

The background of the slide is a light gray gradient with several realistic water droplets of various sizes scattered across it. The droplets have highlights and shadows, giving them a three-dimensional appearance. The main title is centered in the upper half of the slide.

NEUROBIOLOGY

FOR

CLINICIANS

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THE BRAIN

- **IS NOT RATIONAL**
 - **IT MAKES DECISIONS THROUGH EMOTIONS**
 - **IF LOSE CAPACITY TO HAVE EMOTIONS CAN NOT EVEN INITIATE A TASK (ANTONIO DAMASIO)**
 - **MIGHT STARE AT TOOTHBRUSH WITH TOOTHPASTE ON IT**
- **DOES NOT MULTITASK**
 - **DELUSION IS WE WILL GET MORE THINGS DONE IF WE DO MORE THAN ONE THING AT A TIME**

THE BRAIN

- **DOES NOT MULTITASK (CONTINUED)**
 - **MAY FLIP BACK AND FORTH BETWEEN TWO THINGS BUT STILL MISS MORE THAN WE WOULD IMAGINE**
 - **THE MEDIAL PREFRONTAL CORTEX DIVIDES SO THAT HALF THE REGION FOCUSES ON ONE TASK WHILE THE OTHER HALF ON THE OTHER TASK**
 - **NOW CAN SWITCH BACK AND FORTH**

THE BRAIN

- **IS A PATTERN-MAKER NOT A TRUTH-MAKER**
 - **TRIES TO FIT EVERYTHING INTO
RECOGNIZABLE PATTERNS**
 - **SEEKS WHAT IS KNOWN AS OPPOSED TO
WHAT IS UNKNOWN**

THE BRAIN

- **WEIGHS ABOUT 1.3 KILOGRAMS**
- **CONSUMES 20% OF BODY'S ENERGY BUDGET**
- **HAS 86 BILLION NERVE CELLS CALLED NEURONS**
- **CONDUCTS TINY ELECTRICAL CURRENTS AT AROUND 120 METERS PER SECOND**
- **A TYPICAL NEURON TRANSMITS TO ABOUT 7000 NEIGHBORING CELLS**

THE HUMAN BRAIN

- **THIS VENTROLATERAL FRONTAL CORTEX AREA OF THE BRAIN IS INVOLVED IN MANY OF THE *HIGHEST ASPECTS OF COGNITION AND LANGUAGE*, AND IS ONLY PRESENT IN HUMANS AND OTHER PRIMATES. SOME PARTS ARE IMPLICATED IN PSYCHIATRIC CONDITIONS LIKE ADHD, DRUG ADDICTION OR COMPULSIVE BEHAVIOR DISORDERS. LANGUAGE IS AFFECTED WHEN OTHER PARTS ARE DAMAGED AFTER STROKE OR NEURODEGENERATIVE DISEASE.**

THE HUMAN BRAIN

- **THE BRAIN AREA PINPOINTED IS KNOWN TO BE INTIMATELY INVOLVED IN SOME OF THE MOST ADVANCED PLANNING AND DECISION-MAKING PROCESSES THAT WE THINK OF AS BEING ESPECIALLY HUMAN.**
- **BEING ABLE TO PLAN INTO THE FUTURE, BE FLEXIBLE IN OUR APPROACH, MULTI-TASKING AND LEARNING FROM OTHERS INVOLVES THIS BRAIN AREA**

FRANZ-XAVER NEUBERT, ROGIER B. MARS, ADAM G. THOMAS, JEROME SALLET, MATTHEW F.S. RUSHWORTH. **COMPARISON OF HUMAN VENTRAL FRONTAL CORTEX AREAS FOR COGNITIVE CONTROL AND LANGUAGE WITH AREAS IN MONKEY FRONTAL CORTEX.** *NEURON*, 2014; 81 (3): 700 DOI: [10.1016/J.NEURON.2013.11.012](https://doi.org/10.1016/j.neuron.2013.11.012)

NEUROPLASTICITY

- **HUMANS CREATE NEW NEURONS IN AREAS OF THE BRAIN INVOLVED IN NEW LEARNING**
 - **AMYGDALA**
 - **HIPPOCAMPUS**
 - **CORTEX**
- **THE CORTEX IS FIRST ORGANIZED BY OUR EXPERIENCE AND THIS ORGANIZES OUR INTERACTIONS WITH THE WORLD**

NEUROPLASTICITY

- **BRAIN AT ALL AGES IS RESPONSIVE TO ENVIRONMENTAL STIMULI**
- **SYNAPSES CAN CHANGE IN MINUTES WHEN STIMULATED**
- **NEUROPLASTICITY IS MODULATED BY**
 - **GENETIC FORCES**
 - **EPIGENETIC FORCES**
- **THESE FACTORS INFLUENCE THE EXPRESSION OF GENES WITHOUT CHANGING THE DNA SEQUENCE**

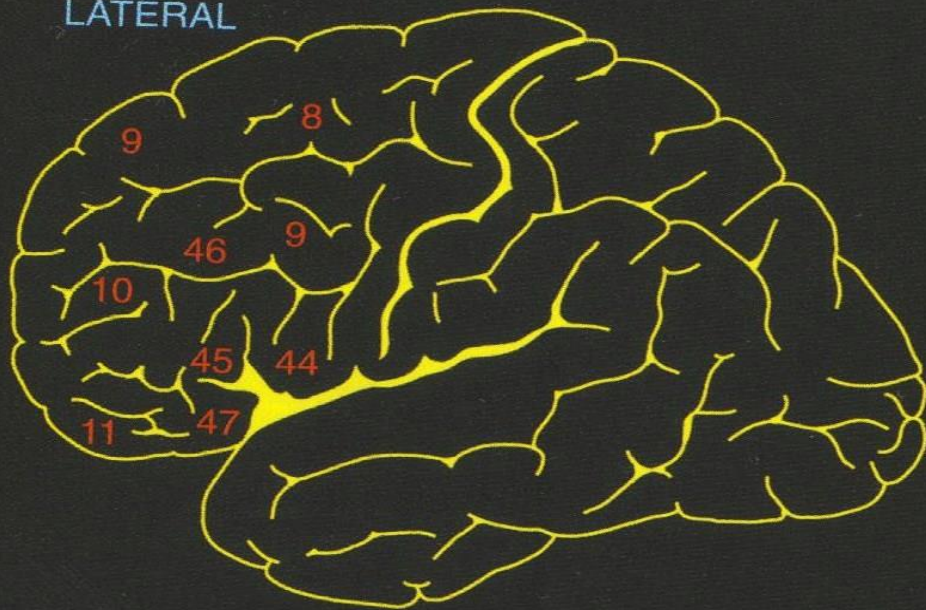
NEUROPLASTICITY

- **EPIGENETIC CHANGES ARE POTENTIALLY REVERSIBLE**
- **BRAIN IS VERY SENSITIVE TO SOCIAL STIMULI**
- **SOCIAL STIMULI (PARENTING, STYLE, EARLY STRESS, ETC.) CAN EPIGENETICALLY MODIFY THE EXPRESSION OF GENES THAT INFLUENCE BRAIN STRUCTURE AND FUNCTION (INCLUDING SENSITIVITY TO STRESS)**

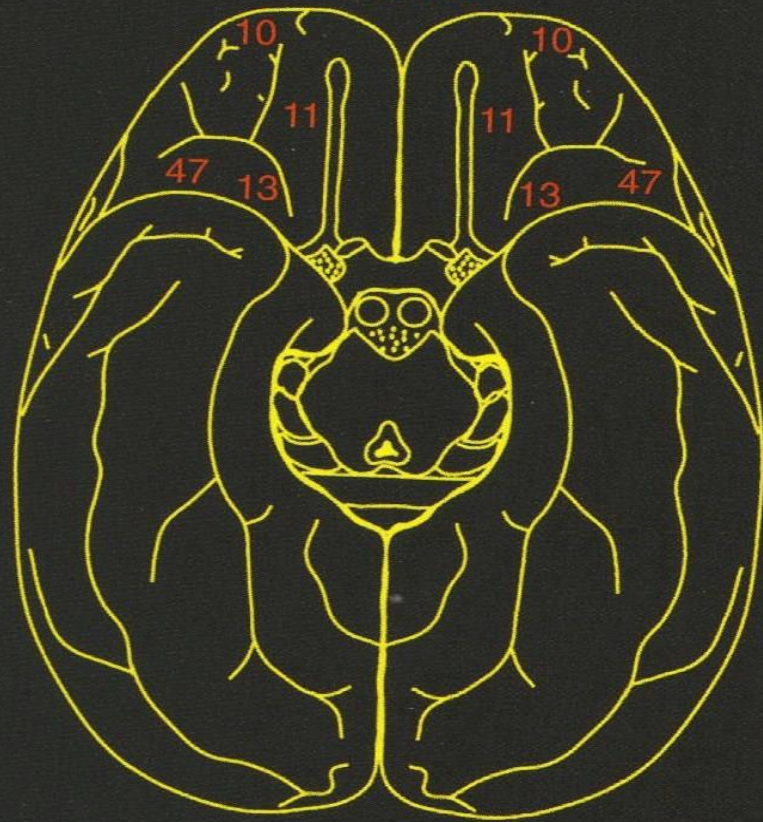
NEUROPLASTICITY

- **PREVENTION BASED ON IMPROVED PARENTING STYLE REDUCED RISK OF SUBSTANCE ABUSE IN ADOLESCENTS WITH A PARTICULAR VARIANT OF A GENE THAT RECYCLES SEROTONIN BACK INTO THE NEURON**
 - **THIS VARIANT IS VERY SENSITIVE TO SOCIAL ADVESITY**

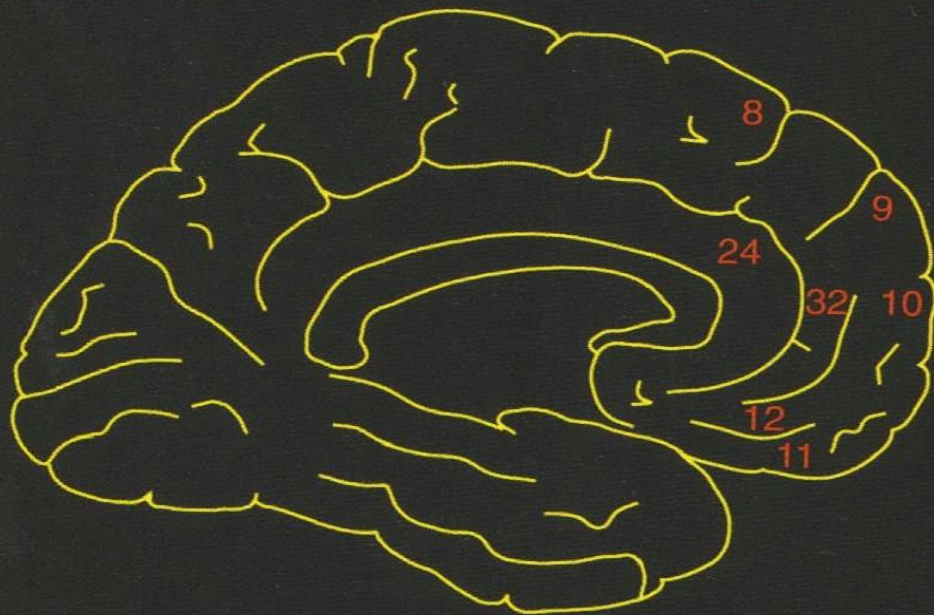
LATERAL



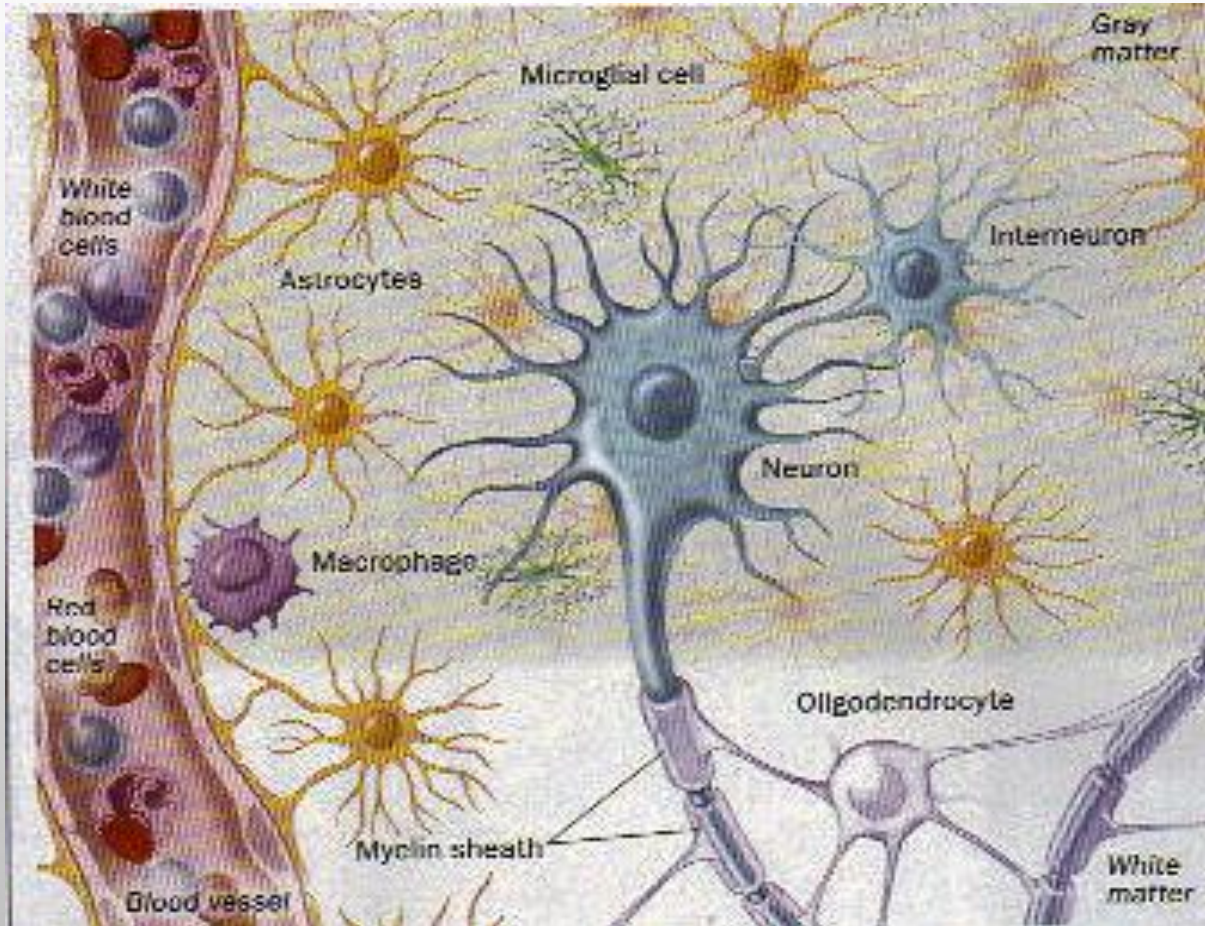
ORBITAL



MEDIAL / CINGULATE



GLIAL CELLS



GLIAL CELLS

- **NEURON DOCTRINE IS FLAWED**
- **SOME INFORMATION BYPASSES NEURONS COMPLETELY FLOWING WITHOUT ELECTRICITY THROUGH NETWORKS OF GLIAL CELLS**
- **GLIAL CELLS INTERACT WITH NEURONS AND CONTROL THEM**
- **BRAIN IS COMPOSED OF 85% GLIAL CELLS AND 15% NEURONS**

GLIAL CELLS

- **ASTROCYTES**

- **FERRY NEUROTRANSMITTERS, FOOD AND WASTE**
- **CONTROL SYNAPTIC COMMUNICATION**

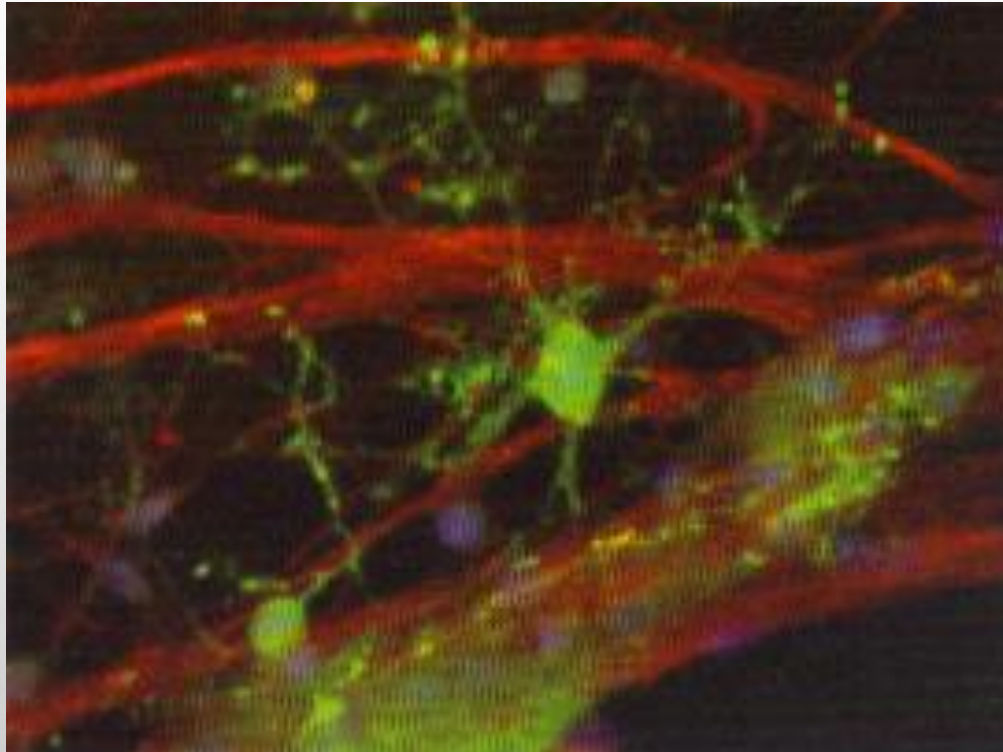
- **OLIGODENDROCYTES**

- **WRAP THEMSELVES AROUND NEURONS LIKE SHEATHS (MYELIN) AND SPEED CONDUCTION BY UP TO 50 X'S**

- **MICROGLIA**

- **FIRST RESPONDERS TO INJURY AND DISEASE KILLING INVADING GERMS AND INITIATING**

GLIAL CELLS



GLIAL CELLS

- **NEURONS ARE DEPENDENT ON GLIA TO FIRE ELECTRICAL IMPULSES AND TO PASS MESSAGES ACROSS SYNAPSES**
- **GLIA HAVE SAME NEUROTRANSMITTER (NT) RECEPTORS AS NEURONS**
- **WHEN NEURONS RELEASE NT SO DO GLIA**
- **GLIA NT RELEASE IMPACTS IMMEDIATE AND DISTANT SYNAPSES**

GLIAL CELLS

- **GLIAL SIGNALING OCCURS IN DEGREES AND OCCURS SLOWLY**
- **ARE INVOLVED IN SYNAPTIC PLASTICITY DETERMINING WHERE AND WHEN NEW SYNAPSES FORM**
 - **THE PROTEIN THROMBOSPONDIN-ACTIVE DURING BRAIN DEVELOPMENT AND AFTER INJURY-IS RELEASED BY ASTROCYTES TO ACTIVATE SYNAPSE FORMATION**

GLIAL CELLS

- **POSTMORTEM BRAIN TISSUE ANALYSIS LINKS OLIGODENDROCYTES AND ASTROCYTES TO DEPRESSION AND SCHIZOPHRENIA**
 - **SEE REDUCED NUMBERS CONFIRMED BY MRI FINDINGS**
 - **ALL HALLUCINOGENIC DRUGS (LSD, PCP, ETC.) PRODUCE THEIR EFFECTS BY ALTERING LEVELS OF NTS IN SPECIFIC CIRCUITS**
 - **ASTROCYTES REGULATE NT LEVELS AT SYNAPSES**

GLIAL CELLS

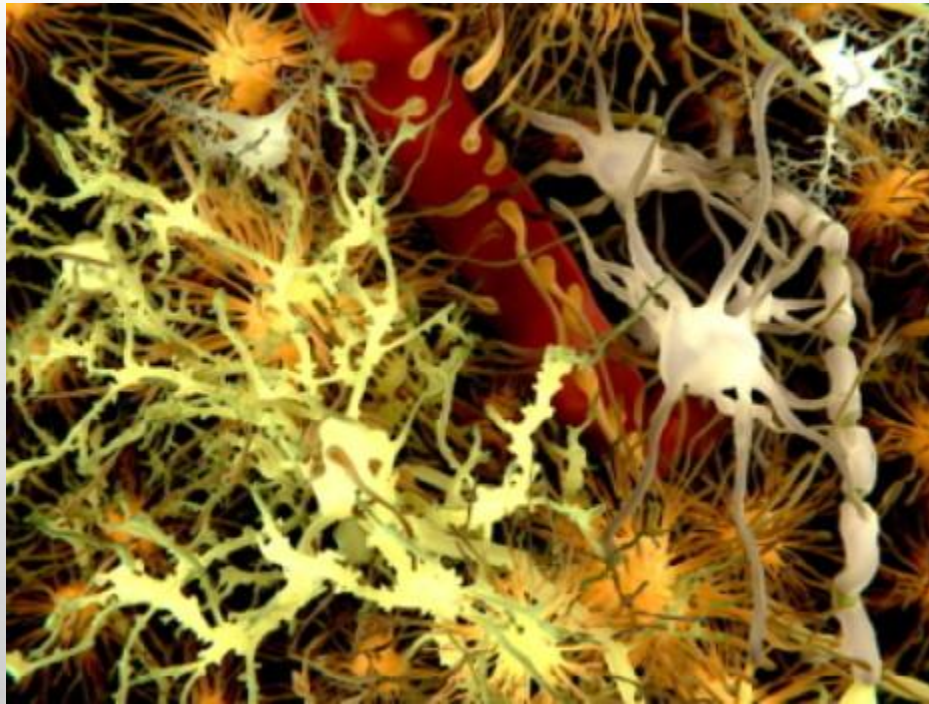
- **ASTROCYTES HAVE A PRINCIPLE ROLE IN WORKING MEMORY**
- **MARIJUANA IMPAIRS WORKING (SHORT TERM) MEMORY**
 - **EXAMPLE-LOOSE TRAIN OF THOUGHT IN MID-SENTENCE**
 - **DISCOVERED BY REMOVING CB1 RECEPTORS FROM ASTROCYTES LEAVING NO SHORT TERM DEFICIT BUT REMOVING CB1 RECEPTORS FROM NEURONS CREATED FORGETFULNESS IN MICE THE SAME AS WITH RECEPTORS**
 - **“WHAT MARIJUANA REVEALS ABOUT MEMORY” SCAMMIND. JULY/AUGUST, 2012, PG. 10.**

GLIAL CELLS

- **ASTROCYTES INGEST WEAK, EXTRANEIOUS AND REDUNDANT SYNAPSES DURING BRAIN “PRUNING”**
- **WITHOUT THESE STAR-SHAPED CELLS SYNAPSES FAIL TO SEND STRONG SIGNALS**
- **WITHOUT THE ASTROCYTES, NEURONS ARE NOT AS GOOD AT CREATING NEW SYNAPSES**
- **MICROGLIA ALSO DIGEST CERTAIN SYNAPSES**

BRAIN IN THE NEWS. VOL. 21 NO.1, JANUARY 2014

GLIAL ASTROCYTES (YELLOW)



SUPRACHIASMATIC NUCLEUS

- **BRAINS MASTER CIRCADIAN CLOCK**
- **FOUND IN HYPOTHALAMUS**
- **CONTROLS SLEEP-WAKE CYCLE**
- **SCN CELLS ACTIVE DURING THE DAY AND SILENT AT NIGHT**
- **BEGINS TO DECLINE IN MIDDLE AGE**
 - **REDUCED ACTIVITY DURING THE DAY AND INCREASE DURING THE NIGHT**
 - **REDUCED AMPLITUDE**

SUPRACHIASMATIC NUCLEUS

- **BEGINS TO DECLINE DURING MIDDLE AGE
(CONTINUED)**
 - **DIFFICULTY SLEEPING**
 - **DIFFICULTY ADJUSTING TO TIME ZONES**
 - **DIFFICULTY WITH SHIFT WORK**
 - **REDUCED ALERTNESS WHEN AWAKE**
 - **IMPACTS MEMORY AND METABOLIC
PROCESSES**

CONSCIOUS AND UNCONSCIOUS ASPECTS

- **CONSCIOUS MIND OR BRAIN**
 - **PREFRONTAL CORTEX**
 - **ALSO CALLED THE SOCIAL BRAIN**
- **UNCONSCIOUS MIND**
 - **GENETIC AND SPECIES SPECIFIC**
 - **SURVIVAL ORIENTED**

Unconscious

Homeostasis

Stereotypic
Movements

Learned
Movements

Neurotransmitter
and Hormone
Release

Autonomic
Regulation

Responds to
Generalized
Features
of objects

Responses
are fast



Conscious

Novel Movement
Sequences

Can assume
Voluntary control
of some unconscious
Processes

Neurotransmitter
and Hormone
Release

Autonomic
Regulation

Can address
Specific
Detail

Responses
can be slow

UNCONSCIOUS MIND

“THE UNCONSCIOUS HANDLES A VARIETY OF IMPORTANT TASKS THAT ARE BEST ACCOMPLISHED AUTOMATICALLY, WITH GREAT SPEED AND NO OPPORTUNITY FOR DEVIATION, OR, IN OTHER WORDS, NO ROOM FOR CHOICE.”

VIAMONTES AND BEITMAN, “MAPPING THE UNCONSCIOUS IN THE MIND”.
PSYCH ANNALS. 37:4, APRIL 2007, PG. 250.

FIVE LEVELS OF UNCONSCIOUS REACTION

- **LEVEL 1: ORGANIZE HOMEOSTATIC FUNCTIONS, AUTOMATIC ACTIONS AND STEREOTYPIC BEHAVIOR**
 - **NEUROLOGICAL SYSTEMS**
 - **BRAIN STEM**
 - **BASAL FOREBRAIN**
 - **HYPOTHALAMUS**
 - **INVOLVES ANXIETY, FEAR AND ANGER**
 - **INAPPROPRIATE ACTIVATION CAN CAUSE PATHOLOGICAL STATES-ANXIETY, FEAR AND ANGER**

FIVE LEVELS OF UNCONSCIOUS REACTION

- **LEVEL 2: INTENSITY OF ENGAGEMENT WITH ENVIRONMENT**

- BRAIN STEM AROUSAL AND SLEEP CENTERS
- STATE OF DA, SER, NE AND ACETYLCHOLINE RECEPTORS THROUGHOUT BRAIN
- MODULATION OF CORRESPONDING NEUROTRANSMITTERS
- BRAIN ENERGY MODULATION
 - REDUCED ATP CAUSES INCREASED ADENOSINE CREATING LETHARGY
 - CAFFEINE BLOCKS ADENOSINE RECEPTORS

FIVE LEVELS OF UNCONSCIOUS REACTION

- **LEVEL 3: INTERACTIONS WITH PRIMARY REWARDS AND PUNISHERS ENCODED IN GENES**
 - **AMYGDALA AND ORBITOFRONTAL CORTEX**
 - **BOTH MODULATE THE AUTONOMIC CENTER**
 - **BOTH ACT AS “COUPLERS” THAT TIE RECOGNITION OF THE PRIMARY REINFORCER TO THE GENETICALLY PROGRAMMED RESPONSE**
 - **PRIMARY REINFORCERS ARE CERTAIN TASTES AND SMELLS, PLEASANT TOUCH AND PROBABLY SMILING FACES**
 - **PRIMARY PUNISHERS INCLUDE UNPLEASANT TASTE AND ODORS, PAINFUL SOMATOSENSORY STIMULI AND PROBABLY LOUD VOICES AND ANGRY/THREATENING FACES**

FIVE LEVELS OF UNCONSCIOUS REACTION

- **LEVEL 3: (CONTINUED)**
 - **STEREOTYPED BEHAVIORS**
 - **EXAMPLE-PUT BITTER TASTE IN MOUTH AND IT IS IMMEDIATELY ‘SPIT” OUT**
 - **THE BASIC STATES THAT ARE INDUCED IN ENCOUNTERS WITH PRIMARY REWARDS AND PUNISHERS ARE THE FOUNDATION FOR THE DEVELOPMENT OF EMOTIONS**

FIVE LEVELS OF UNCONSCIOUS REACTION

- **LEVEL 4: DEFINE UNCONSCIOUS REACTIONS TO SECONDARY REWARDS AND PUNISHERS THAT HAVE BEEN LEARNED**
 - **AMYGDALA AND ORBITOFRONTAL CORTEX MEDIATE RESPONSE TO SIMPLE OBJECTS THAT BECOME ASSOCIATED WITH REWARD AND PUNISHMENT**
 - **EXAMPLE- “CRAVING”**
 - **OFTEN FOUND IN CERTAIN ANXIETY DISORDERS LIKE PHOBIAS, OCD**

FIVE LEVELS OF UNCONSCIOUS REACTION

- **LEVEL 4:**
 - **MANY CATEGORIES OF PSYCHOPATHOLOGY INVOLVE LEARNING OF INAPPROPRIATE RESPONSES TO PREVIOUSLY NEUTRAL STIMULI**
 - **INVOLVES ATTACHING THE SOMATIC STATE PATTERN THAT NORMALLY ACCOMPANIES A PRIMARY REINFORCER TO A PREVIOUSLY NEUTRAL OBJECT**

FIVE LEVELS OF UNCONSCIOUS REACTION

- **LEVEL 5: MEDIANE SOCIAL FUNCTIONING**
- **SIGNIFICANT IMPACT ON BEHAVIOR AND PSYCHOPATHOLOGY**
 - **FACIAL EXPRESSIONS**
 - **AMYGDALA APPEARS TO HAVE PREWIRED PROGRAMS FOR RECOGNITION OF NEGATIVE FACIAL EXPRESSIONS**
 - **THEORY OF MIND**

THEORY OF MIND

- ABILITY TO THINK ABOUT WHAT ANOTHER IS THINKING
- STARTS AS VISCERAL-EMOTIONAL SENSE OF OTHERS GAINED FROM “MIRROR” NEURON SYSTEM
- KEY COMPONENT OF SOCIAL INTERACTION
- INVOLVES
 - *RIGHT ORBITOFRONTAL CORTEX*
 - DECODES MENTAL STATES
 - *LEFT ORBITOFRONTAL CORTEX*
 - REASONING ANALYSIS OF MENTAL STATES

THEORY OF MIND

- **INVOLVES (CONTINUED)**
 - **AMYGDALE**
 - **INSULA**
 - **EXPERIENCE OF SELF**
 - **ABILITY TO DISTINGUISH SELF FROM OTHER**
 - **ANTERIOR CINGULATE**
 - **PAIR-BONDING**
 - **NURTURANCE**

THEORY OF MIND


- **INVOLVES (CONTINUED)**
 - ***DORSOLATERAL PREFRONTAL CORTEX***
 - **EXECUTIVE FUNCTIONS**
 - **ACTIONS**
 - **GOALS**
 - **ABSTRACTIONS**

SYMPTOMS RESIDE IN CIRCUITS

- **PROBLEMS OCCUR WHEN NETWORKS DO NOT COMMUNICATE PROPERLY**
 - **NEUROTRANSMITTERS**
 - **TRANSPORTERS OR VESICLES**
 - **REUPTAKE PUMPS**
 - **RECEPTORS**
- **NEURAL CIRCUITS IN DEPRESSION**



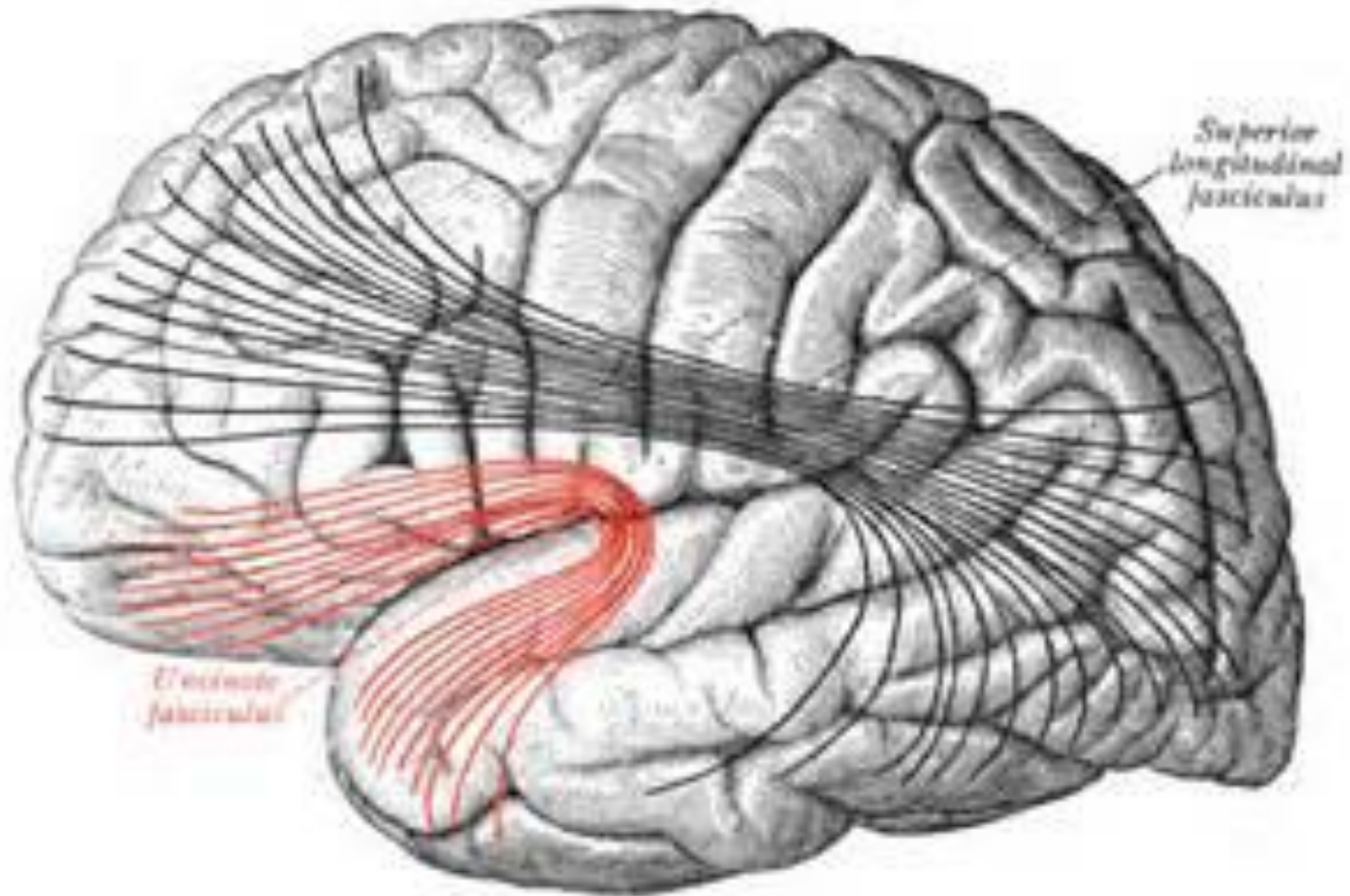
GENERALIZED ANXIETY DISORDER

- **WEAKER WHITE MATTER CONNECTIONS BETWEEN BRAIN REGIONS IN CHARGE OF EMOTIONAL RESPONSE (ORBITOFRONTAL CORTEX AND ANTERIOR CINGULATE GYRUS) AND THE AMYGDALA**
 - **BRAINS PANIC BUTTON MAY BE CHRONICALLY PUSHED DOWN DUE TO LACK OF REGULATION**
- 

GENERALIZED ANXIETY DISORDER

- **THE WHITE MATTER PATH IS CALLED *UNCINATE FASCICULUS* WHICH CONNECTS THE PREFRONTAL AREAS WITH THE AMYGDALA**
- **THEORY IS THE WEAK CONNECTION CREATES DEFENSIVE ANXIETY BECAUSE THE ANTERIOR CINGULATE IS UNABLE TO TELL THE AMYGDALA TO “CHILL OUT”**

UNCINATE FASCICULUS



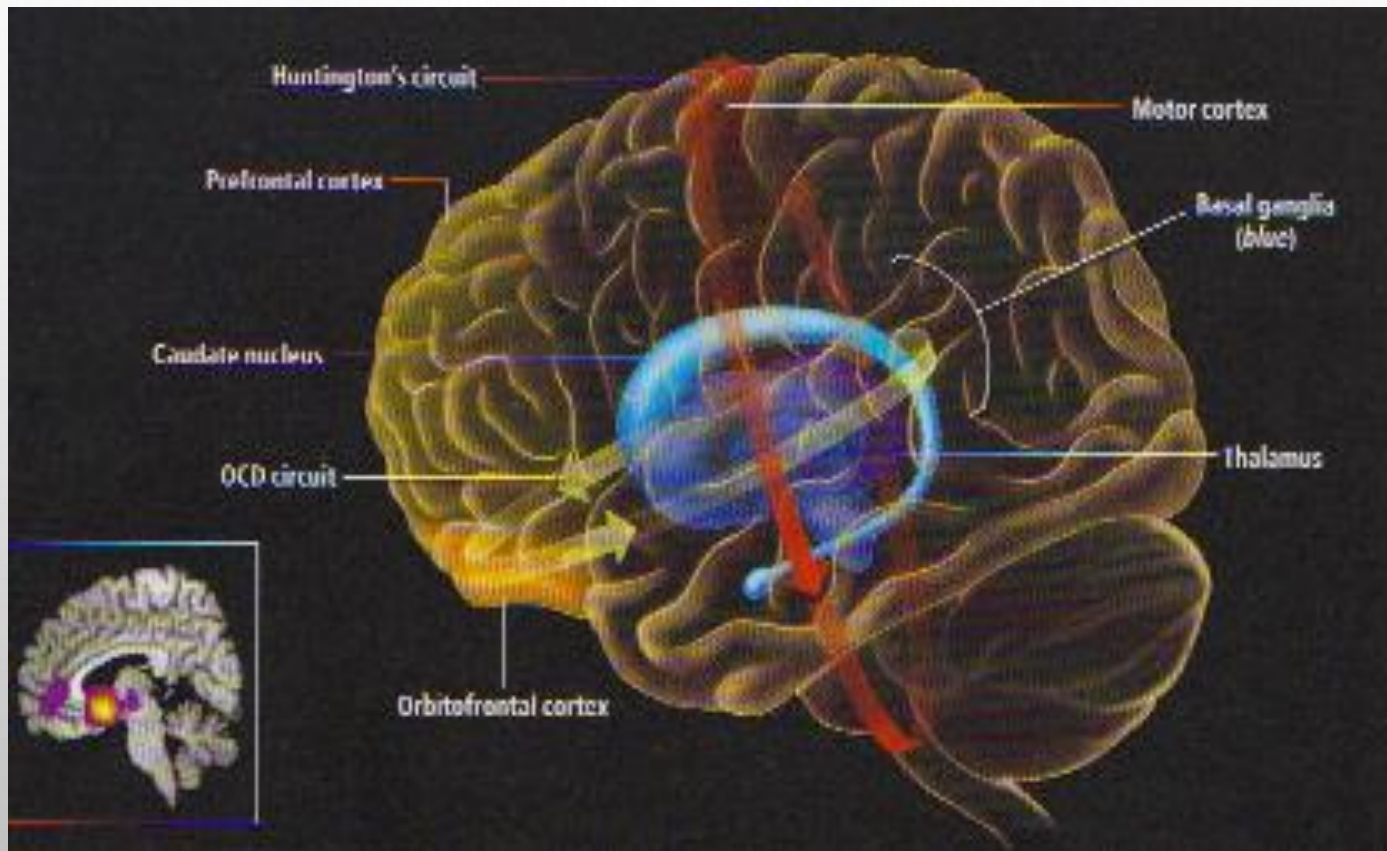
GENERALIZED ANXIETY DISORDER

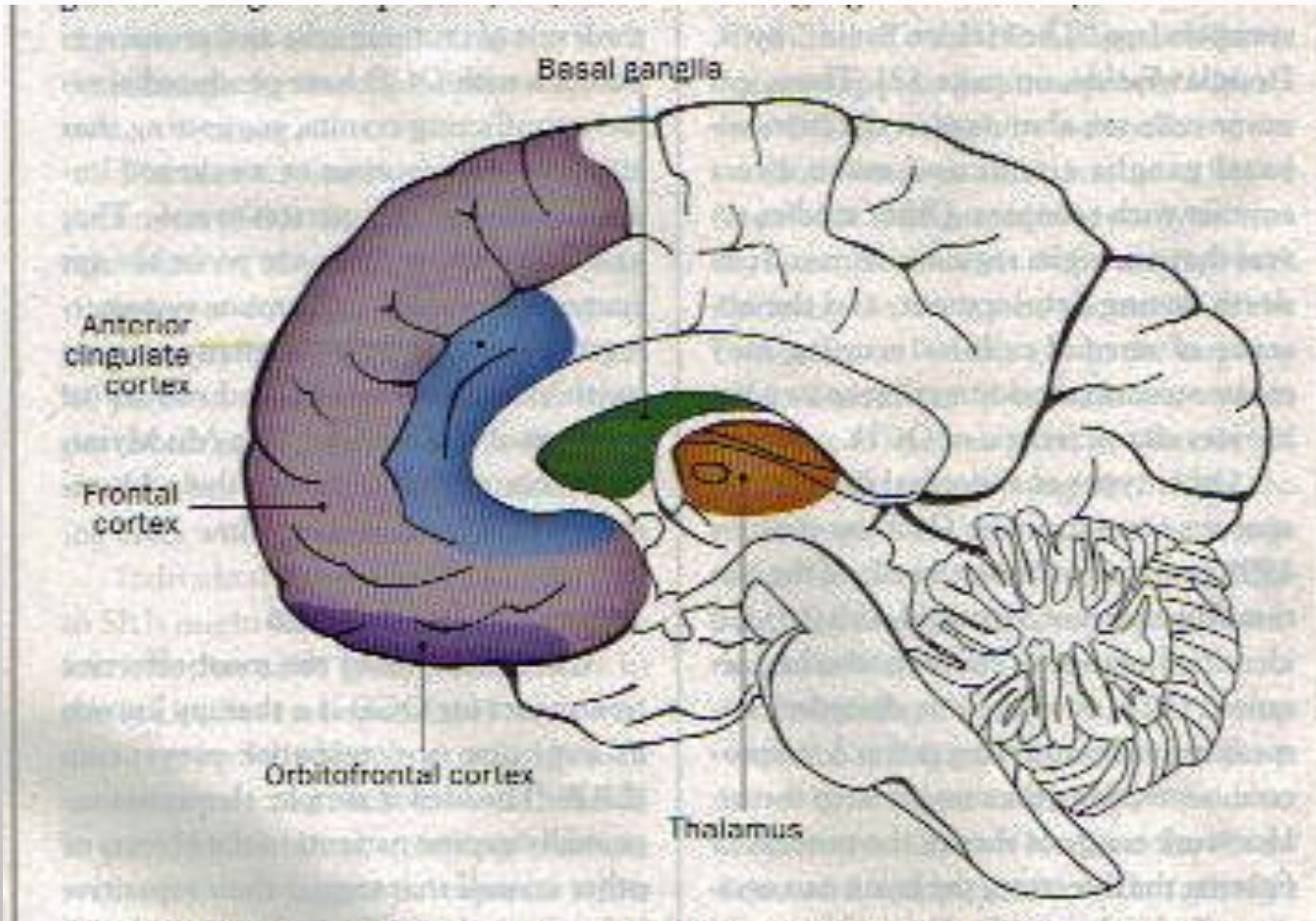
- **SUGGESTS BEHAVIORAL THERAPY WHERE PATIENT LEARNS TO CONSCIOUSLY ATTEMPT TO REGULATE THE EMOTION MIGHT STRENGTHEN THE CONNECTION**

PEDERSEN, T. (2012). "WEAK BRAIN CONNECTIONS FOUND IN PEOPLE WITH ANXIETY DISORDER." *PSYCH CENTRAL*

[HTTP://PSYCHCENTRAL.COM/NEWS/2012/09/05/WEAK-BRAIN-CONNECTIONS-FOUND-IN-PEOPLE-WITH-ANXIETY-DISORDER/44119.HTML](http://psychcentral.com/news/2012/09/05/weak-brain-connections-found-in-people-with-anxiety-disorder/44119.html)

OBSESSIVE-COMPULSIVE DISORDER CIRCUIT





OBSESSIVE-COMPULSIVE DISORDER CIRCUIT

- **NORMALLY WHEN WE MAKE A MISTAKE**
 - **WE GET A “MISTAKE FEELING”-A NAGGING SENSE SOMETHING IS WRONG**
 - **OFC DETECTS MISTAKE**
 - **THE MORE ACTIVE THE OFC THE MORE OBSESSIVE THE PERSON IS**
 - **NEXT WE BECOME ANXIOUS-THIS DRIVES US TO CORRECT THE MISTAKE**
 - **ANTERIOR CINGULATE TRIGGERS THE ANXIETY THAT SOMETHING BAD WILL HAPPEN IF MISTAKE IS NOT CORRECTED**
 - **AC SENDS SIGNALS TO THE HEART AND GUT**

OBSESSIVE-COMPULSIVE DISORDER CIRCUIT

- **NORMALLY WHEN WE MAKE A MISTAKE**
 - **WHEN THE MISTAKE IS CORRECTED AN AUTOMATIC “GEAR SHIFT” ALLOWS US TO MOVE ON-THE “MISTAKE FEELING’ AND ANXIETY DISAPPEAR**
 - **CAUDATE NUCLEUS IS THE “GEAR SHIFT”**
 - **IN OCD THE PAGE IS NOT TURNED AND THE “MISTAKE FEELING” AND THE ANXIETY INCREASE BECAUSE THE CAUDATE IS “STICKY”**
 - **ALL THREE AREAS BECOME HYPERACTIVE-A FORM OF “BRAIN LOCK”**

OBSESSIVE-COMPULSIVE DISORDER CIRCUIT

- **MAY CONSIDER GETTING THE PERSON WITH OCD TO RELABEL WHAT IS HAPPENING**
 - **NOT AN ATTACK OF GERMS OR AIDS BUT AN EPISODE OF OCD**
 - **THIS CREATES SOME SEPARATION BY REMINDING THEMSELVES IT IS A FAULTY CIRCUIT**
 - **NEED TO DISTINGUISH BETWEEN THE FORM OF OCD (WORRISOME THOUGHTS AND URGES) AND THE CONTENT OF THE OBSESSION (DANGEROUS GERMS)**
 - **THE MORE ONE FOCUSES ON THE CONTENT THE MORE THE SYMPTOMS INCREASE**

OBSESSIVE-COMPULSIVE DISORDER CIRCUIT

- **THEN HAVE THE PATIENT REFOCUS ON A POSITIVE, WHOLESOME IDEALLY PLEASURABLE ACTIVITY**
 - **EVERY MOMENT YOU THINK OF THE CONTENT YOU STRENGTHEN THE CIRCUIT**
 - **EVERY TIME YOU DO SOMETHING DIFFERENT YOU STRENGTHEN A DIFFERENT CIRCUIT**
 - **“THE MORE YOU DO IT THE MORE YOU WANT TO”**
 - **“THE LESS YOU DO IT THE LESS YOU WANT TO”**

OBSESSIVE-COMPULSIVE DISORDER CIRCUIT

- **ORBITOFRONTAL CORTEX-A DECISION MAKING HUB**
- **BASAL GANGLIA-MEDIATES REWARD FEELINGS AND INITIATES BEHAVIOR**
- **THALAMUS-STIMULUS FILTERING**
- **ANTERIOR CINGULATE-MONITORS MISTAKES AND FOCUSES ATTENTION**

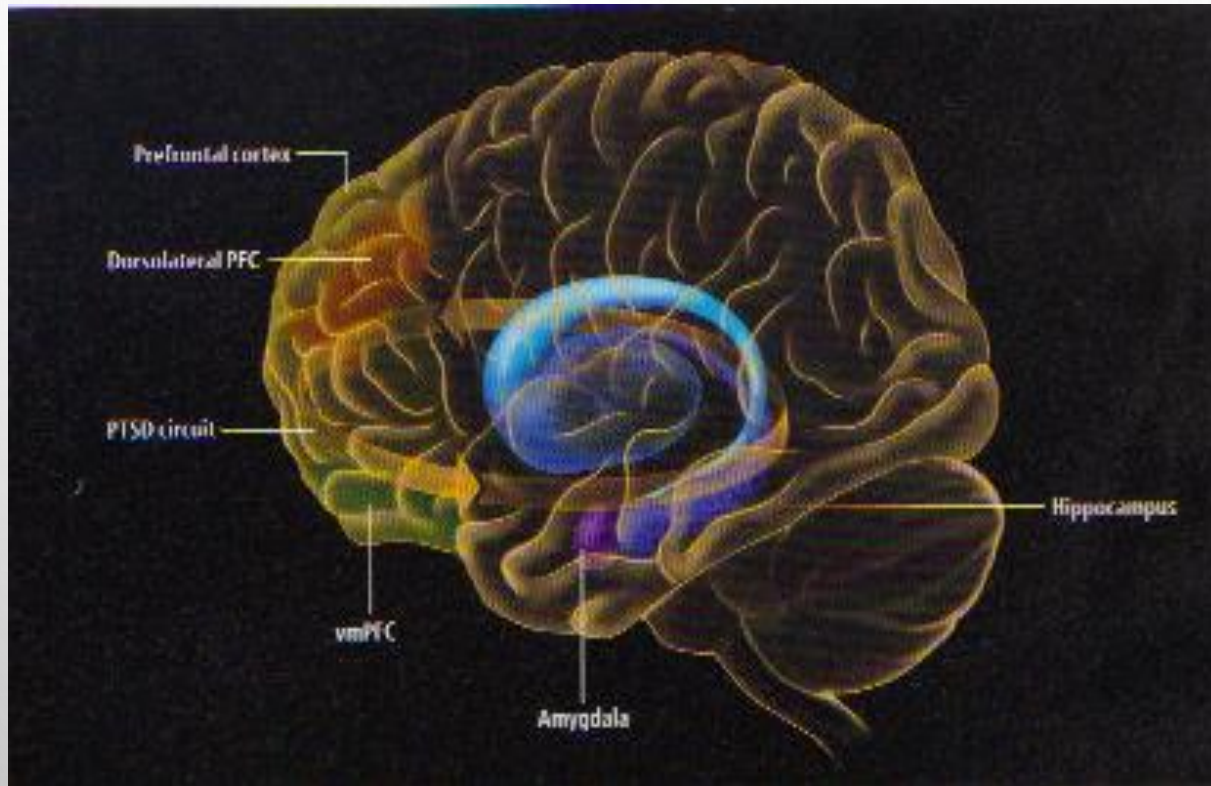
OBSESSIVE-COMPULSIVE DISORDER CIRCUIT

- **INVOLUNTARY MOVEMENTS ORIGINATE IN THE BASAL GANGLIA, A GROUP OF STRUCTURES INVOLVED IN INITIATING AND COORDINATING BASIC MOTOR ACTIONS**
- **THE CAUDATE NUCLEUS OF THE BASAL GANGLIA IS A PART OF THE BRAIN CIRCUIT THAT DRIVES OCD ALONG WITH THE ORBITOFORNAL CORTEX, A REGION CRITICAL TO DECISION MAKING AND MORAL JUDGMENT AND THE THALAMUS WHICH RELAYS AND INTEGRATES SENSORY INFORMATION**
- **OCD SUFFERERS SHOW HYPERACTIVITY IN AREAS OF THE FRONTAL CORTEX AND THE BASAL GANGLIA**

OBSESSIVE-COMPULSIVE DISORDER CIRCUIT

- **WHEN SYMPTOMS IMPROVE-EITHER BY PSYCHOTHERAPY OR MEDICATION-A DECREASE IN ORBITOFRONTAL CORTICAL ACTIVITY IS OBSERVED**
- **IN NON-RESPONSIVE PATIENTS DISCONNECTING THE ORBITOFRONTAL FROM THE CAUDATE NUCLEUS REDUCES SYMPTOMS IN SEVERE OCD**

POST-TRAUMATIC STRESS DISORDER CIRCUIT



POST-TRAUMATIC STRESS DISORDER CIRCUIT

- **MALFUNCTIONING OF THE VENTROMEDIAL PREFRONTAL CORTEX (VMPFC) IS THOUGHT TO INCREASE VULNERABILITY BECAUSE IT MODULATES THE AMYGDALA, A DRIVER OF FEAR AND ANXIETY**
- **NORMALLY EXTINCTION REPLACES A FEAR RESPONSE WHEN A NEUTRAL RESPONSE IS LEARNED BY THE HIPPOCAMPUS AND THE DORSOLATERAL PREFRONTAL CORTEX**
- **THE VMPFC IS BELIEVED TO SERVE AS THE CRITICAL LINK BETWEEN THE DORSOLATERAL PFC AND THE AMYGDALA ALLOWING EXTINCTION LEARNING TO QUIET THE AMYGDALA**

POST-TRAUMATIC STRESS DISORDER CIRCUIT

- **SYMPTOMS SUCH AS DISTURBED SLEEP AND INCREASED VIGILANCE ARE EXPECTED IMMEDIATELY AFTER A TRAUMATIC EVENT**
- **PTSD DEVELOPES WEEKS, MONTHS AND YEARS LATER IN ABOUT 20% OF TRAUMA VICTIMS**
- **EXTINCTION CAN OCCUR VIA REPEATED EXPOSURE TO A PARTICULAR TRAUMA-RELATED MEMORY OR CUE**
- **THE FEAR RESPONSE IS REPLACED BY A NEUTRAL RESPONSE. PTSD CAN BE CONSIDERED A FAILURE OF EXTINCTION**

POST-TRAUMATIC STRESS DISORDER CIRCUIT

- **EVIDENCE SUGGESTS A DYSFUNCTIONAL CIRCUIT MAKES EXTINCTION HARDER TO ACHIEVE**
- **KEY BRAIN HUBS FOR FEAR ARE THE AMYGDALA AND A GALAXY OF ADJACENT CELLS CALLED THE BED NUCLEUS OF THE STRIA TERMINALIS**
- **THESE TWO AREAS DRIVE VIRTUALLY ALL SYMPTOMS OF FEAR INCLUDING RACING HEART, INCREASED SWEATING, FREEZING AND EXAGGERATED STARTLE RESPONSE**

POST-TRAUMATIC STRESS DISORDER CIRCUIT

- **IF AMYGDALA IS THE ENGINE OF FEAR, SOMETHING SHOULD BE RESPONSIBLE FOR TURNING IT OFF**
- **GREG QUIRK AT THE UNIVERSITY OF PUERTO RICO SHOWED A TINY AREA IN THE PREFRONTAL CORTEX OF RODENTS CALLED THE INFRALIMBIC REGION IS CENTRAL TO FEAR EXTINCTION**
- **ACTIVITY IN THIS AREA INCREASES DURING EXTINCTION SERVING AS A BRAKE ON THE AMYGDALA WHILE BLOCKING THE INFRALIMBIC REGION IMPAIRS EXTINCTION**

POST-TRAUMATIC STRESS DISORDER CIRCUIT

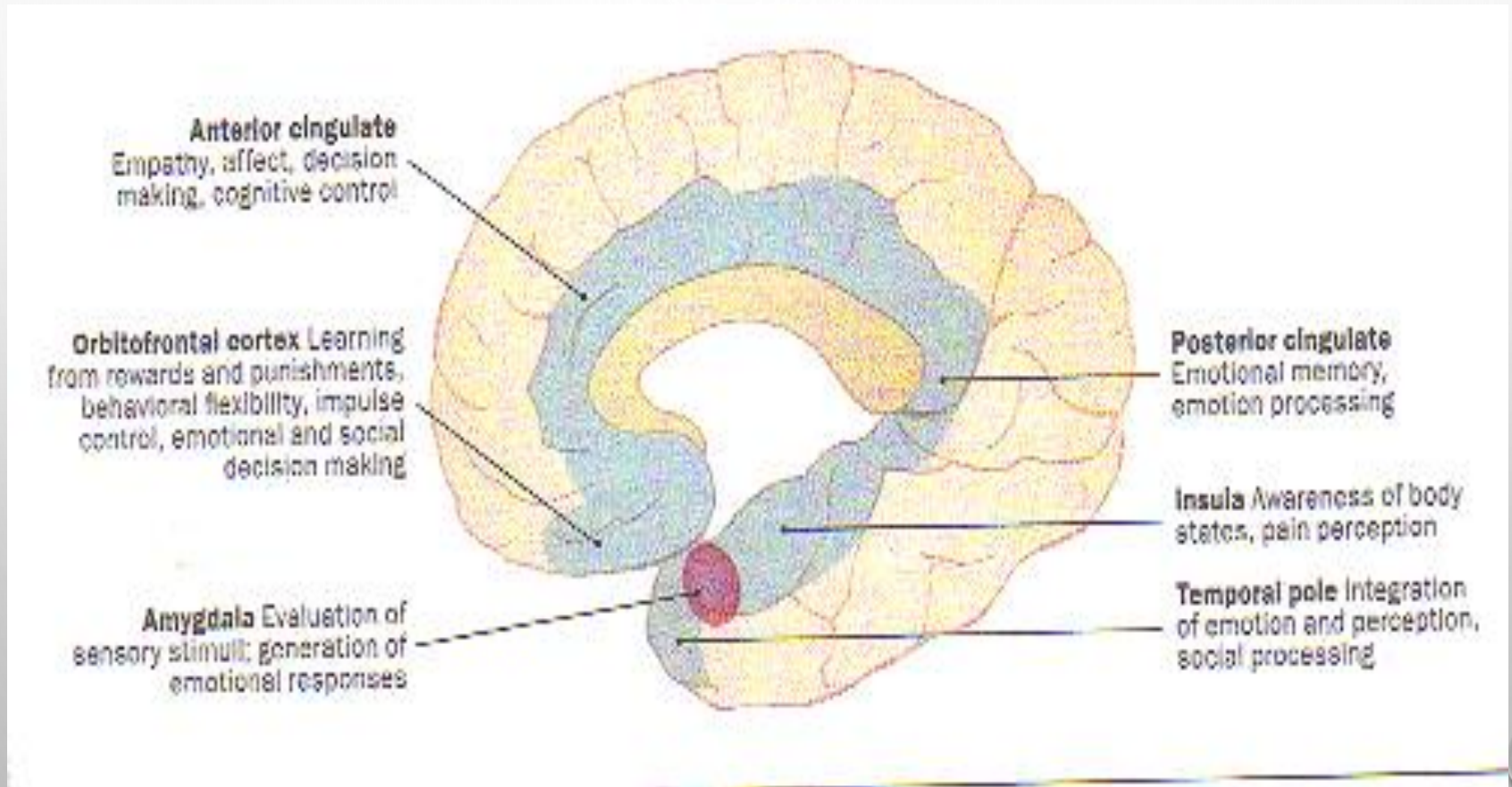
- **IN PTSD, NEUROIMAGING SHOWS REDUCED ACTIVITY IN VMPFC WHICH IS COMPARABLE TO THE RAT'S INFRALIMBIC REGION**
- **THE PATIENTS ALSO HAD SMALLER VMPFC RELATIVE TO TRAUMA –EXPOSED CONTROLS**
- **EXTINCTION INVOLVES INCREASE IN VMPFC ACTIVITY AND REDUCED FIRING OF PFC**

POST-TRAUMATIC STRESS DISORDER CIRCUIT

- **IN COGNITIVE-BEHAVIORAL THERAPY IMAGING SHOWS THE IMPORTANCE OF THE HIPPOCAMPUS FOR ASSESSING CONTEXT AND THE DORSOLATERAL PFC FOR LEARNING TO TOLERATE AND OVERCOME FEAR**
- **THE DORSOLATERAL PFC DOESN'T DIRECTLY CONNECT TO THE AMYGDALA**
- **THE VMPFC IS THOUGHT TO BE THE CRITICAL LINK BETWEEN THE DORSOLATERAL PFC AND AMYGDALA ALLOWING COGNITIVE TREATMENT TO PRODUCE NEW LEARNING AND RECOVERY**

INSEL, THOMAS. "FAULTY CIRCUITS". *SCIENTIFIC AMERICAN*. APRIL 2010, PPGS 44-51.

PARALIMBIC SYSTEM AND ASPD



PARALIMBIC SYSTEM AND ASPD

- **PARALIMBIC SYSTEM IS A CIRCUIT OF INTERCONNECTED BRAIN REGIONS THAT MAY WELL BE THE AREA OF MALFUNCTION IN ASPD**
- **THESE INTERCONNECTED BRAIN REGIONS REGISTER FEELINGS AND OTHER SENSATIONS AND ASSIGN EMOTIONAL VALUE TO EXPERIENCES, AS WELL AS, BEING INVOLVED IN DECISION MAKING, HIGH LEVEL REASONING AND IMPULSE CONTROL**
- **AREA IS UNDERDEVELOPED IN ASPD AND DAMAGE TO THESE AREAS CAN CREATE PSYCHOPANTIC TRAITS**

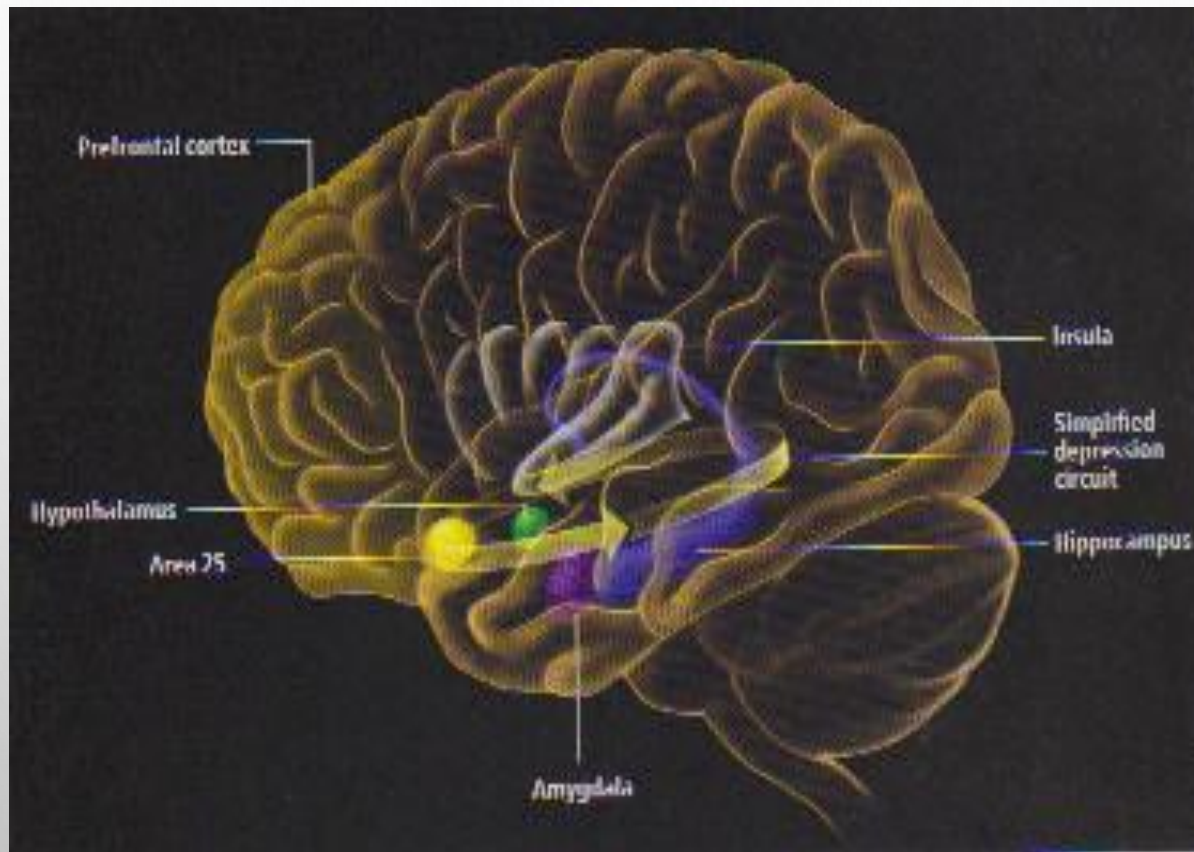
PARALIMBIC SYSTEM AND ASPD

- **OFC INVOLVED IN SOPHISTICATED DECISION-MAKING TASKS THAT INVOLVE SENSITIVITY TO RISK, REWARD AND PUNISHMENT**
- **LEADS TO PROBLEMS OF IMPULSIVITY AND INSIGHT AND LASH OUT IN RESPONSE TO PERCEIVED AFFRONTS**
- **THESE WERE GAGES'S PREDOMINANT SYMPTOMS ALTHOUGH HE STILL POSSESSED EMPATHY**

PARALIMBIC SYSTEM AND ASPD

- **THE ANTERIOR CINGULATE REGULATES EMOTIONAL STATES AND HELPS PEOPLE CONTROL THEIR IMPULSES AND MONITOR THEIR BEHAVIOR FOR MISTAKES**
- **THE INSULA PLAYS A KEY ROLE IN THE RECOGNITION OF VIOLATION OF SOCIAL NORMS, AS WELL AS, THE EXPERIENCING OF ANGER, FEAR, EMPATHY AND DISGUST**
- **INSULA ALSO INVOLVED IN PAIN PERCEPTION AND PSYCHOPATHS ARE STRIKINGLY UNFAZED BY THREAT OF PAIN**

DEPRESSION CIRCUIT



DEPRESSION CIRCUIT

- **BRODMANN AREA 25 ACTS AS A HUB OF THE DEPRESSION CIRCUIT**
- **AREA 25 CONNECTS DIRECTLY TO THE AMYGDALA WHICH MEDIATES ANXIETY AND FEAR, AND THE HYPOTHALAMUS INVOLVED IN STRESS REPOSES**
- **THESE REGIONS EXCHANGE SIGNALS WITH THE HIPPOCAMPUS, A CENTER OF MEMORY PROCESSING, AND THE INSULA WHERE SENSORY PERCEPTION AND EMOTIONS ARE PROCESSED**
- **A SMALLER AREA 25 IS SUSPECTED OF CREATING A HIGHER RISK OF DEPRESSION IN PEOPLE WITH A GENE VARIANT THAT INHIBITS SEROTONIN PROCESSING**

DEPRESSION CIRCUIT

- **HELEN MAYBERG AT EMORY HAS SHOWN AREA 25 IS OVERLY ACTIVE IN DEPRESSED PATIENTS AND SYMPTOM IMPROVEMENT IS CORRELATED WITH REDUCED ACTIVITY**
- **AREA 25 IS EXCEPTIONALLY RICH IN SEROTONIN TRANSPORTERS AND THOSE WITH A SHORT VARIANT OF THE SEOTONIN TRANSPORTER GENE HAVE A RELATIVE “UNCOUPLING” WITH SUBCORTICAL AREAS AND ALSO CONNECTION WITH FRONTAL CORTEX THAT DISTURBS INSIGHT AND SELF-ESTEEM. CAN LEAD TO DISTORTED ASSESSMENT OF THE INTERNAL AND EXTERNAL WORLD**

DEPRESSION CIRCUIT

- **“UNCOUPLING” CAUSES DISRUPTED CONNECTIONS WITH...**
 - **HYPOTHALAMUS**
 - ***CHANGES IN APPETITE***
 - ***CHANGES IN SLEEP***
 - ***CHANGES IN ENERGY***
 - **AMYGDALA AND INSULA**
 - ***ANXIETY***
 - ***MOOD CHANGES***
 - **HIPPOCAMPUS**
 - ***MEMORY PROCESSING***
 - ***ATTENTION***

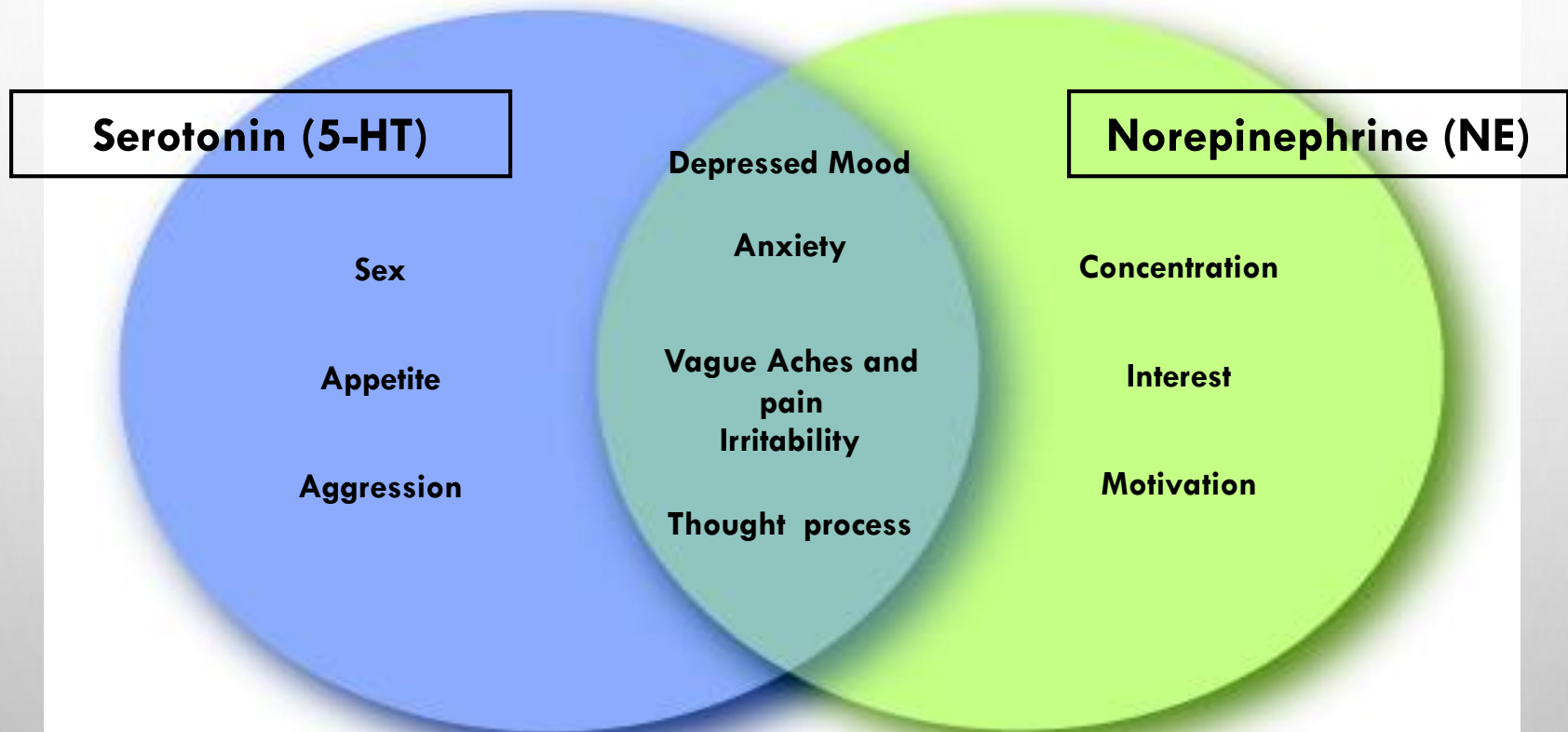
DEPRESSION. IT'S NOT ONLY A STATE OF MIND.

The symptoms of depression

Emotional Symptoms Include:	Physical Symptoms Include:
Sadness	Vague aches and pains
Loss of interest or pleasure	Headache
Overwhelmed	Sleep disturbances
Anxiety	Fatigue
Diminished ability to think or concentrate, indecisiveness	Back pain
Excessive or inappropriate guilt	Significant change in appetite resulting in weight loss or gain

THERE ARE AT LEAST TWO SIDES TO THE NEUROTRANSMITTER STORY

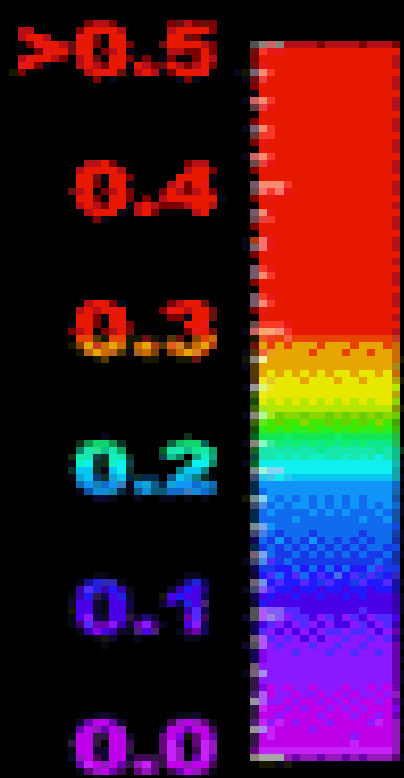
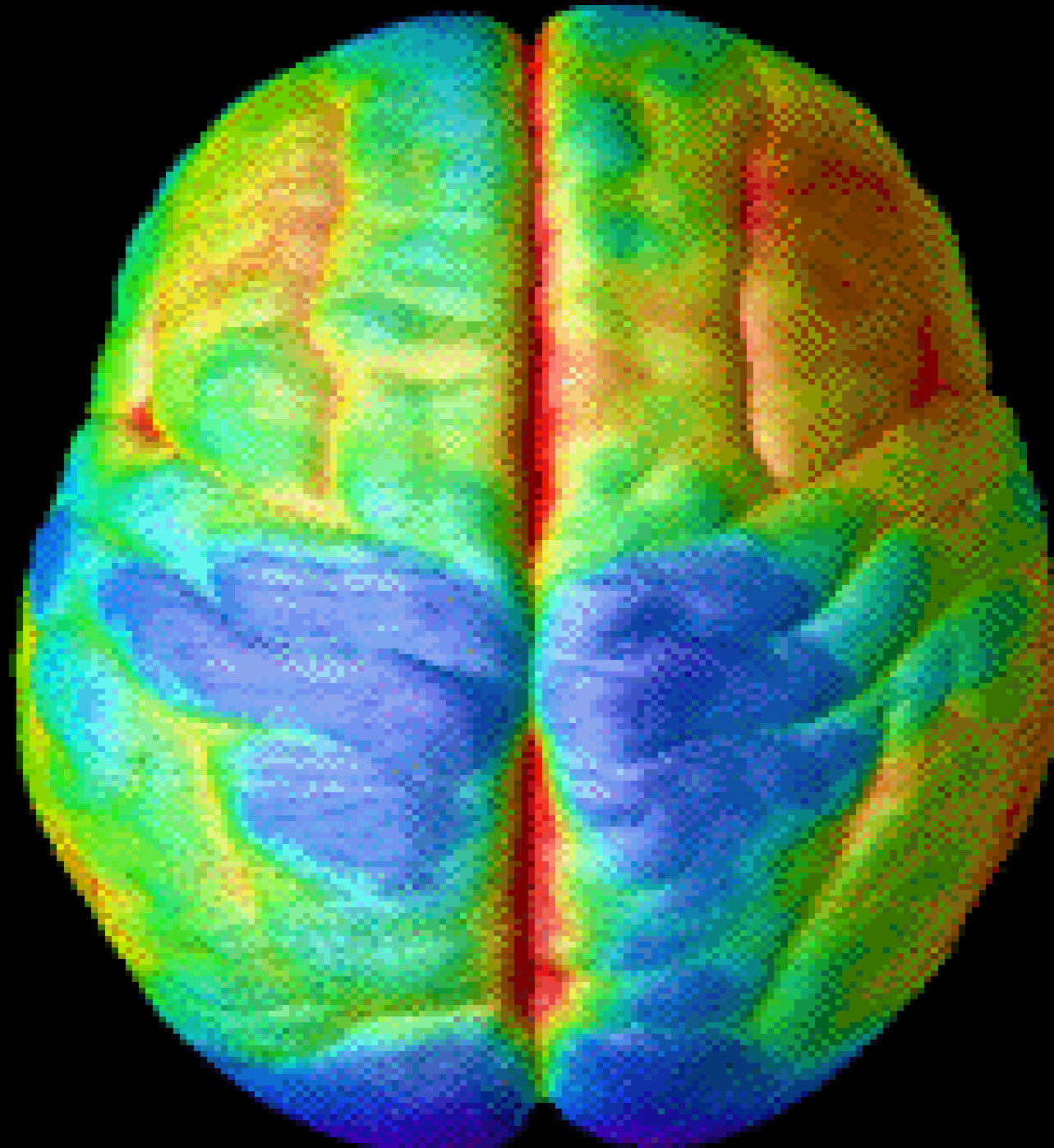
Functional domains of Serotonin and Norepinephrine¹⁻⁴



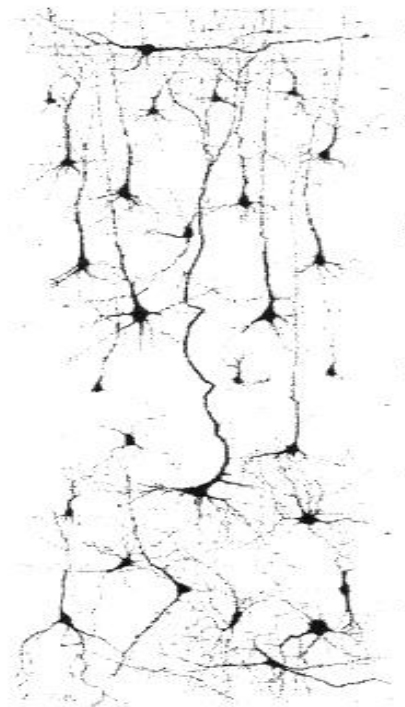
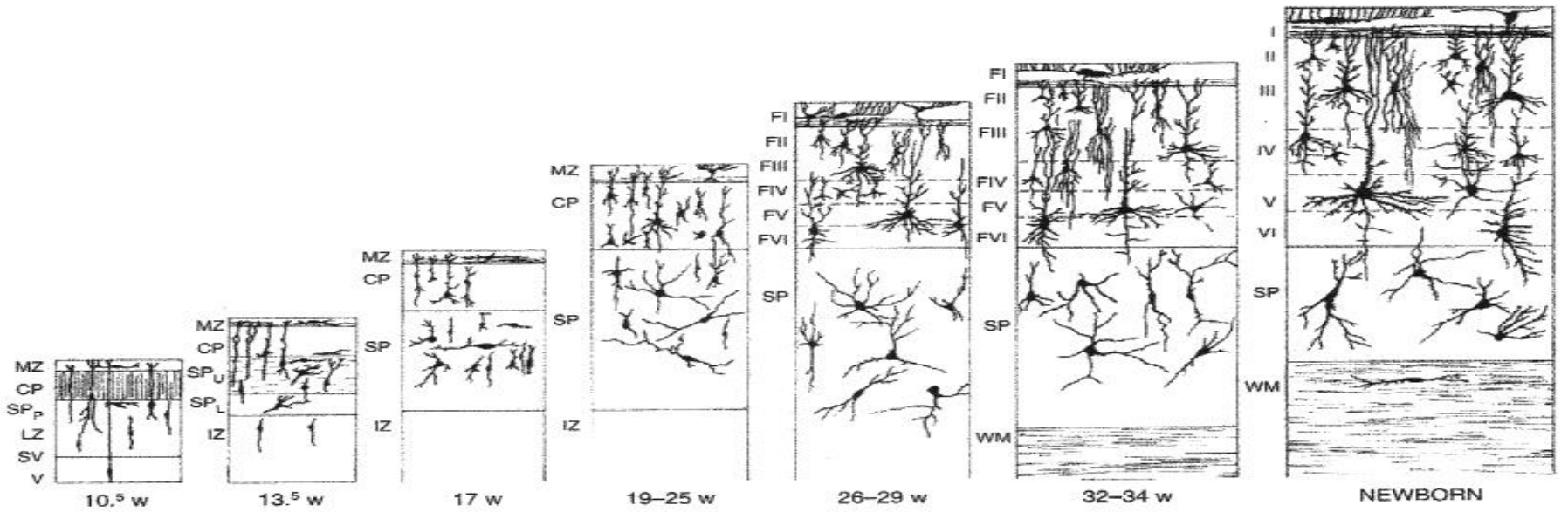
- **BOTH SEROTONIN AND NOREPINEPHRINE MEDIATE A BROAD SPECTRUM OF DEPRESSIVE SYMPTOMS**

BRAIN DEVELOPMENT

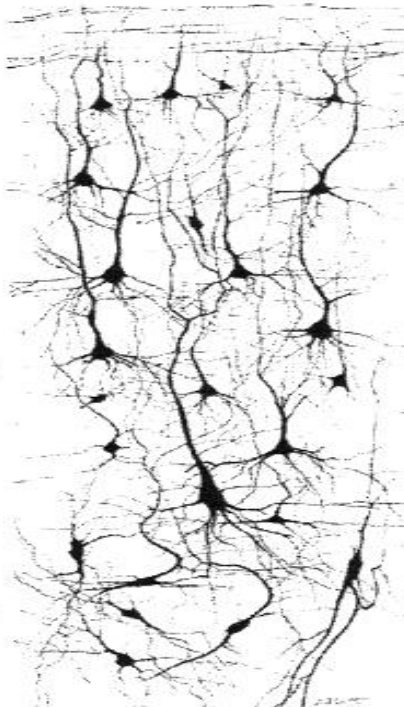
- **LOWER BRAIN MOSTLY BORN INTACT**
- **PREFRONTAL CORTEX (PFC) PLASTIC ESPECIALLY BETWEEN 0-5 AND 10-20 YEARS OF AGE**
- **PFC TAKES UP TO 25 YEARS TO DEVELOP**
- ***DEVELOPMENTAL DELAYS OCCUR SECONDARY TO EARLY LIFE TRAUMA AND EARLY ONSET ALCOHOL/DRUG ABUSE.***
- **PFC CRITICAL TO BECOMING RESILIENT**



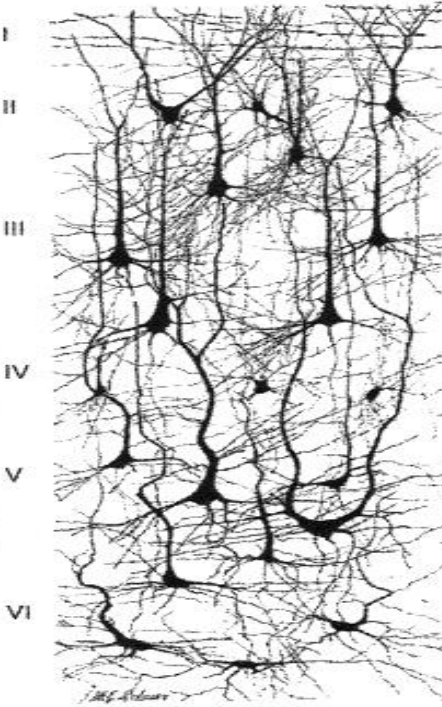
**Gray Matter
Volume**



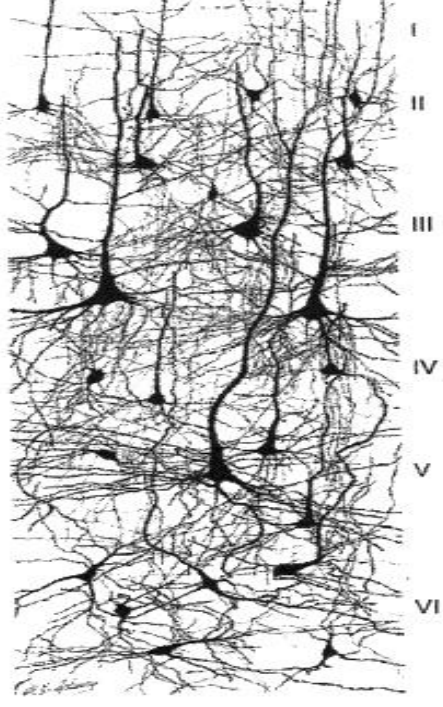
3 mo.



6 mo.



15 mo.



24 mo.

RESILIENCE AND THE PFC

- WHAT CAN WE TREAT?

Cognition

Affect

PEER AND PARENTAL
RELATIONSHIPS

BALANCE BETWEEN FRONTAL AND LIMBIC SYSTEMS CHANGES

- **PREFRONTAL LOBE CIRCUITRY INCREASES**
 - **SOME ABILITY TO DELAY GRATIFICATION**
 - **INITIAL DEVELOPMENT OF EXECUTIVE FUNCTIONING**
 - **PROBLEM SOLVING**
 - **ABSTRACTION**
 - **CONCEPTUALIZATION**
 - **JUDGMENT**





MODULATION RATIO

- IN ORDER TO USE THE COGNITIVE AND BEHAVIORAL STRATEGIES
WANT STUDENT TO HAVE:

INHIBITION

EXCITATION

WHAT CHANGES MODULATION RATIO AND INCREASES RISK OF ANGER AND AGGRESSION?

- **ANYTHING THAT**  **EXCITATION IN THE LOWERS AREAS OF THE BRAIN (BRAINSTEM AND DIENCEPHALON)**
- **ANYTHING THAT**  **INHIBITION IN THE AREAS OF HIGHER BRAIN FUNCTION (NEOCORTEX AND LIMBIC SYSTEM)**

LEFT/RIGHT BRAIN

- **LEFT HEMISPHERE**
 - **CONSCIOUS**
 - **SERIAL**
 - **INFORMATION PROCESSING**
- **RIGHT HEMISPHERE**
 - **UNCONSCIOUS**
 - **NONVERBAL**
 - **EMOTIONAL PROCESSING**

RIGHT HEMISPHERE

- **EARLY DEVELOPMENTAL UNCONSCIOUS**
- **EMOTIONAL “SELF”**
- **80-90% IS UNCONSCIOUS**
- **THE ABOVE DRIVES OR MOTIVATES HUMAN EMOTION**
- **HUMAN EMOTION IS THE DRIVING FORCE BEHIND COGNITION AND BEHAVIOR**
- **EMOTION IS MEDIUM IN WHICH PRIMARY INTERPERSONAL INFORMATION IS TRANSMITTED**

RIGHT HEMISPHERE (RH)


- **RECOGNITION AND EXPRESSION OF EMOTION**
- **NONVERBAL EMOTIONAL EXPRESSION**
- **RH TO RH AFFECTIVE COMMUNICATION
EQUALS THE RELATIONAL UNCONSCIOUS**
- **UNCONSCIOUS RH IMPLICIT SELF
CONTINUOUSLY APPRAISES LIFE EXPERIENCES
AND RESPONDS ACCORDING TO ITS SCHEME
OF INTERPRETATION**

THE PREFRONTAL CORTEX

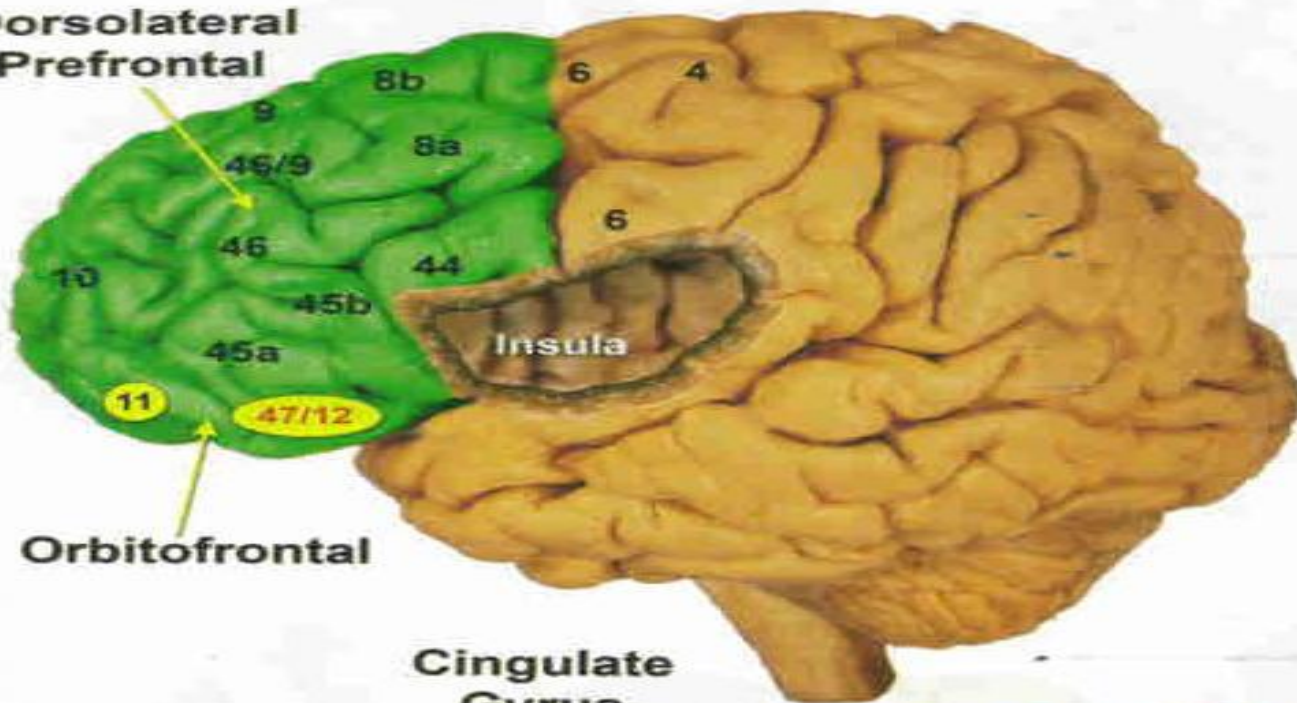
- **ANTERIOR CINGULATE CORTEX**
- **ORBITOFRONTAL CORTEX**
- **DORSOLATERAL PREFRONTAL CORTEX**
- *THERAPIST TASK-OPTIMIZE PLASTICITY*



• **DORSOLATERAL PREFRONTAL CORTEX**

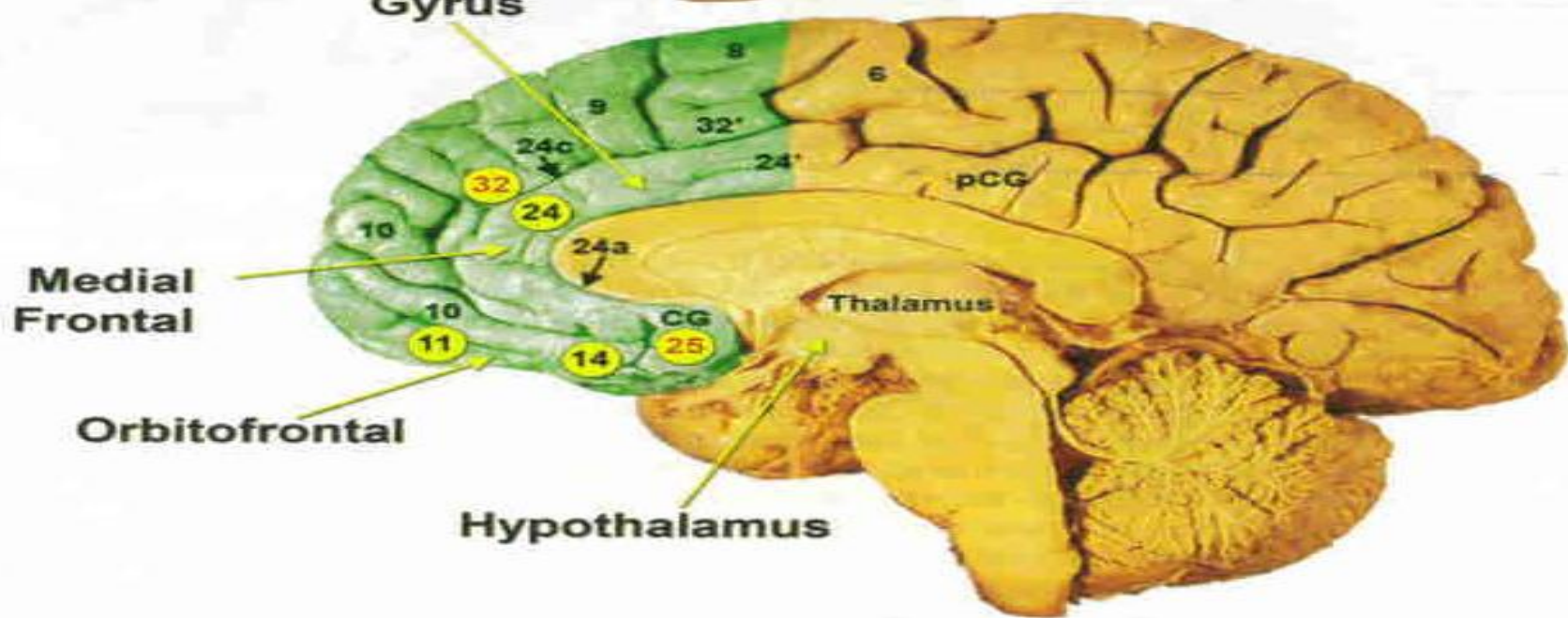
- **ENTRY POINT FOR VERBAL PSYCHOTHERAPY**
 - **ESSENTIAL FOR ADVANCED REASONING**
 - **MODULATION OF BEHAVIOR THRU USE OF WORDS**
- 

Dorsolateral Prefrontal



Orbitofrontal

Cingulate Gyrus



Medial Frontal

Orbitofrontal

Hypothalamus

DORSOLATERAL PREFRONTAL CORTEX

- **DORSOLATERAL PREFRONTAL CIRCUIT**
 - *MODULATES EXECUTIVE FUNCTIONS*
 - **ORGANIZATION**
 - **PROBLEM SOLVING**
 - **WORKING MEMORY**
 - **MEMORY RETRIEVAL**
 - **SELF-DIRECTEDNESS**
 - **ABILITY TO ADDRESS NOVELTY**
 - **USE OF LANGUAGE TO GUIDE BEHAVIOR**

EXECUTIVE FUNCTIONS

- ***ABSTRACT THINKING***
 - **DISCERNING RELATIONSHIPS**
 - **“SEEING THE FOREST FOR THE TREES”**
- ***ATTENTION SHIFTING***
 - **ABILITY TO SHIFT ATTENTION WHEN NEEDED**
- ***INFORMATION MANIPULATION***
 - **MANIPULATE INFORMATION IN SHORT-TERM MEMORY**

EXECUTIVE FUNCTIONS

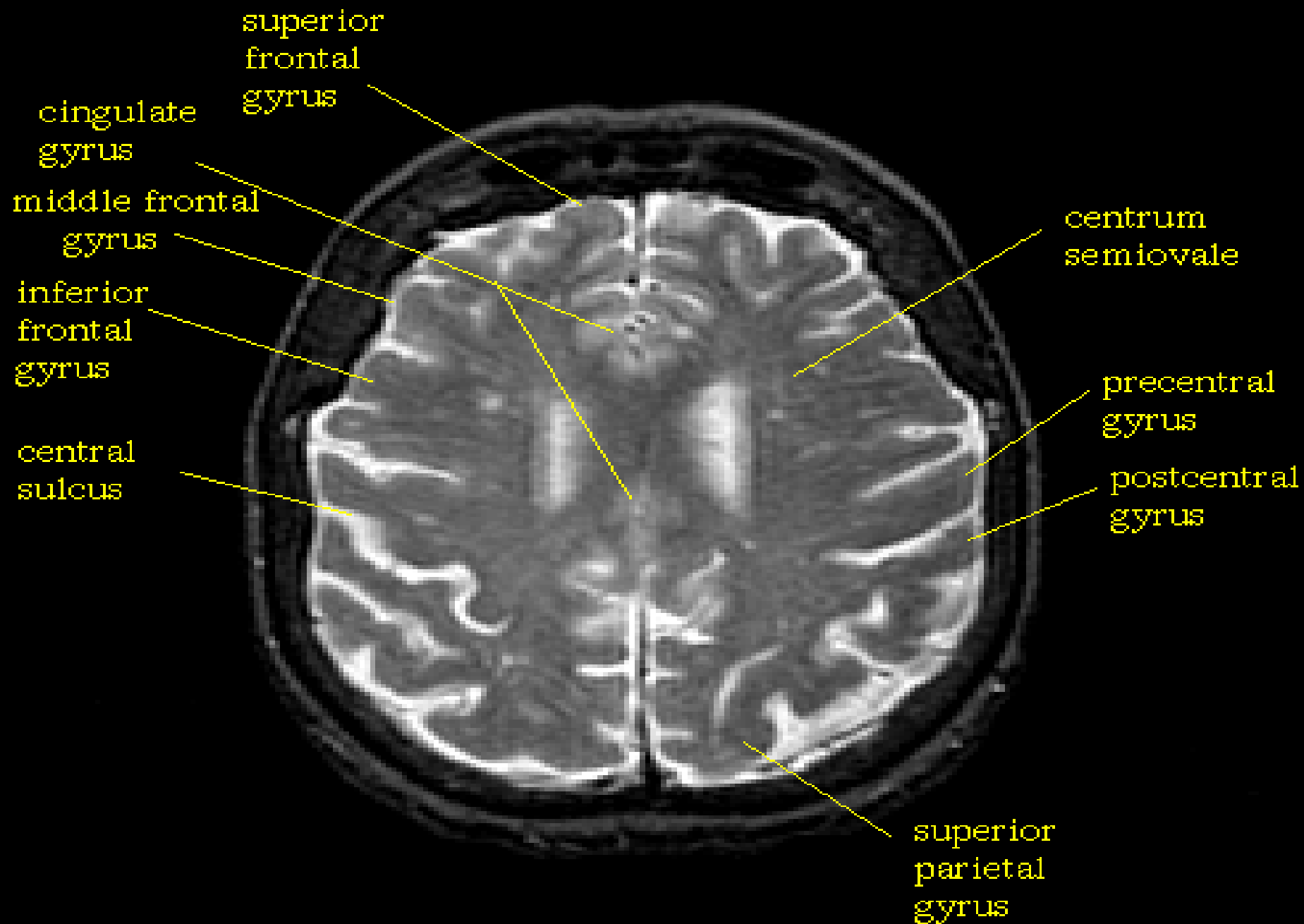
- ***PLANNING AND FORESIGHT***
 - **FORMING A MENTAL MODEL OF A FUTURE EVENT OR SITUATION**
- ***MONITORING AND ERROR CORRECTION***
 - **ENGAGED WHEN RESULTS DO NOT MATCH INTENTIONS**
- ***DECISION MAKING***
 - **WEIGH OPTIONS, ARRIVE AT A DECISION AND SEE IT THROUGH**

EXECUTIVE FUNCTIONS

- ***INHIBITION***
 - **ABILITY TO INHIBIT IMPULSES AND DELAY GRATIFICATION**
- ***SOCIAL FUNCTIONING***
 - **APPROPRIATE PROCESSING OF SOCIAL CUES**

ANTERIOR CINGULATE

- ***ANTERIOR CINGULATE CIRCUIT***
 - **MOTIVATES GOAL-DIRECTED BEHAVIOR**
 - **CONFLICT MONITORING**
 - **COMPONENT OF REWARD CIRCUITRY**
 - **EMOTIONAL-COGNITIVE INTEGRATION**
 - **PLAYS A PART IN EXPERIENCE OF EMPATHY**
- **IF DAMAGED-APATHY**



ANTERIOR CINGULATE

- **COORDINATES**
 - *MATERNAL BEHAVIOR*
 - *NURSING*
 - *PLAY*
- **MONITORS PERSONAL, ENVIRONMENTAL AND INTERPERSONAL INFORMATION**
- **HELPS REGULATE EMOTION AND PAIN**
- **ALLOCATES ATTENTION TO WHATEVER IS MOST SALIENT**

ANTERIOR CINGULATE

- **COCAINE CRAVING**
 - **INCREASES ACTIVATION OF THE ANTERIOR CINGULATE WHICH CONTROLS**
 - *MATERNAL BEHAVIOR*
 - *NURTURANCE*
 - *BONDING*
- **SUBSTANCE ABUSERS MAY SEEK TO SATISFY INTIMACY NEEDS BY MANIPULATING THE NEUROBIOLOGY OF ATTACHMENT**

ANTERIOR CINGULATE

- **DETECTION OF ERRORS**
- **ADJUSTMENT OF RESPONSE ACCORDING TO NEW INFORMATION**
- **CLIENTS WITH ALEXYTHYMIA (INABILITY TO EXPERIENCE OR EXPRESS FEELINGS) HAVE SMALLER ANTERIOR CINGULATE CORTICES**
- **LARGER ANTERIOR CORTICES ASSOCIATED WITH WORRY AND FEARFULNESS**
- **ANTERIOR CINGULATE HAS OVERLAPPING FUNCTIONS WITH OTHER PREFRONTAL CORTICES**

SPINDLE CELLS

- IN ANTERIOR CINGULATE AND INSULA
- SPINDLE CELLS (VON ECONOMO CELLS) APPEAR TO PLAY A CENTRAL ROLE IN THE DEVELOPMENT OF *INTELLIGENT BEHAVIOR AND ADAPTIVE RESPONSE TO CHANGING CONDITIONS* AND COGNITIVE DISSONANCE. THEY BECOME WIDELY CONNECTED WITH DIVERSE PARTS OF THE BRAIN, INDICATING THEIR ESSENTIAL CONTRIBUTIONS TO THE SUPERIOR CAPACITY OF HOMINIDS TO FOCUS ON DIFFICULT PROBLEMS.
- SPINDLE CELLS EMERGE AFTER BIRTH AND ARE EXPERIENCE-DEPENDENT
- *EARLY NEGLECT AND ABUSE NEGATIVELY IMPACT DEVELOPMENT CAUSING DEFICITS IN ANTERIOR CINGULATE ABILITIES*

SPINDLE CELLS

- **AUTISM**

- **INVOLVES THEORY OF MIND WHICH EMERGES AROUND 4 YO**
- **IF CANNOT FIGURE OUT OTHER PEOPLE SOCIAL INTERACTIONS ARE BAFFLING**
- **DON'T LOOK AT THE OTHERS FACE, DON'T COPY. DON'T MIMIC AND DON'T YAWN WHEN OTHERS AROUND THEM DO**

SPINDLE CELLS

- **AUTISM**
 - **AREAS OF THE INSULA AND ANTERIOR CINGULATE WHICH ARE ACTIVATED BY SOCIAL INTERACTION ARE RELATIVELY INACTIVE IN AUTISM**
 - **MAY INVOLVE SPINDLE NEURONS WHICH ARE FOUND ONLY IN THE TWO ABOVE AREAS**
 - **THESE NEURONS KEEP TRACK OF SOCIAL EXPERIENCES AND PROVIDE BASIS FOR INTUITIVE SOCIAL LEARNING WHEN WE WATCH AND COPY OTHERS**
 - **SCIENTIFIC AM MIND. MARCH/APRIL 2011, PG 16-17.**

ANTERIOR CINGULATE DEFICITS

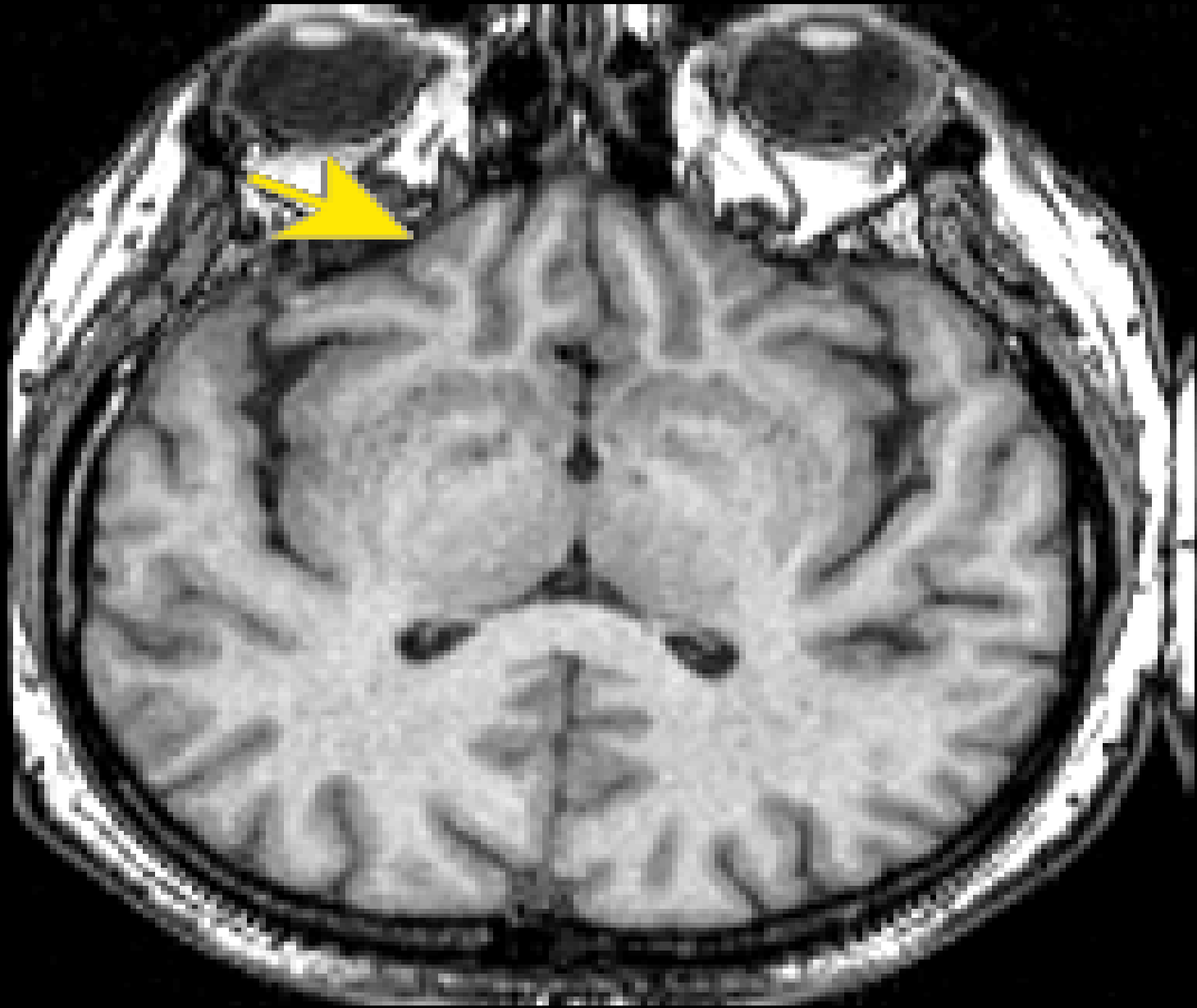
- **DECREASED MATERNAL BEHAVIOR**
- ***DECREASED EMPATHY***
- **DECREASED EMOTIONAL STABILITY**
- **DISRUPTION OF AUTONOMIC NERVOUS SYSTEM (ANS) AND HYPOTHALAMIC-PITUITARY-ADRENAL (HPA) FUNCTIONING**
- **INCREASED RESPONSE TO STRESS**
- **DECREASED EXPRESSIVENESS**
- **INAPPROPRIATE SOCIAL BEHAVIOR**
- **IMPULSIVENESS**

EMPATHY ALSO...

- **REQUIRES**
 - *CONCEPTUAL UNDERSTANDING*
 - *EMOTIONAL ATTUNEMENT*
 - *ABILITY TO REGULATE AFFECT*
- **DAMAGE TO ORBITO FRONTAL CORTEX**
 - **IMPAIRS EMOTIONAL RESONANCE**
- **DAMAGE TO DORSOLATERAL PFC**
 - **LOSS OF COGNITIVE FLEXIBILITY**
- **ACQUIRED PSEUDOPSYCHOPATHIC PERSONALITY**

ORBITOFRONTAL CORTEX

- **ORBITOFRONTAL CIRCUIT**
 - **MODULATES PURSUIT OF REWARD**
 - **RISK**
 - **CONTEXT**
 - **POTENTIAL CONSEQUENCES**
 - **IN CONJUNCTION WITH AMYGDALA CAN STIMULATE OR INHIBIT ANS**
 - ***IF DAMAGED-IMPULSIVITY, SOCIAL INAPPROPRIATENESS, DISREGARD FOR RULES AND CONSEQUENCES***



ORBITOFRONTAL CORTEX

- ***SENIOR EXECUTIVE OF THE EMOTIONAL BRAIN***
- ***REGULATES INTERPERSONAL AND SOCIAL BEHAVIOR***
- ***DIRECTLY CONNECTS TO ALL AREAS OF THE BRAIN***
 - ***BRAIN STEM***
 - ***LIMBIC SYSTEM***
 - ***CEREBRAL CORTEX***
 - ***RIGHT HEMISPHERE SPECIALIZES IN INHIBITORY CONTROL***

ORBITOFRONTAL CORTEX

- **MODULATES INSTINCTIVE BEHAVIOR AND INTERNAL DRIVES**
- ***PROCESSES FACE AND VOICE INFORMATION FOR APPRAISAL OF EXTERNAL ENVIRONMENT***
- **THEREFORE, INTEGRATES EXTERNAL AND INTERNAL ENVIRONMENT**
- **EARLY DEVELOPMENTAL TRAUMA HAS NEGATIVE IMPACT ON OFC**

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