Amitriptyline	Useful in depressed patients with insomnia, restlessness, and nervousness	Increase delta and theta while decreasing alpha; increase beta 25 Hz and up band
Antipsychotics	Lithium	Used for the treatment of manic/depressive (bipolar) and depressive disorders	Increases theta, mildly decreases alpha and increases beta
Amphetamines	Adderall, Vyvanse, and Dexedrine.	a group of drugs that act by increasing levels of norepinephrine, serotonin, and dopamine in the brain	Decrease slow-wave activity and increase beta in the 12-26 Hz range
Marijuana		Recreational	Increases frontal low frequency alpha; affects EEG for three days
Opiates	Opium, hydromorphone, oxymorphone, heroin, morphine, oxycodone, Talwin, codeine, methadone, meperdine, hydrocodone, Vicodin	Pain relief	Generate high amplitude slow alpha in the 8 Hz range
Barbiturates	Brevital, thiamylal (Surital), thiopental (Pentothal), amobarbital, Amytal, pentobarbital, Nembutal, secobarbital, Seconal, Tuinal, Phenobarbital, Luminal, mephobarbital, Mebaral	Produce a wide spectrum of central nervous system depression, from mild sedation to coma, and have been used as sedatives, hypnotics, anesthetics, and anticonvulsants	Increase beta at 25-35 Hz amplitude
Caffeine		Increases alertness	Increases beta and decreases slower waves

Brodmann Areas:

Table 3: Brodmann Areas and Localization of Function

SITE	BRODMANN AREA	FUNCTION
Fpz	10, 11, 32	Emotional inhibition, oversensitive, impulsive Motivation & attention
Fp1	10, 11, 46	Cognitive emotional valence - lateral orbital frontal Irritability, intrusive, depression Social awareness - approach behaviors
Fp2	10, 11, 46	Emotional inhibition - lateral orbital frontal Impulsivity, tactlessness, mania Social awareness - avoidance behaviors
F7	45, 47, 46	Working memory - visual & auditory Divided & selective attention - filtering Broca's area - semantic short-term buffer (word retrieval)
F8	45, 47, 46	Prosody Working memory - spatial & visual, gestalt Facial emotional processing Sustained attention
F3	8, 9, 46	Short-term memory - verbal episodic retrieval Facial recognition, object processing Planning & problem solving - Wisconsin card sort (rigidity)
F4	8, 9, 46	Short-term memory - spatial/object retrieval Vigilance area - selective & sustained attentional area
Fz	8, 6, 9	Personality changes Intention & motivation - poverty of speech, apathy Possible anterior cingulate - internal vs. external attention Basal ganglia output
C3	3, 1, 4	Sensory & motor functions
C4	3, 1, 4	Sensory & motor functions
Cz	6, 4, 3	Sensory & motor functions
T3	42, 22, 21	Language comprehension - verbal understanding Wernicke's area - inner voice Long-term memory - declarative & episodic processing Event sequencing - visualization Amygdala/hippocampal area
T4	42, 22 ,21	Personality - emotional tonality (anger, sadness) Categorization & organization Visualization and auditory cortex
T5	39, 37, 19	Meaning construction - angular gyrus Acalcula Short-term memory
T6	39, 37, 19	Facial recognition - emotional content, amygdalic connection
P3	7, 40, 19	Digit span problems, information organization problems Self-boundaries excessive thinking
P4	7, 40, 19	Visual processing - spatial sketch pad, vigilance Personality - excessive self-concern, victim mentality Agnosia, apraxia, context boundaries, rumination
Pz	7, 5, 19	Attentional shifting- perseverance Self-awareness, orientation association area Agnosia, apraxia
O1, O2	18, 19, 17	Visual processing, procedural memory, dreaming
Oz	18, 17, 19	Visual processing, hallucinations


Brodmann Areas
Parietal Lobe
somatosensory perception integration
of visual & somatospatial information
Frontal Lobe
Thinking, Planning,
Motor execution,
Executive Functions,
Mood Control
Temporal Lobe
language function and
auditory perception
involved in long term
memory and emotion
Occipital Lobe
Visual perception &
Spatial processing
Posterior Cingulate
attention, long-term
memory
Anterior Cingulate Gyrus
Volitional movement, attention,
long term memory
Parahippocampal Gyrus
Short-term memory, attention