Interpersonal Neurobiology, the Brain, Psychotherapy, Brain Plasticity/Neuroplasticity, the Mind vs the Brain, and Consciousness

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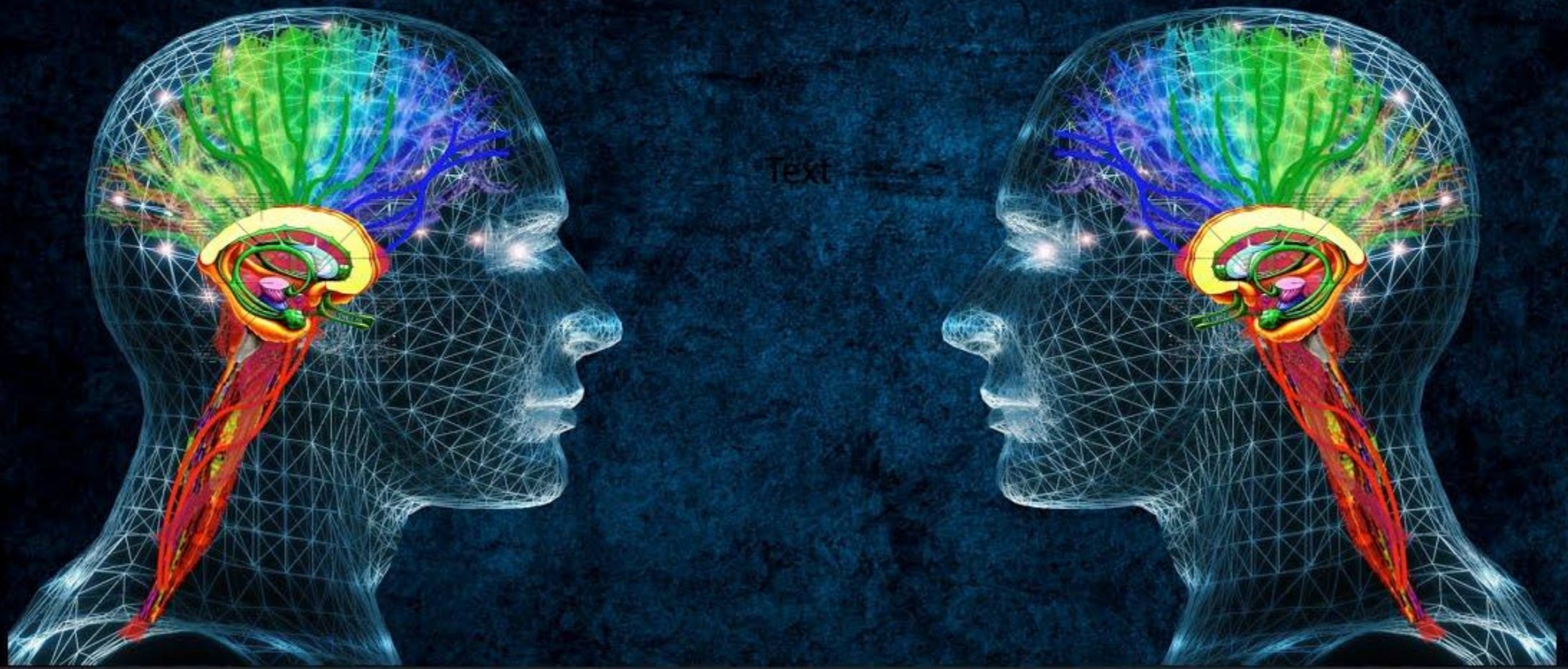
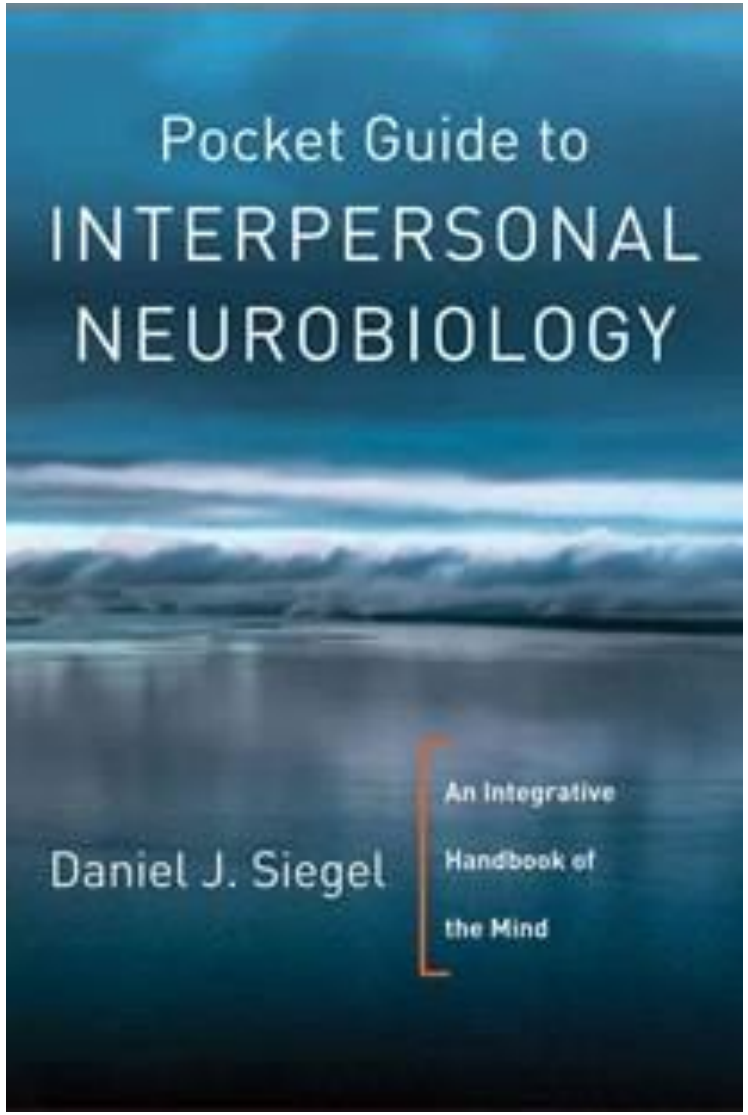
Interpersonal Neurobiology (IPNB) is just a fancy way of saying that the brain is a social organ of the body… Relationships are our life's blood, and this is what gives us resilience, not only as individuals, but as a collective community" – Dr. Dan Siegel M.D.

INTERPERSONAL NEUROBIOLOGY

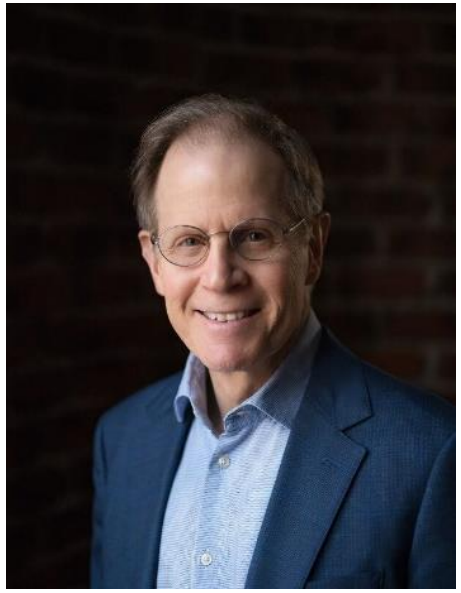




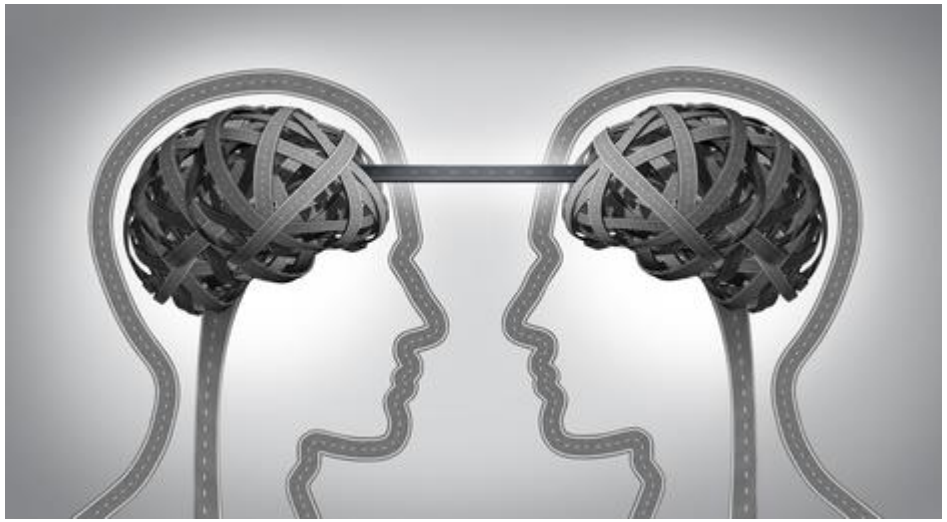
Interpersonal Neurobiology

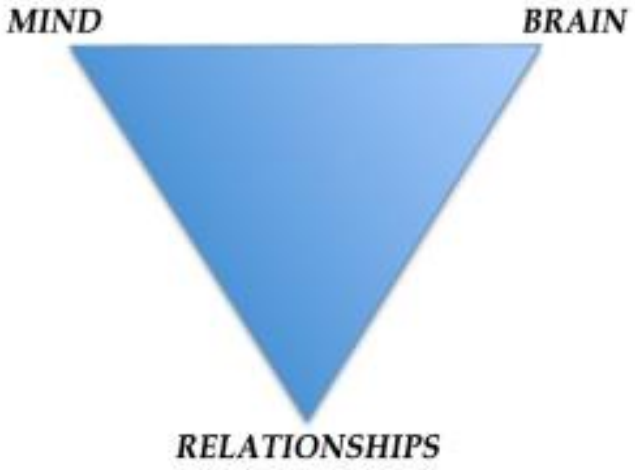
Interpersonal neurobiology (IPNB) is a term coined by Dr. Dan Siegel in his book *The Developing Mind* (1999), as an interdisciplinary field which seeks to understand the mind and mental health.

IPNB is primarily a theory and practical working model which describes human development and functioning as being a product of the relationship between the body, mind and relationships.



Dr. Siegel is a Clinical Professor of Psychiatry at the UCLA School of Medicine and the founding co-director of the Mindful Awareness Research Center at UCLA. An award-winning educator, he is a Distinguished Fellow of the American Psychiatric Association and recipient of several honorary fellowships. Dr. Siegel is also the Executive Director of the Mindsight Institute, an educational organization, which offers online learning and in-person seminars that focus on how the development of mindsight in individuals, families and communities can be enhanced by examining the interface of human relationships and basic biological processes. His psychotherapy practice includes children, adolescents, adults, couples, and families. He serves as the Medical Director of the LifeSpan Learning Institute and on the Advisory Board of the Blue School in New York City, which has built its curriculum around Dr. Siegel's Mindsight approach.





Interpersonal Neurobiology (Cont.)

IPNB explores the brain property of **“emergence”** – the brain’s capacity to learn and grow. This includes appreciating how somatic and mindfulness-based techniques help individuals to tap into this emergence to build self-awareness, self-regulation, and freedom from rigidity and chaos.

The brain is always in a process of working towards integration. According to Dr. Siegel, integration is viewed as the core mechanism in the cultivation of well-being and healing.

Another major concept in IPNB is the concept of **“neuroplasticity”**, which entails the rewiring of the brain through the use of mindfulness practices, or, what Dr. Dan Siegel refers to as **“Mindsight”.**

At its core, IPNB is based on attachment theory, and holds that we are ultimately who we are because of our relationships. We simply can’t grow and evolve without intimate relationships.

Brain Basics

- **Size:**
  - 1. 3 Kg (3 pounds) of tofu-like tissue
  - 1.1 trillion brain cells
  - 100 billion “gray matter" neurons
- **Activity:**
  - Always on 24/7/365 - Instant access to information on demand
  - 20-25% of blood flow, oxygen, and glucose
- **Speed:**
  - Neurons firing around 5 to 50 times a second (or faster)
  - Signals crossing your brain in a tenth of a second
- **Connectivity:**
  - Typical neuron makes ~ 5000 connections with other neurons: ~ 500 trillion synapses
- **Complexity:**
  - Potentially 10 to the millionth power brain states

Our Three Brains

Rational or Thinking Brain
(Neocortex)

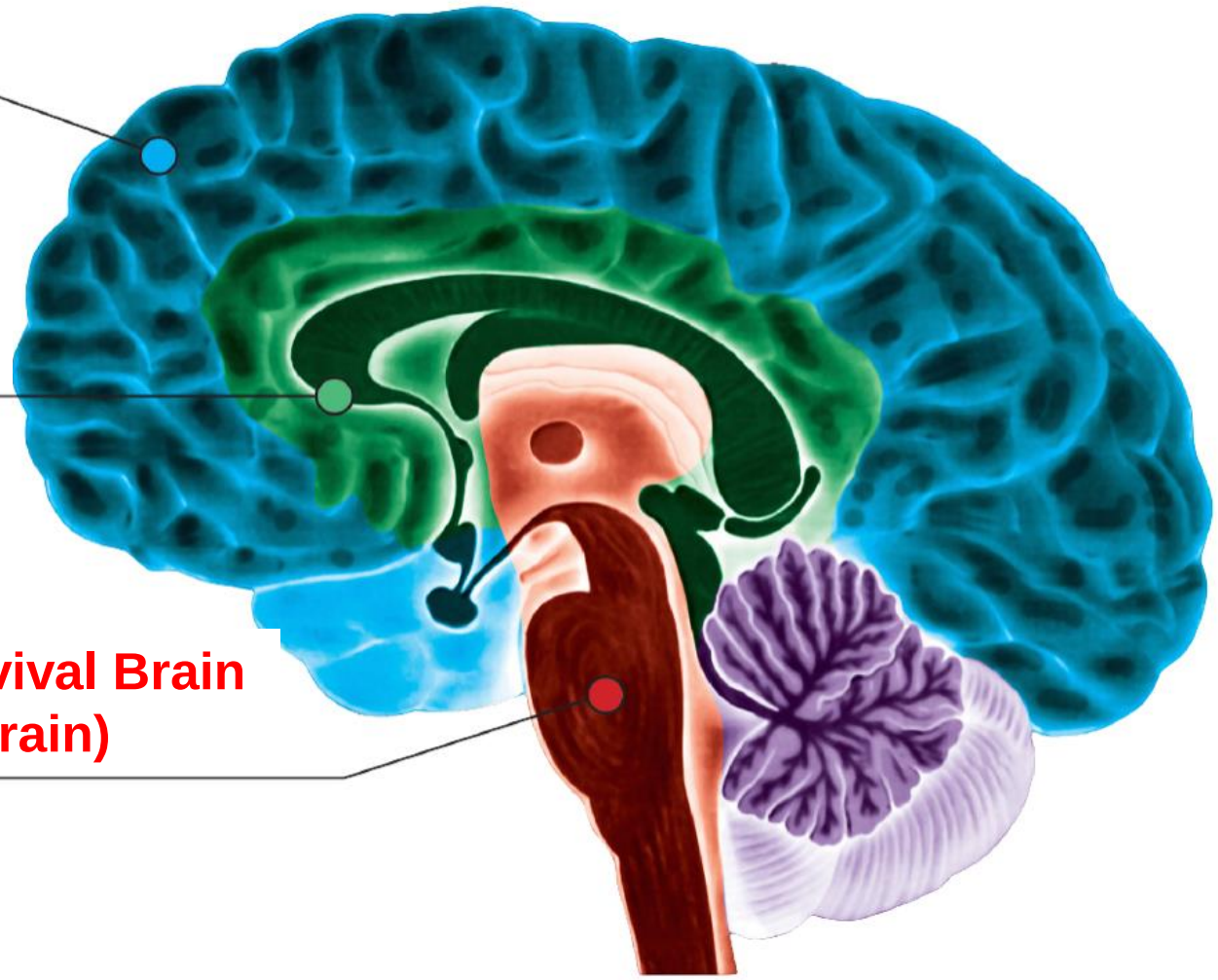
2 to 3-million-year-old

Emotional or
Feeling Brain
(Limbic System)

150-million-year-old

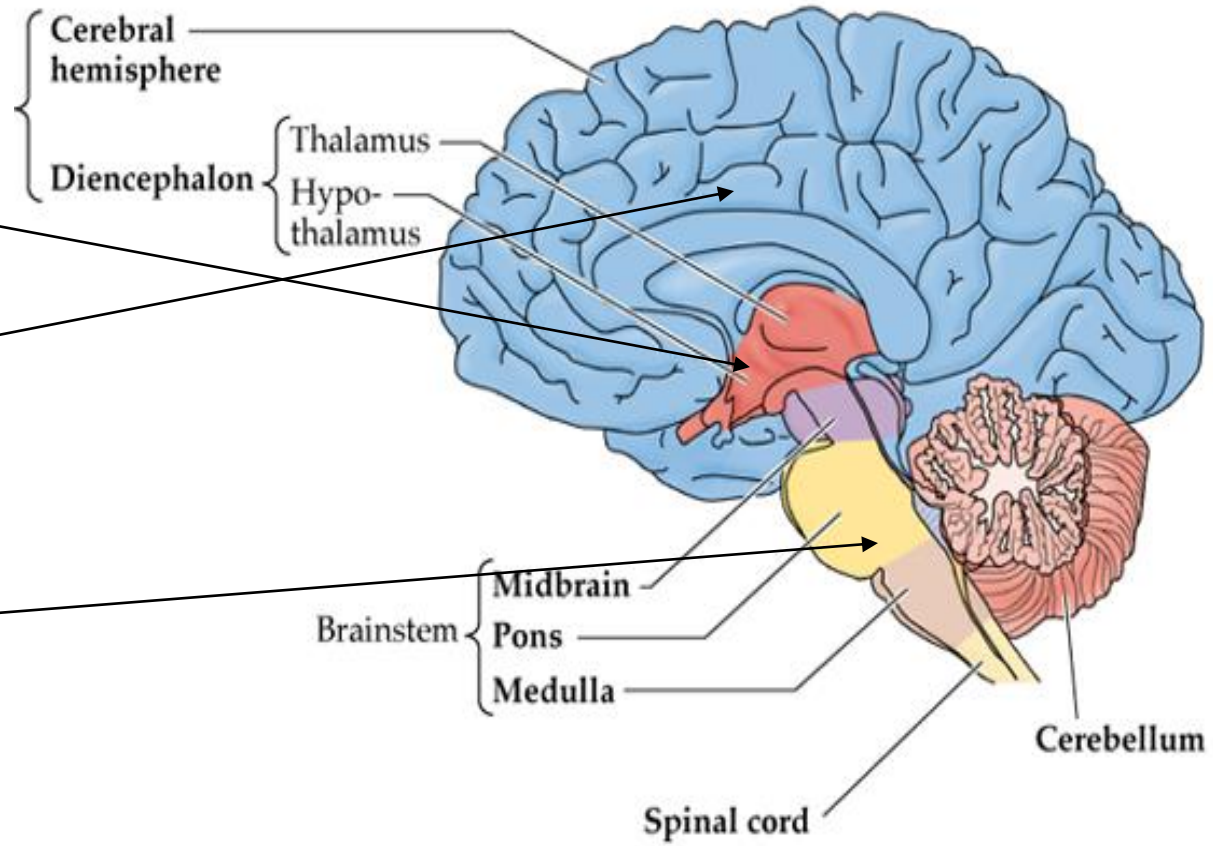
Instinctual or Survival Brain
(Basic/Reptilian Brain)

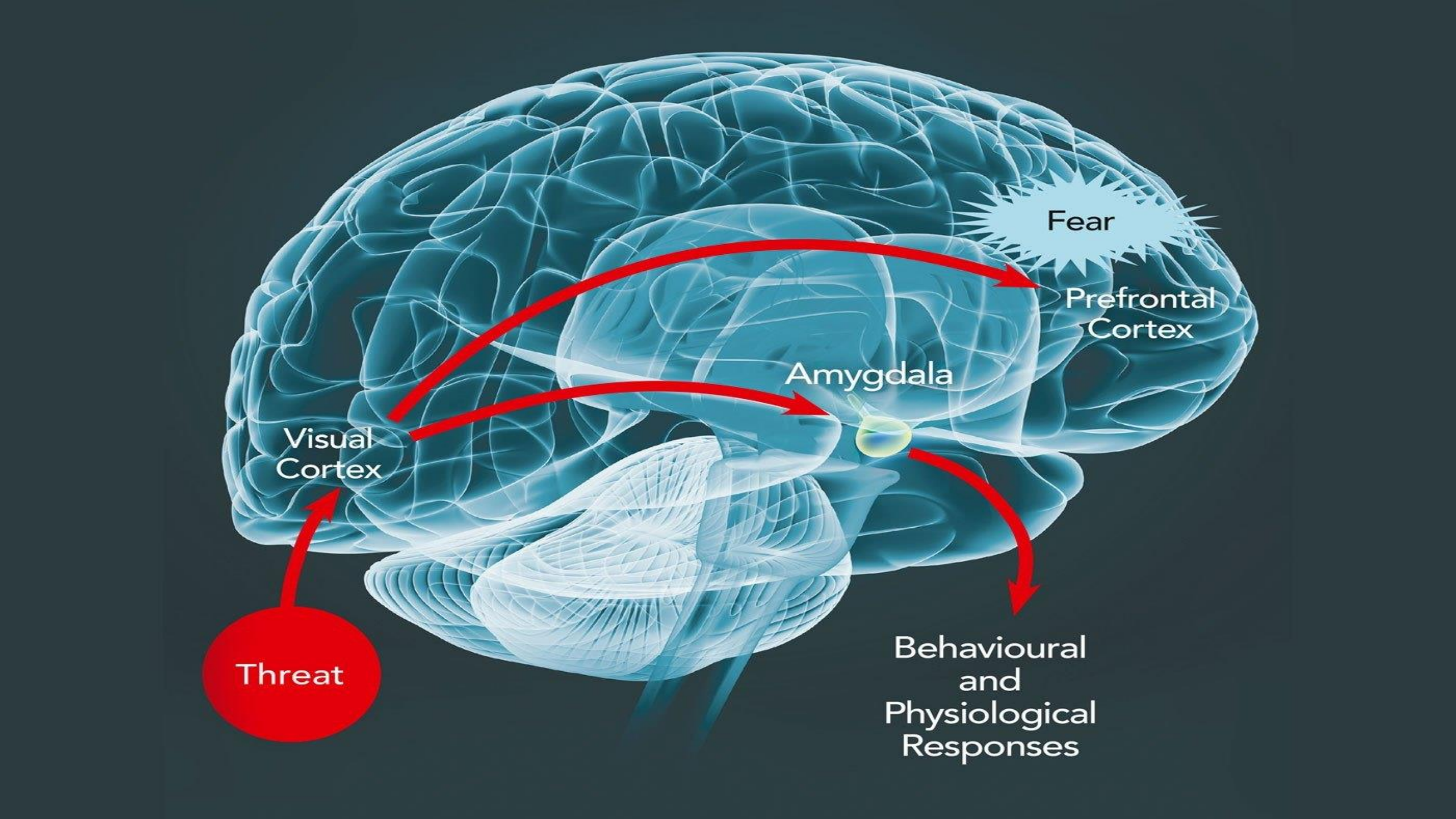
250-million-year-old



Brain Structures That Mediate Emotion

- Hypothalamus
- Limbic System
  - limbic cortex
  - amygdala
- Brainstem




Fear
Prefrontal Cortex
Amygdala
Visual Cortex
Threat
Behavioural and Physiological Responses

THE ANATOMY OF ANXIETY

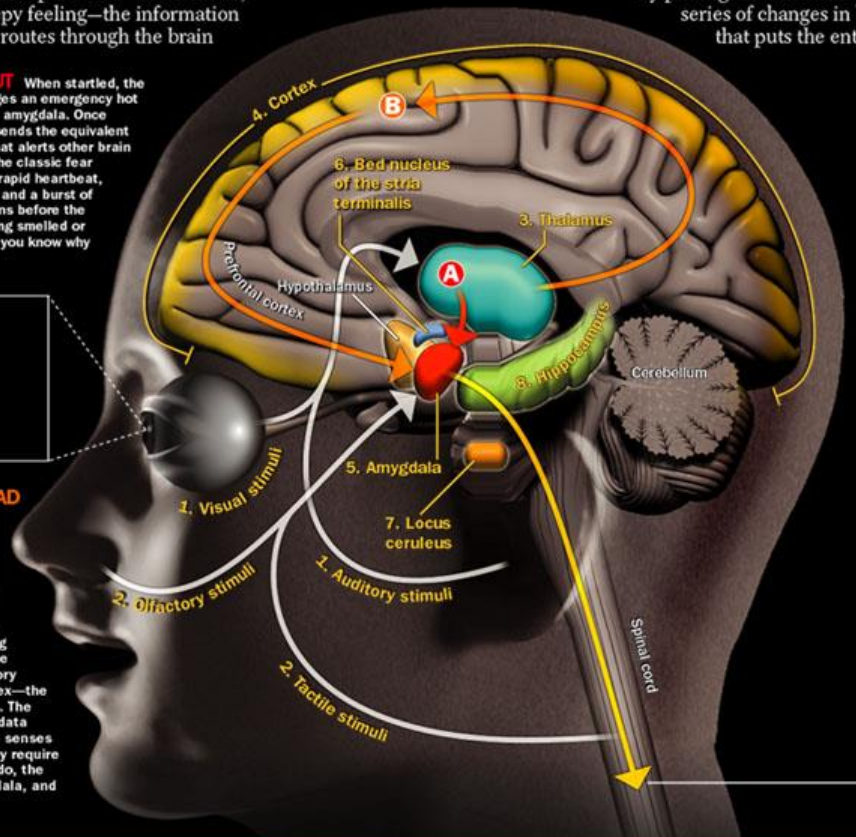
TIME Diagram by Joe Lertola.
Text by Alice Park

WHAT TRIGGERS IT . . .

When the senses pick up a threat—a loud noise, a scary sight, a creepy feeling—the information takes two different routes through the brain

A THE SHORTCUT When startled, the brain automatically engages an emergency hot line to its fear center, the amygdala. Once activated, the amygdala sends the equivalent of an all-points bulletin that alerts other brain structures. The result is the classic fear response: sweaty palms, rapid heartbeat, increased blood pressure and a burst of adrenaline. All this happens before the mind is conscious of having smelled or touched anything. Before you know why you're afraid, you are

B THE HIGH ROAD Only after the fear response is activated does the conscious mind kick into gear. Some sensory information, rather than traveling directly to the amygdala, takes a more circuitous route, stopping first at the thalamus—the processing hub for sensory cues—and then the cortex—the outer layer of brain cells. The cortex analyzes the raw data streaming in through the senses and decides whether they require a fear response. If they do, the cortex signals the amygdala, and the body stays on alert

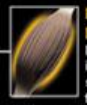


. . . AND HOW THE BODY RESPONDS

By putting the brain on alert, the amygdala triggers a series of changes in brain chemicals and hormones that puts the entire body in anxiety mode

STRESS-HORMONE BOOST Responding to signals from the hypothalamus and pituitary gland, the adrenal glands pump out high levels of the stress hormone cortisol. Too much cortisol short-circuits the cells in the hippocampus, making it difficult to organize the memory of a trauma or stressful experience. Memories lose their context and become fragmented

RACING HEARTBEAT The body's sympathetic nervous system, responsible for heart rate and breathing, shifts into overdrive. The heart beats faster, blood pressure rises and the lungs hyperventilate. Sweat increases, and even the nerve endings on the skin tingle into action, creating goose bumps



FIGHT, FLIGHT OR FRIGHT The senses become hyperalert, drinking in every detail of the surroundings and looking for potential new threats. Adrenaline shoots to the muscles, preparing the body to fight or flee

DIGESTION SHUTDOWN The brain stops thinking about things that bring pleasure, shifting its focus instead to identifying potential dangers. To ensure that no energy is wasted on digestion, the body will sometimes respond by emptying the digestive tract through involuntary vomiting, urination or defecation

1. Auditory and visual stimuli Sights and sounds are processed first by the thalamus, which filters the incoming cues and shunts them either directly to the amygdala or to the appropriate parts of the cortex

2. Olfactory and tactile stimuli Smells and touch sensations bypass the thalamus altogether, taking a shortcut directly to the amygdala. Smells, therefore, often evoke stronger memories or feelings than do sights or sounds

3. Thalamus The hub for sights and sounds, the thalamus breaks down incoming visual cues by size, shape and color, and auditory cues by volume and dissonance, and then signals the appropriate parts of the cortex

4. Cortex It gives raw sights and sounds meaning, enabling the brain to become conscious of what it is seeing or hearing. One region, the prefrontal cortex, may be vital to turning off the anxiety response once a threat has passed

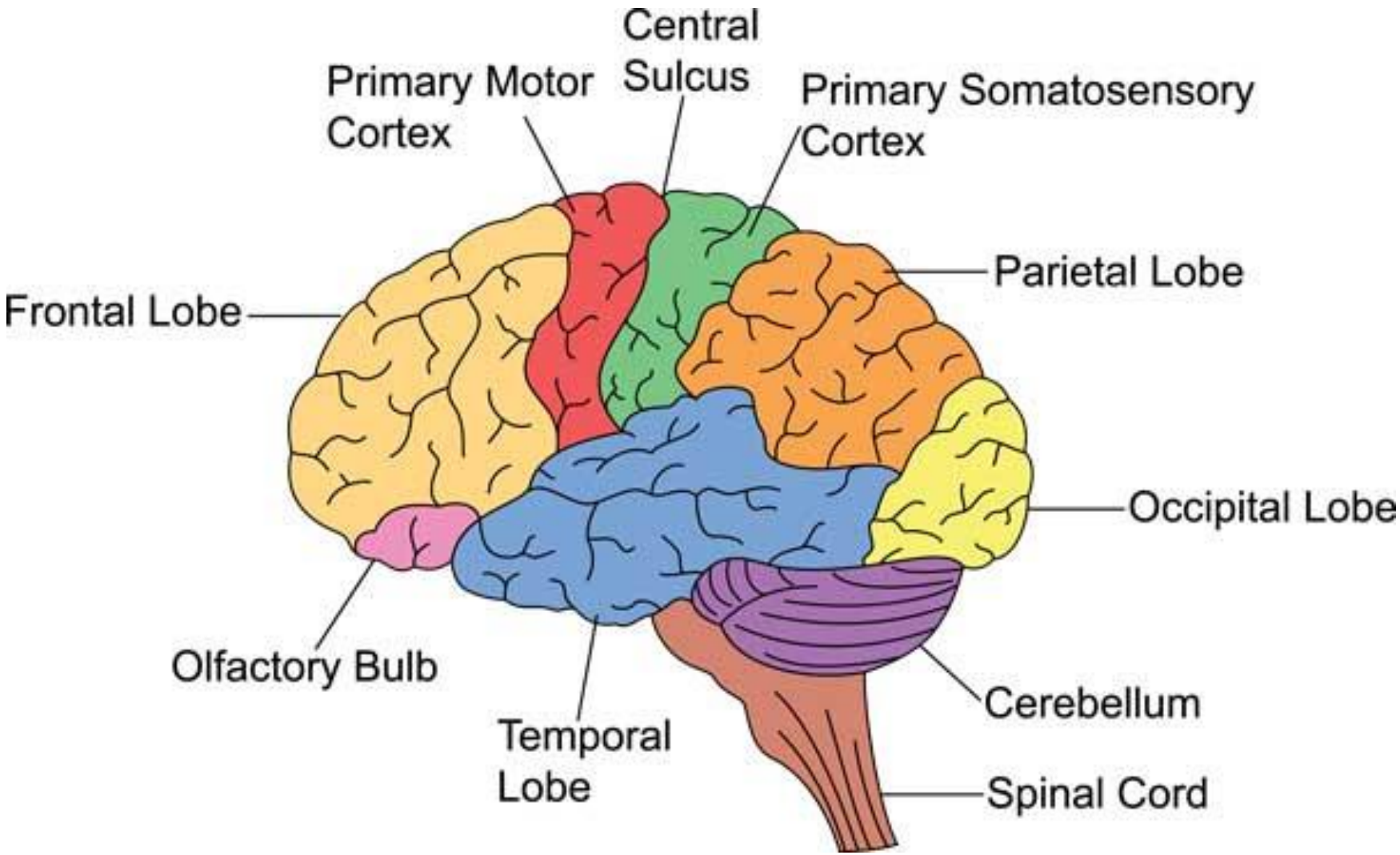
5. Amygdala The emotional core of the brain, the amygdala has the primary role of triggering the fear response. Information that passes through the amygdala is tagged with emotional significance

6. Bed nucleus of the stria terminalis Unlike the amygdala, which sets off an immediate burst of fear, the BNST perpetuates the fear response, causing the longer-term unease typical of anxiety

7. Locus ceruleus It receives signals from the amygdala and is responsible for initiating many of the classic anxiety responses: rapid heartbeat, increased blood pressure, sweating and pupil dilation

8. Hippocampus This is the memory center, vital to storing the raw information coming in from the senses, along with the emotional baggage attached to the data during their trip through the amygdala

Source: Dennis S. Charney, M.D., National Institute of Mental Health


Central Sulcus
Primary Motor Cortex
Primary Somatosensory Cortex
Frontal Lobe
Parietal Lobe
Occipital Lobe
Olfactory Bulb
Temporal Lobe
Cerebellum
Spinal Cord

Frontal Lobe

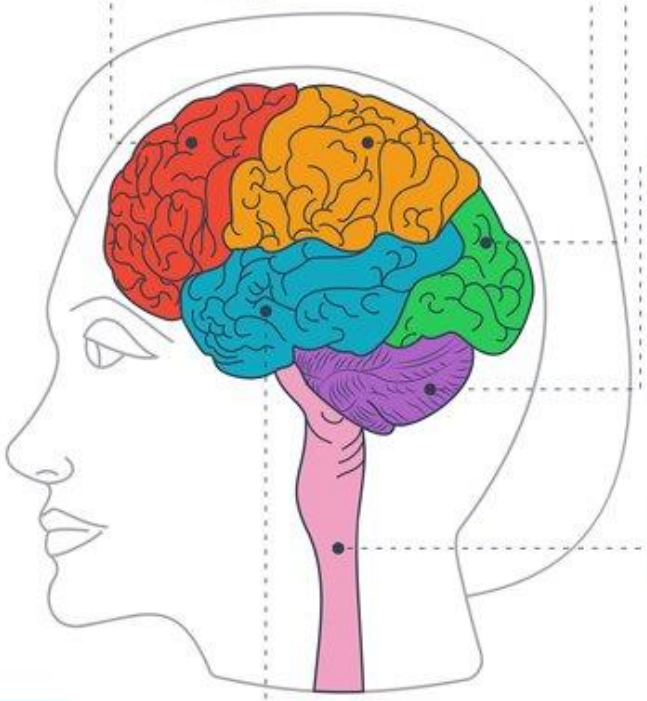
Problem solving
Judgment
Inhibition of behavior
Planning
Anticipation
Speaking (expressive language)
Emotional expression
Awareness of abilities
Self-monitoring
Motor planning
Personality
Sexual behavior
Behavior control
Limitations
Organization
Attention
Concentration
Mental flexibility
Initiation

Parietal Lobe

Sense of touch, taste and smell
Differentiation: size, shape, color
Spatial perception
Visual perception
Academic skills
Math calculations
Reading
Writing

Occipital Lobe

Visual reception area
Visual interpretation
Reading (perception and recognition)



Cerebellum

Coordination of voluntary movement
Balance and equilibrium
Some memory for reflex motor acts

Brain Stem

Sense of balance (vestibular function)
Reflexes to seeing and hearing
Autonomic nervous system
Blood vessel control
Breathing
Heart control
Digestion
Heart rate
Swallowing
Consciousness
Blood pressure
Temperature
Alertness
Ability to sleep
Sweating

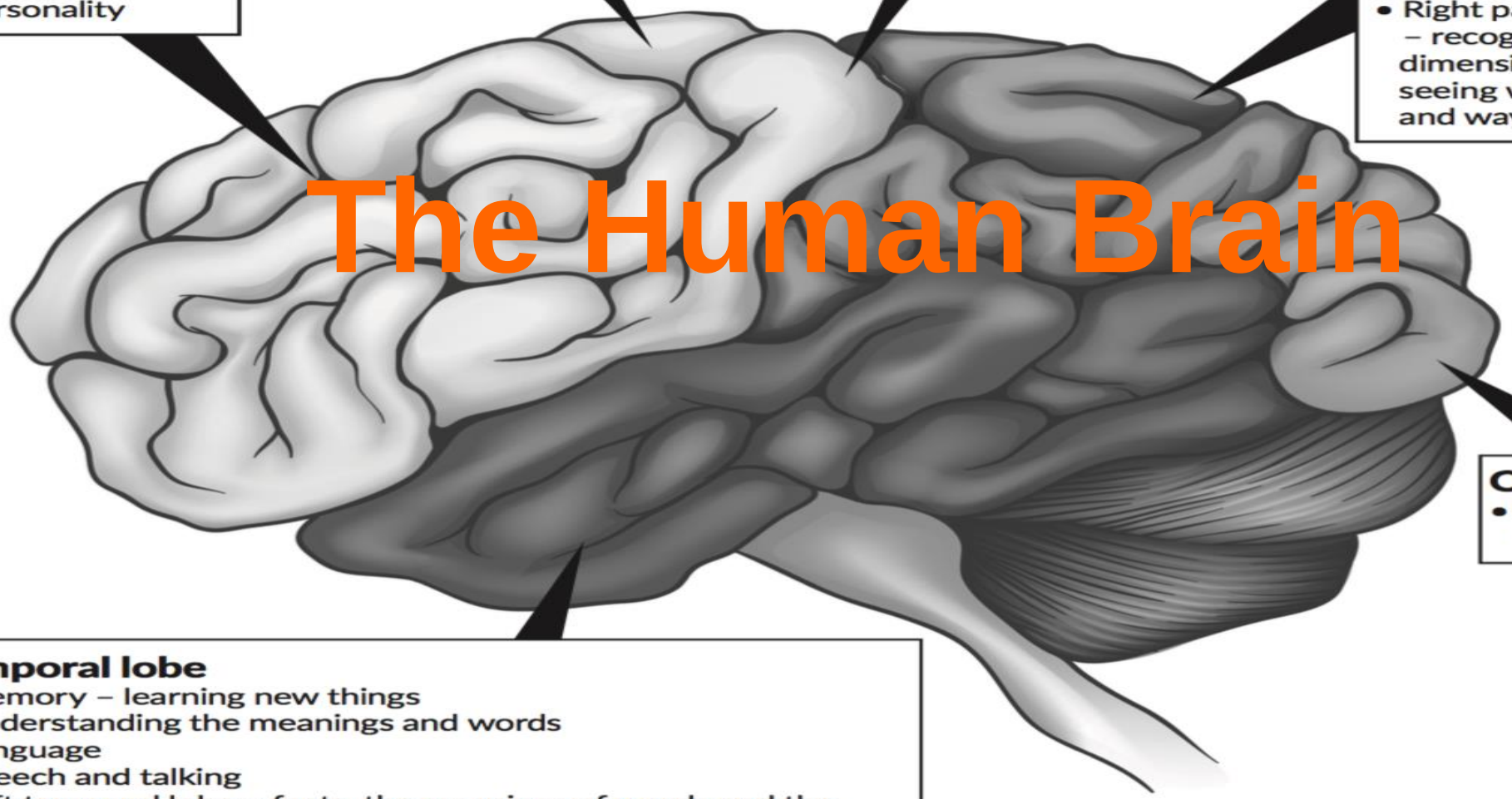
Temporal Lobe

Understanding language
Organization and sequencing
Information retrieval
Musical awareness
Memory
Hearing
Learning
Feelings

BRAIN FUNCTIONS

Segregated by Lobes

The Human Brain



Frontal lobe
- Executive functioning
- Thinking
- Planning
- Problem solving
- Controlling emotions and behaviour
- Personality

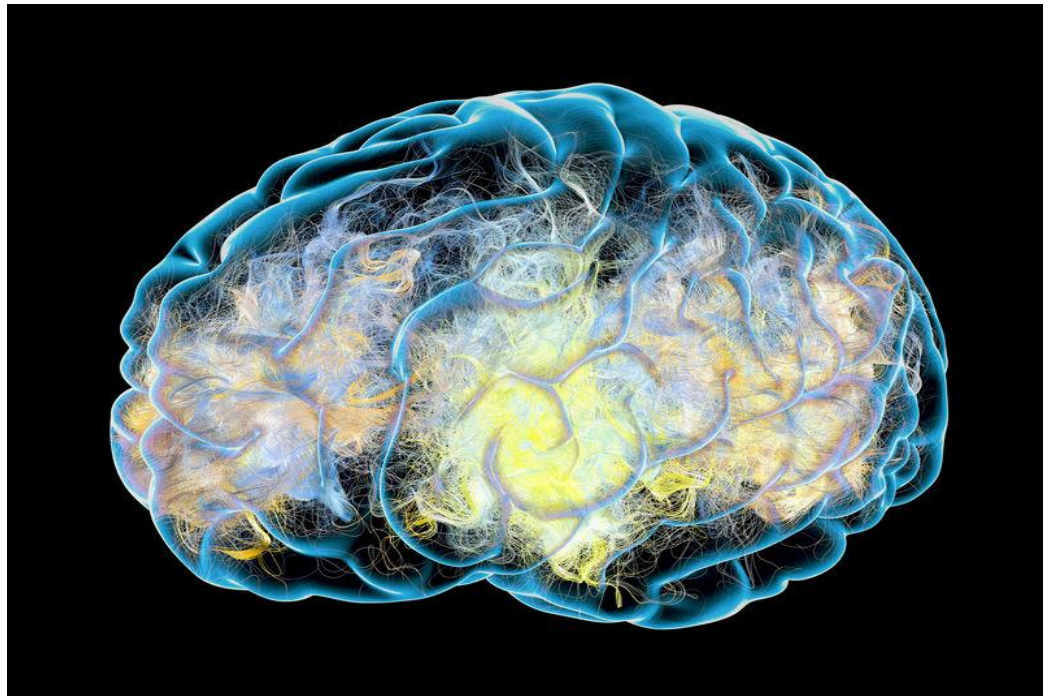
Motor cortex
- Movement - fine motor and whole body

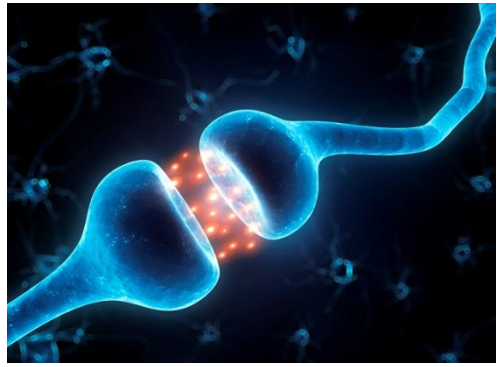
Sensory cortex
- Sensations, e.g. taste, smell

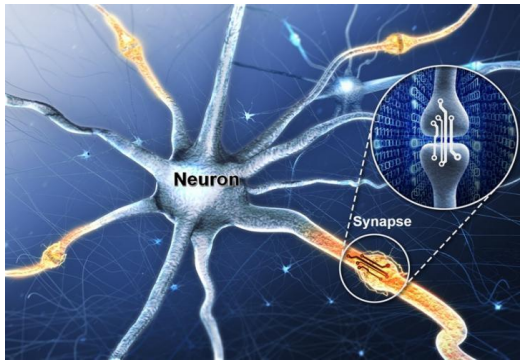
Parietal lobe
- Perception, senses and space
- Making sense of things
- Arithmetic
- Spelling
- Left parietal lobe – reading, writing and processing numbers
- Right parietal lobe – recognising three dimensional objects, seeing where objects are and way finding

Occipital lobe
- Making sense of visual information

Temporal lobe
- Memory – learning new things
- Understanding the meanings and words
- Language
- Speech and talking
- Left temporal lobe – facts, the meanings of words and the names of objects; central to understanding speech and taking
- Right temporal lobe – deals with visual material and is central to recognising familiar objects and faces.





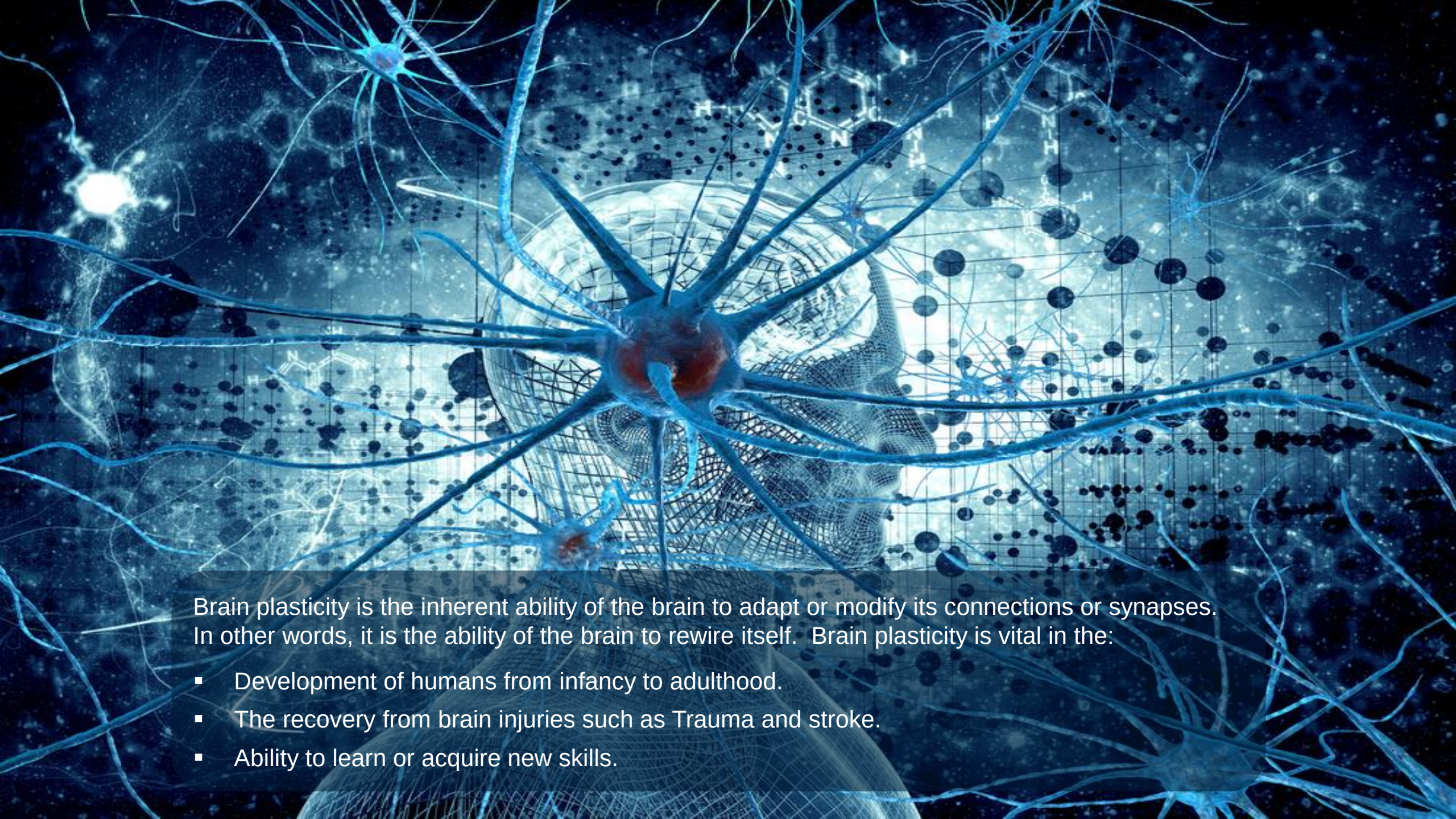


Brain Plasticity/Neuroplasticity

Neuroplasticity – or brain plasticity – is the ability of the brain to modify its connections or re-wire itself. Without this ability, any brain, not just the human brain, would be unable to develop from infancy through to adulthood or recover from brain injury.

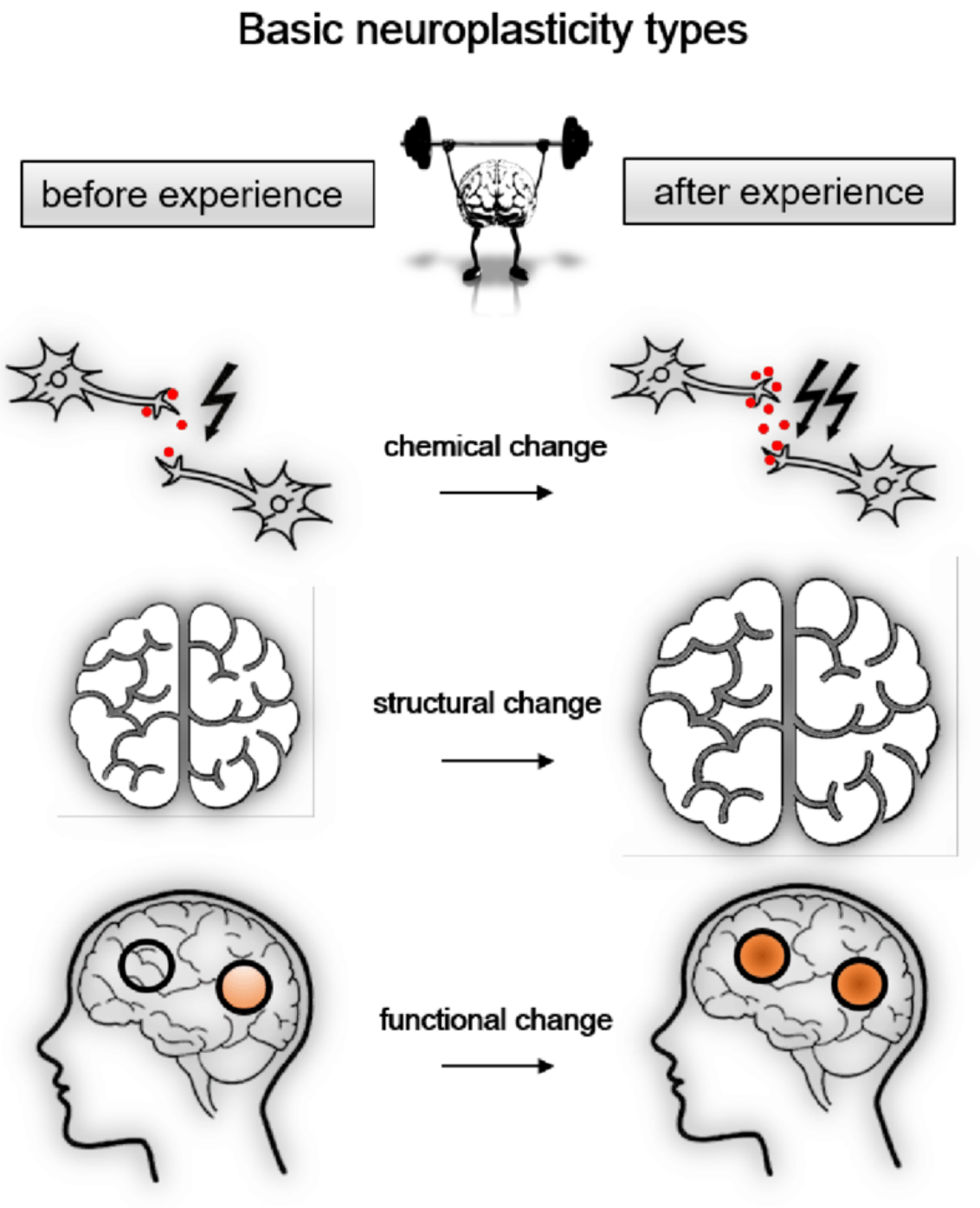
Neuro refers to neurons, the nerve cells that are the building blocks of the brain and nervous system, and plasticity refers to the brain's malleability.

The human brain is composed of approximately 86 billion neurons. Early researchers believed that neurogenesis, or the creation of new neurons, stopped shortly after birth. Today, it's understood that the brain possesses the remarkable capacity to reorganise pathways, create new connections, and, in some cases, even create new neurons—a concept called neuroplasticity, or brain plasticity.



Brain plasticity is the inherent ability of the brain to adapt or modify its connections or synapses. In other words, it is the ability of the brain to rewire itself. Brain plasticity is vital in the:

- Development of humans from infancy to adulthood.
- The recovery from brain injuries such as Trauma and stroke.
- Ability to learn or acquire new skills.



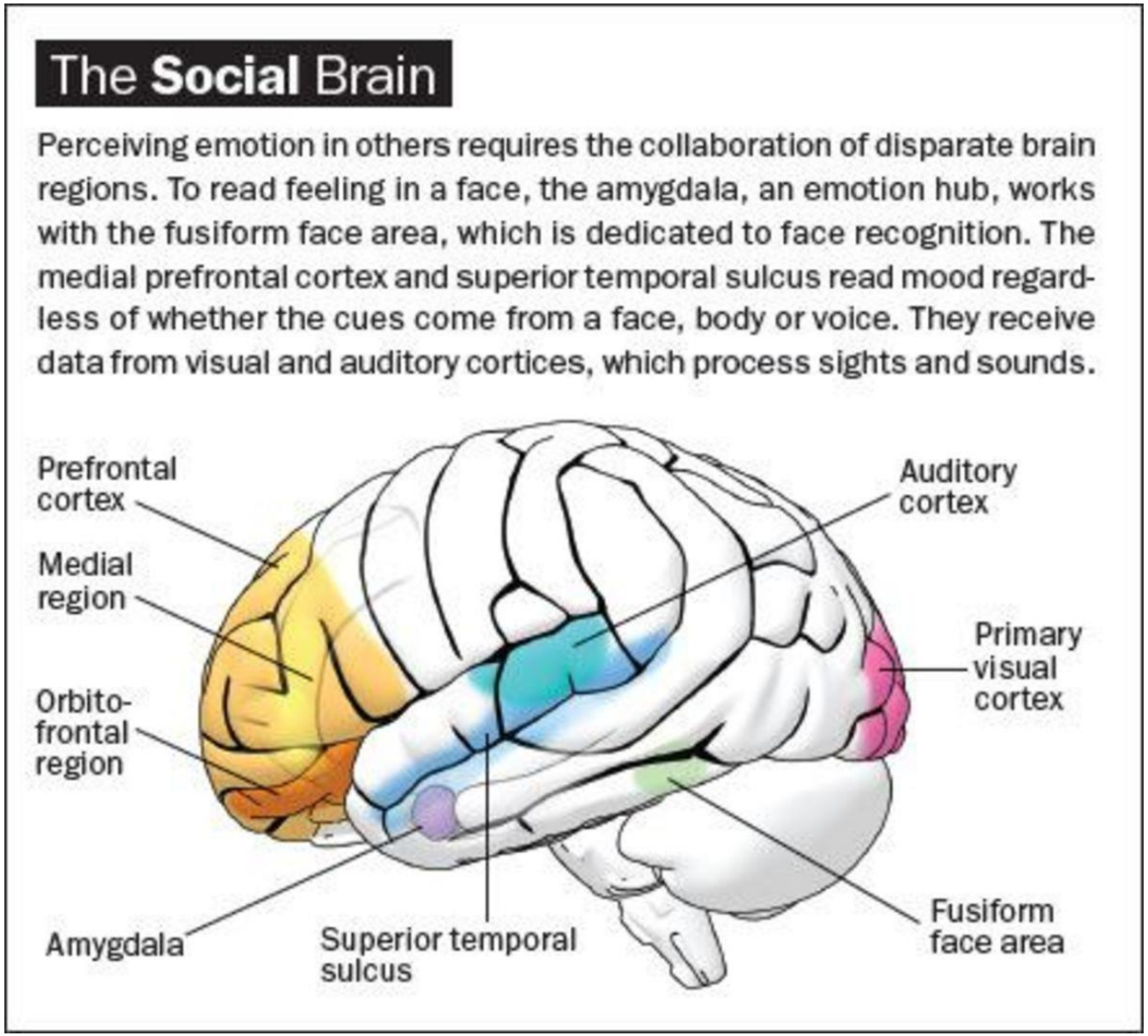
There are two main types of neuroplasticity:

Functional plasticity

The brain's ability to move functions from a damaged area of the brain to other undamaged areas.

Structural plasticity

The brain's ability to actually change its physical structure as a result of learning.

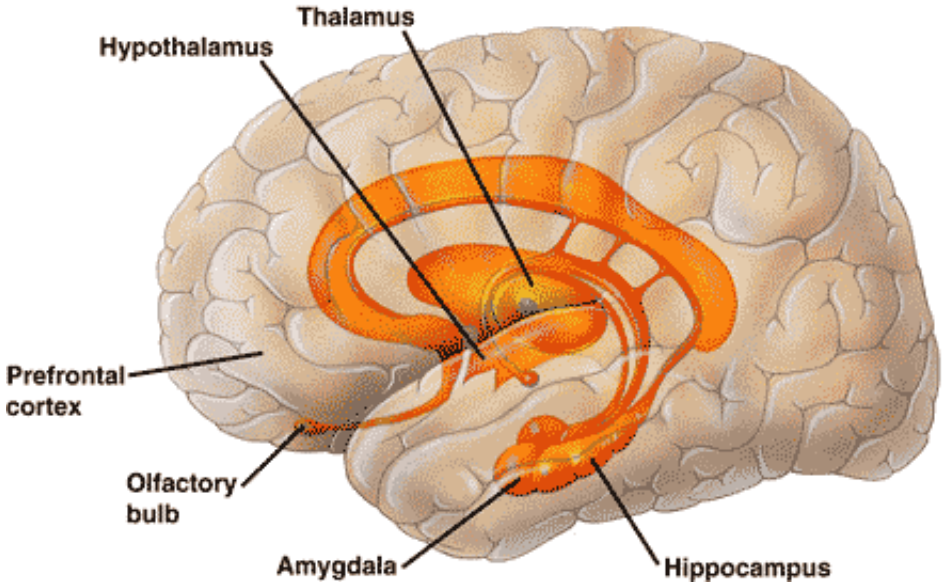


Social relationships have emotional and self-regulating properties. The experience of inter – and intrapersonal safeness is connected to prosocial motives, such as compassion, and the inhibitory function of the prefrontal cortex.

Social relationships and compassion influence different body systems, such as the vagus nerve.

Many forms of psychopathology represent the activation of evolved, defensive strategies especially in contexts where there are few stimuli indicating safeness and social support.

Petrocchi, N., & Cheli, S. (2019). The social brain and heart rate variability: Implications for psychotherapy. *Psychology and Psychotherapy: Theory, Research and Practice, 92*(2), 208–223. https://doi.org/10.1111/papt.12224



The Limbic System

It is where “Flight, Fight, Response” occurs.

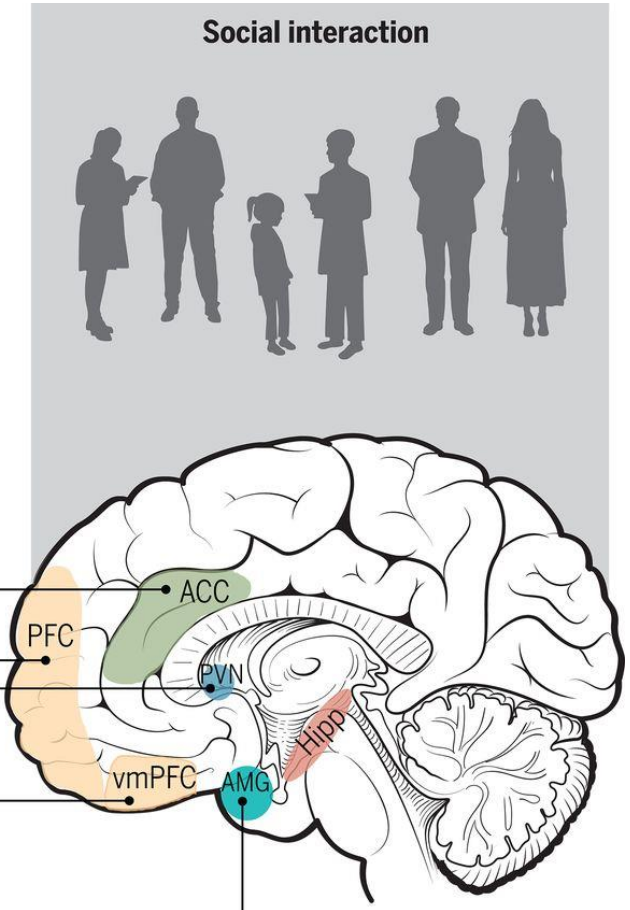
Anterior cingulate cortex (ACC)
This brain region functions in the detection and valuation of social processes such as interactions with dominant males and females in primates, and decision-making games in humans.

Prefrontal cortex (PFC)
In humans, this brain region is activated in response to various social cognitive tasks such as empathy, moral decision making, and judging the mental states of others. In rodents, stimulation of excitatory neurons abolishes social exploration and preference.

Paraventricular nucleus of the hypothalamus (PVN)
Magnocellular neurons of the PVN produce the neuropeptide oxytocin. Oxytocin is secreted to brain regions involved in sociability and social cognition, such as the ventral tegmental area and PFC. Reduced levels of oxytocin are documented in autism.

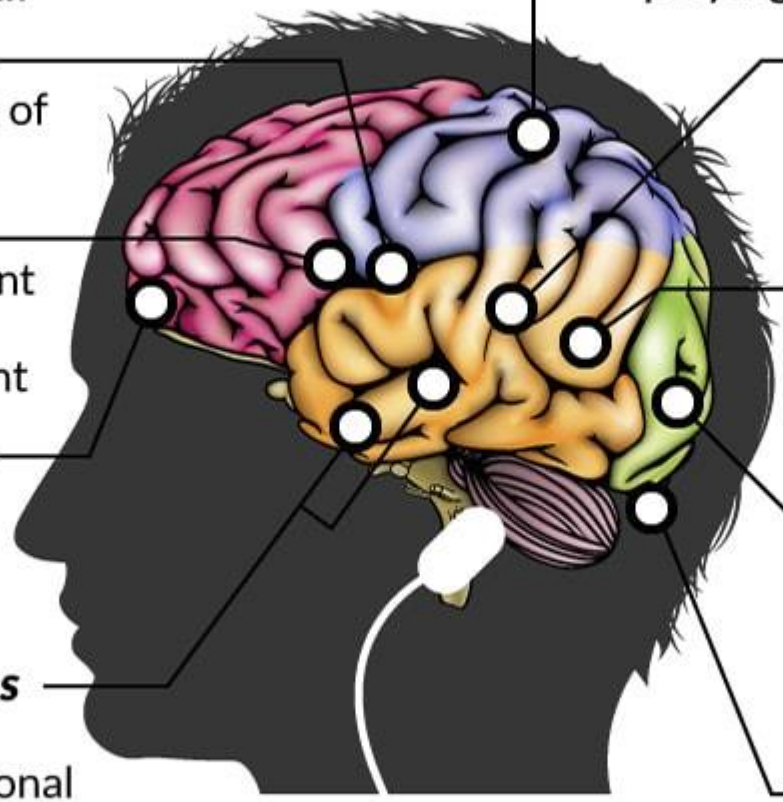
Ventromedial prefrontal cortex (vmPFC)
Lesions to this part of PFC result in social isolation and apathy in humans. The vmPFC is also important in the learning of cues that predict social reward. Children with ASD display reduced vmPFC activation in response to social reward.

Amygdala (AMG)
Amygdalar volume correlates with the size and complexity of social networks in humans. This brain region functions in the analysis of social situations. Individuals with autism demonstrate reduced activation of this brain region in response to social judgment tasks.



Music and the brain

Playing and listening to music works several areas of the brain



Corpus callosum:
Connects both sides of the brain

Motor cortex:
Involved in movement while dancing or playing an instrument

Prefrontal cortex:
Controls behavior, expression and decision-making

Nucleus accumbens and amygdala:
Involved with emotional reactions to music

Sensory Cortex:
Controls tactile feedback while playing instruments or dancing

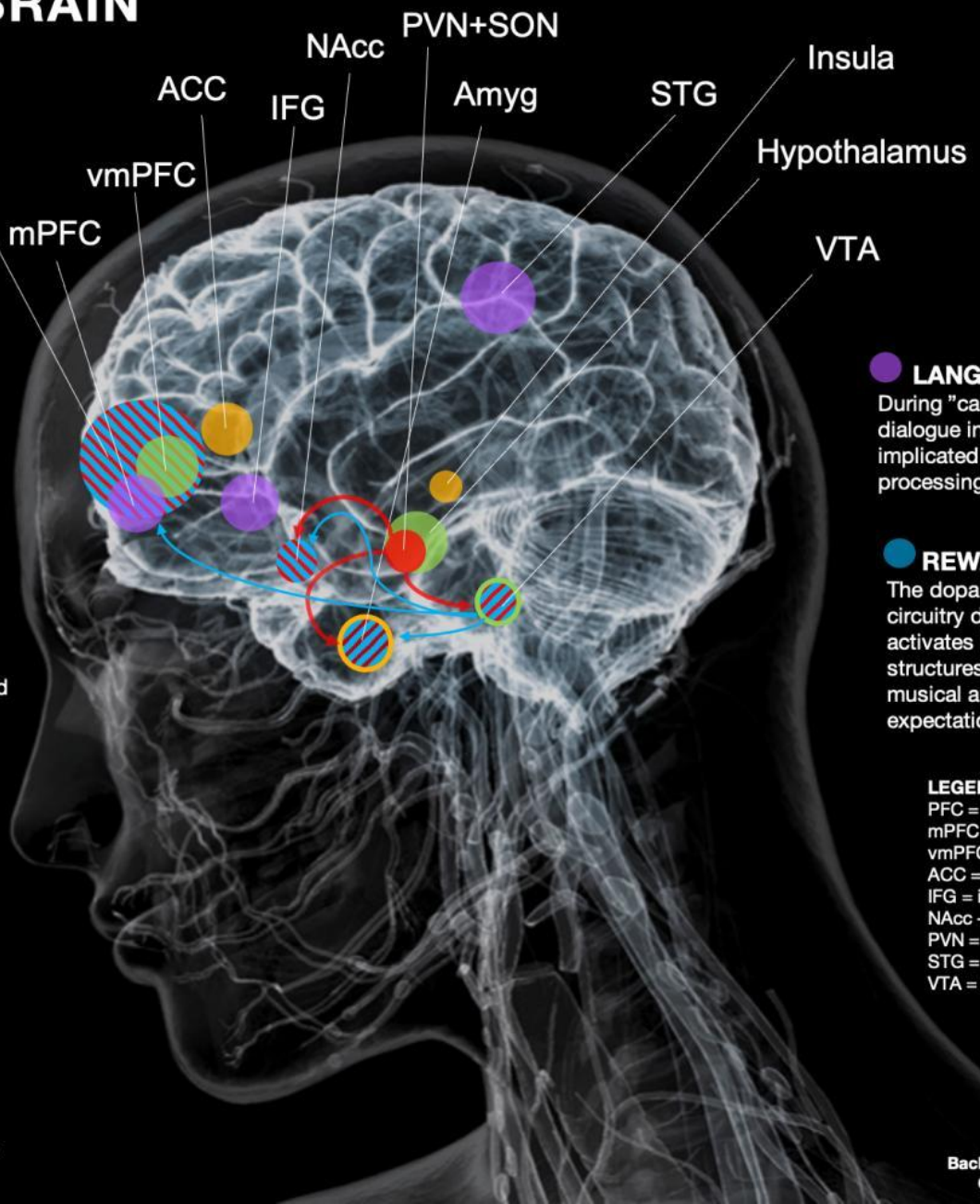
Auditory cortex:
Listens to sounds; perceives and analyzes tones

Hippocampus:
Involved in music memories, experiences and context

Visual Cortex:
Involved in reading music or looking at your own dance moves

Cerebellum:
Involved in movement while dancing or playing an instrument, as well as emotional reactions

THE SOCIAL BRAIN AND MUSIC



EMPATHY CIRCUITS
Empathy is implicated in affective responses to music and promotes interpersonal musical coordination.

OXYTOCIN
Oxytocin is secreted during group choral and improvisational singing.

CORTISOL
Cortisol levels are decreased during group listening and singing.

LANGUAGE STRUCTURES
During "call and response" style musical dialogue in dyads, brain structures directly implicated in syntactic but not semantic processing of language are activated.

REWARD
The dopaminergic reward circuitry drives motivation, activates language-related structures, and is implicated in musical anticipation and expectation.

LEGEND:
PFC = prefrontal cortex
mPFC = medial prefrontal cortex
vmPFC = ventromedial prefrontal cortex
ACC = anterior cingulate cortex
IFG = inferior frontal gyrus
NAcc – nucleus accumbens
PVN = paraventricular nucleus
STG = superior temporal gyrus
VTA = ventral tegmental area

Mesocorticolimbic dopaminergic pathways

Oxytocinergic pathways

A DYNAMIC PROCESS:

Brain
Group music making, including perspective taking and coordination involves varied processes in the brain.

Behavior
Brain activity modulates social behavior including empathy and prosocial behaviors.

Culture
These complex processes can change social perception and behavior, particularly towards someone perceived to be an outgroup member.

Background artwork by Bryan Christie Design
Overlay design by Dr. David M. Greenberg

The Brain and Storytelling

NEURAL COUPLING

When the brain is exposed to a story, parts of it light up and begins to process it to relate to their own ideas and experiences.

MIRRORING

Both the speaker or storyteller and their listeners experience similar brain activity.

DOPAMINE

Dopamine - a chemical messenger is released by the brain into the system when an emotionally-charged event is experienced. This results in easier and more accurate recall.

CORTEX ACTIVITY

At the onset of processing facts, both the Broca's and Wernicke's areas are activated. The more engaging the story, more areas like the motor, sensory and frontal cortices are additionally stimulated.

Source: Onespot

The Difference Between the Mind and the Brain

Psychological states such as thoughts and feelings are real. Brain states are real. The problem is that the two are not real in the same way, creating the mind–brain correspondence problem.

Barrett, L. F. (2009). The future of psychology: Connecting mind to brain. *Perspectives on Psychological Science, 4*(4), 326–339. https://doi.org/10.1111/j.1745-6924.2009.01134.x

Physical concepts are free creations of the human mind, and are not, however it may seem, uniquely determined by the external world.

Einstein, A., & Infeld, L. (1938). *Evolution of physics* (Vol. 10). Cambridge University Press.

The Difference Between the Mind and the Brain

- **Mind = flow of information within the nervous system:**
  - Information is represented by the nervous system.
  - The mind is energy, and generates energy.
  - Most mind is unconscious; awareness is an aspect of mind.
  - The mind uses the brain, and the brain responds to the mind.
- In essence, apart from hypothetical transcendental factors, the mind *is* what the brain *does*.
- **Brain = necessary, *proximally* sufficient condition for mind:**
  - The brain depends on the mind.
  - The headquarters of the nervous system is the brain.
  - The brain depends on the nervous system, which intertwines with and depends on other bodily systems.
  - These systems in turn intertwine with and depend upon nature and culture, both presently and over time.

The Difference Between the Mind and the Brain (cont.)

The mind is a synonymous with our thoughts, feelings, memories, and beliefs, and as the source of our behaviors. It's not made of material, but we think of it as quite powerful, or even as who we are.

Broadly, the mind entails all the intellectual and psychological phenomena of an organism, encompassing motivational, affective, behavioral, perceptual, and cognitive systems; that is, the organised totality of an organism's mental and psychic processes and the structural and functional cognitive components on which they depend.

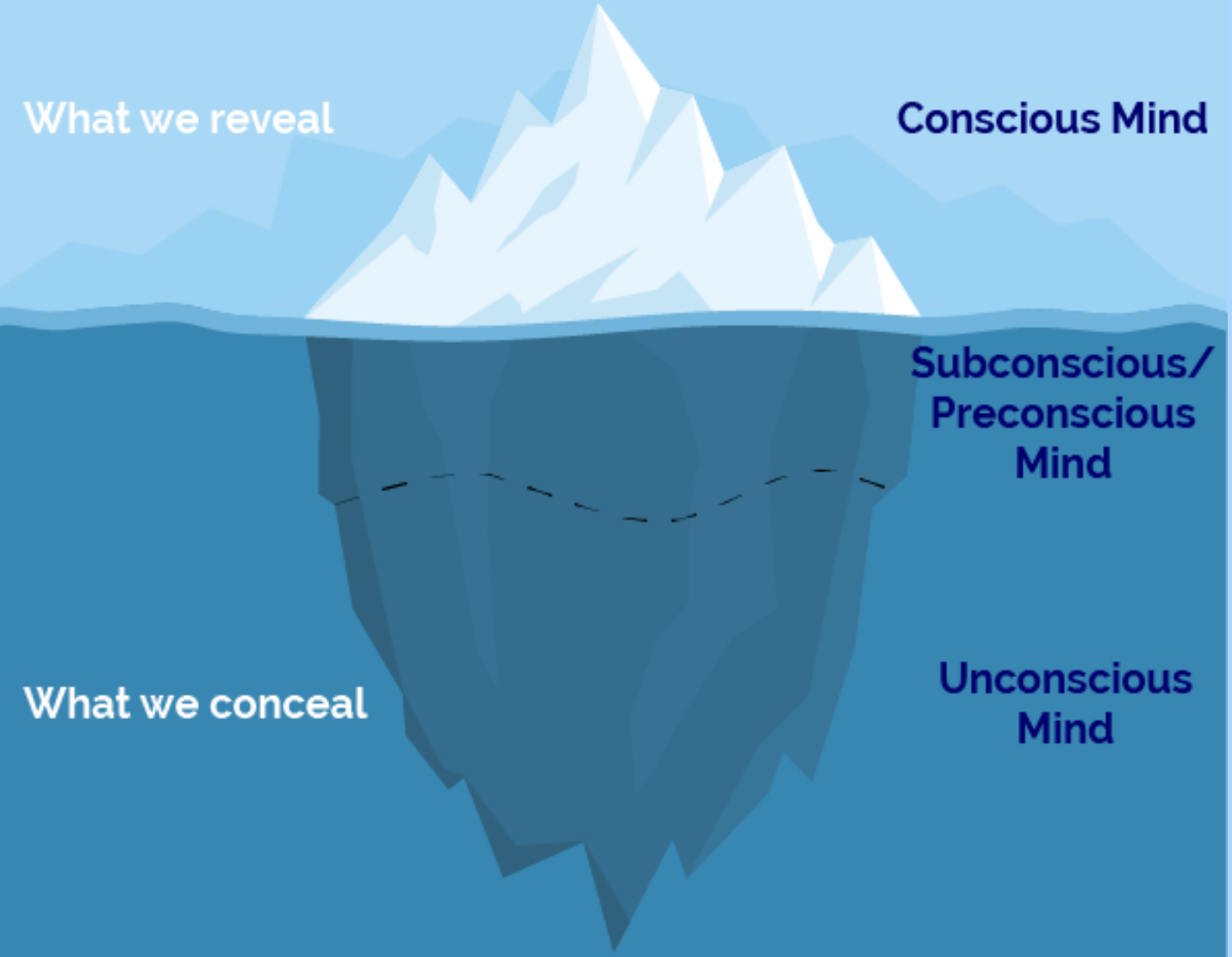
The term, however, is also used more narrowly to denote only cognitive activities and functions, such as perceiving, attending, thinking, problem solving, language, learning, and memory. The nature of the relationship between the mind and the body, including the brain and its mechanisms or activities, has been, and continues to be, the subject of much debate.

Summary of the Difference Between the Mind and the Brain

Brain

Mind

Levels of Mental Life

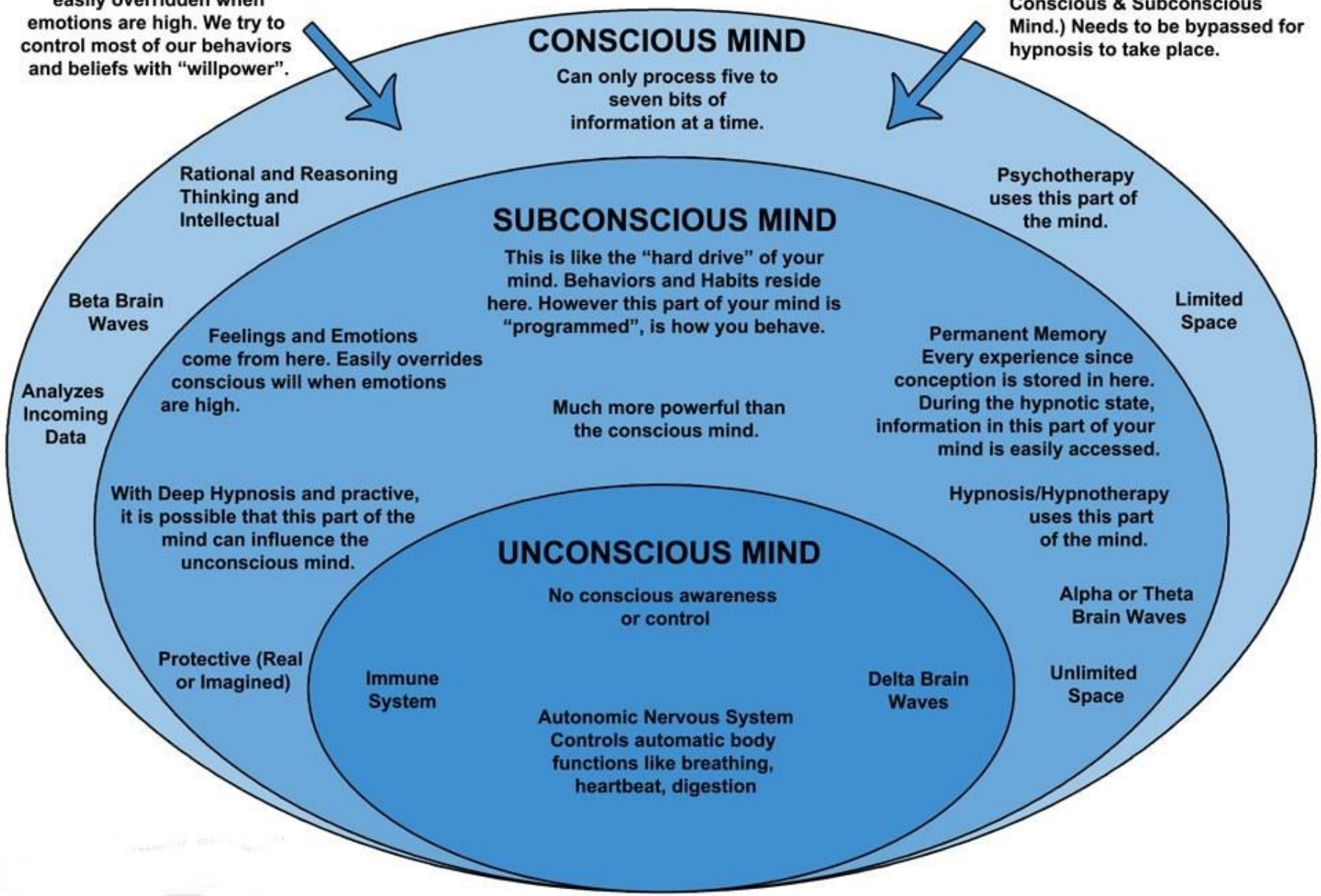


- Perceptions and thoughts about the environment.

- Where emotions and memories live.
- Serves as a filtering system for communication between conscious and unconscious mind.

- Where repressed memories and emotions reside (not accessible to the conscious mind).
- These repressed memories and emotions shape how we interpret the preconscious mind and affect our behaviour.

Human Mind Model



The Subconscious mind only thinks in the present.

The Subconscious mind doesn't know the difference between what is real and what is imagined.

Your Conscious mind is: logical, rational, and analytical.
Your Subconscious is ill-logical, ir-rational, non-analytical.

Your Subconscious mind believes ANYTHING whether it makes no sense, no logical sense at all.

Your Conscious mind know that it takes time to action goals
BUT in **your Subconscious mind**, programme it to believe you have already attainted them right NOW.

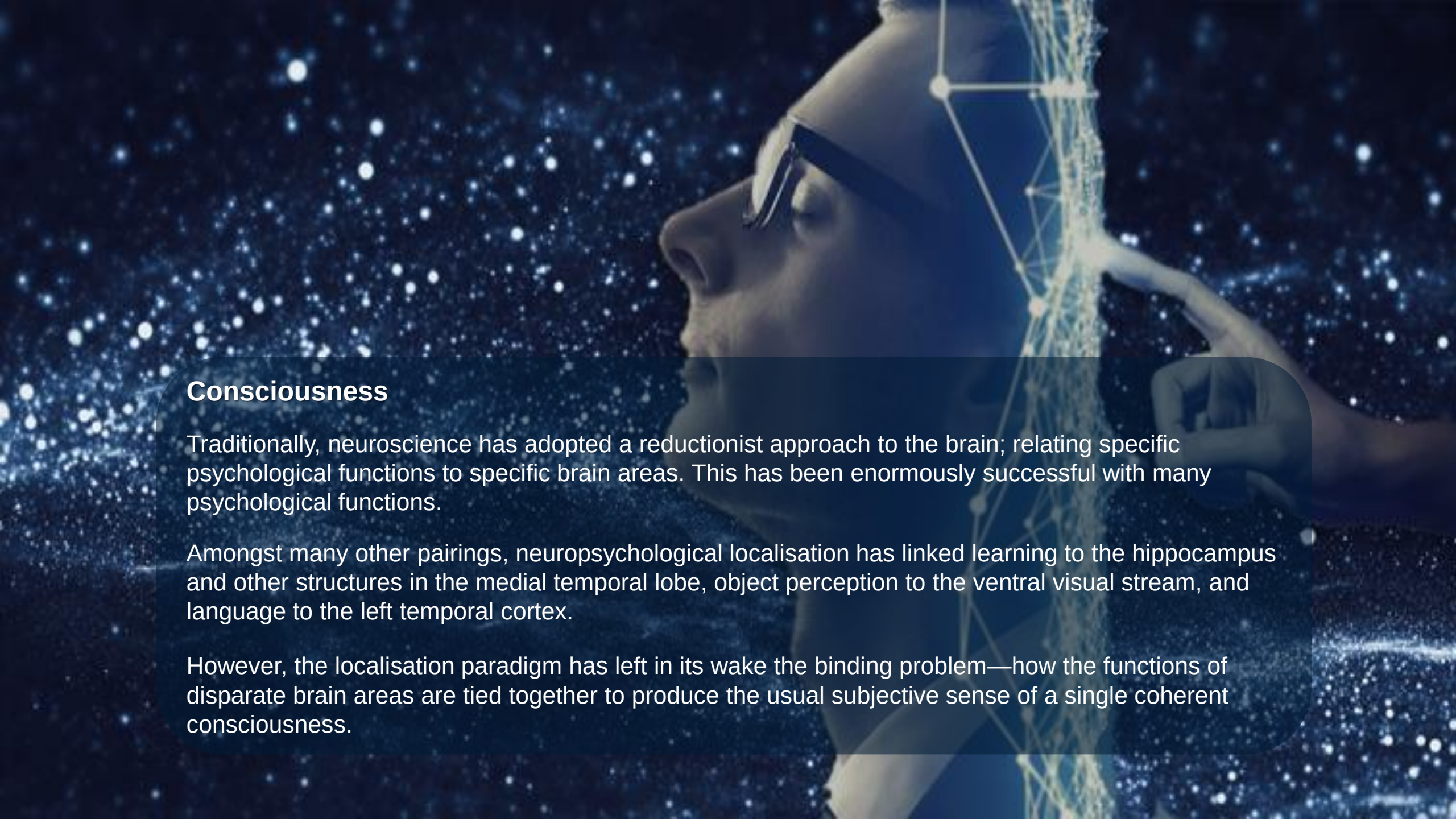
Consciousness

Consciousness is not something that happens inside us. It is something we do or make.

Better: it is something we achieve. Consciousness is more like dancing than it is like digestion….

The idea that the only genuinely scientific study of consciousness would be one that identifies consciousness with events in the nervous system is a bit of outdated reductionism.

Rachlin, H. (2012). Out of our of our heads: Why you are not your brain, and other lessons from the biology of consciousness [Review of the book Is the mind in the brain?, by A. Noē]. *Journal of the Experimental Analysis of Behavior, 98*(1), 131–137. https://doi.org/10.1901/jeab.2012.98-131

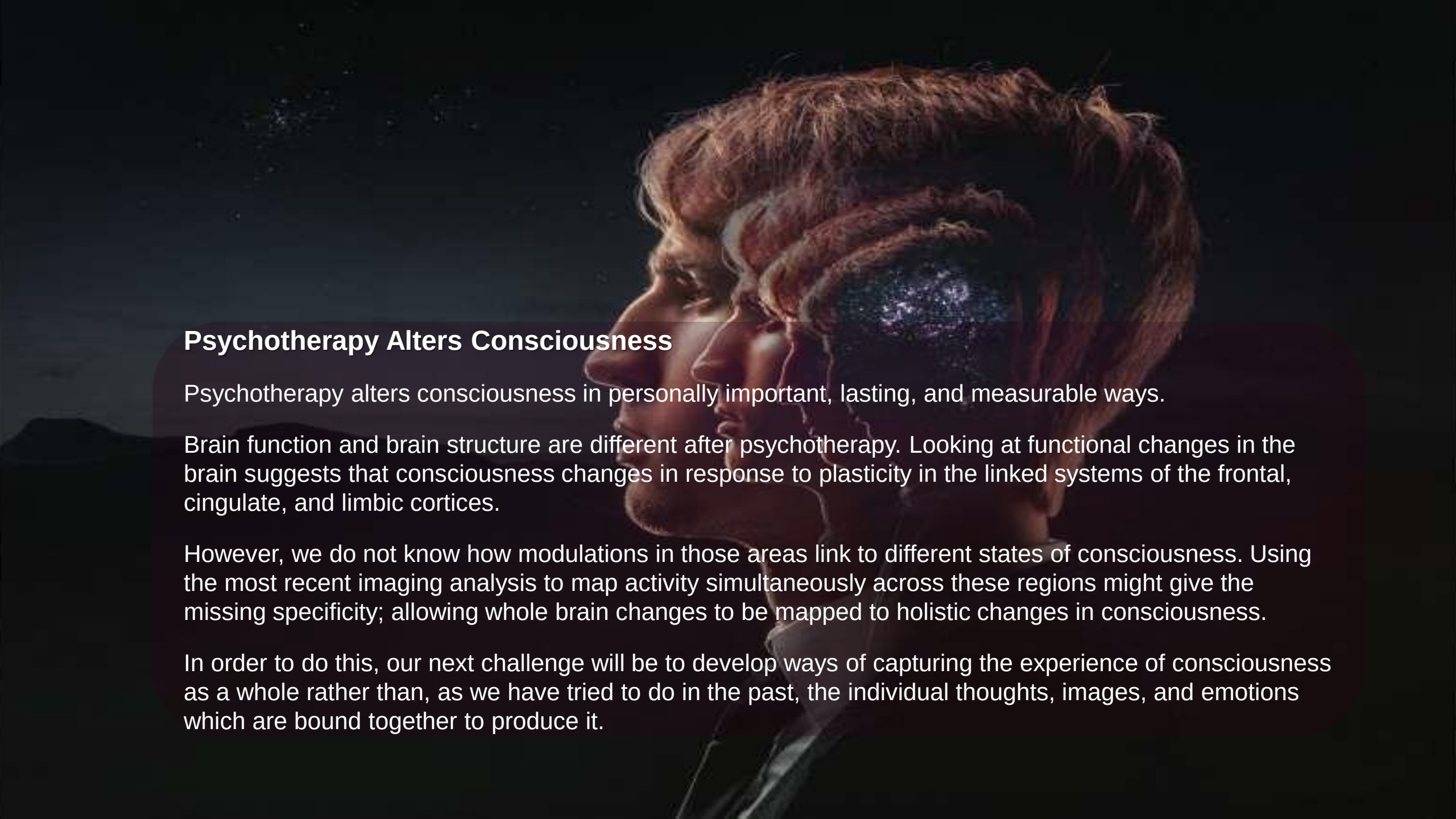


Consciousness

Traditionally, neuroscience has adopted a reductionist approach to the brain; relating specific psychological functions to specific brain areas. This has been enormously successful with many psychological functions.

Amongst many other pairings, neuropsychological localisation has linked learning to the hippocampus and other structures in the medial temporal lobe, object perception to the ventral visual stream, and language to the left temporal cortex.

However, the localisation paradigm has left in its wake the binding problem—how the functions of disparate brain areas are tied together to produce the usual subjective sense of a single coherent consciousness.



Psychotherapy Alters Consciousness

Psychotherapy alters consciousness in personally important, lasting, and measurable ways.

Brain function and brain structure are different after psychotherapy. Looking at functional changes in the brain suggests that consciousness changes in response to plasticity in the linked systems of the frontal, cingulate, and limbic cortices.

However, we do not know how modulations in those areas link to different states of consciousness. Using the most recent imaging analysis to map activity simultaneously across these regions might give the missing specificity; allowing whole brain changes to be mapped to holistic changes in consciousness.

In order to do this, our next challenge will be to develop ways of capturing the experience of consciousness as a whole rather than, as we have tried to do in the past, the individual thoughts, images, and emotions which are bound together to produce it.

The first impetus to story an experience is the awareness of an inner bodily feeling (Damasio, 1999). The most fundamental level of consciousness, “knowing” springs to life when changes in the status of the body-self are connected to environmental impacts. At a higher level of consciousness, all emotions are storied and that personal stories are shaped by—emplotted within—the trajectory of emergent emotion themes. It is often the rise and fall of emotional themes—and the conflicting desires, intentions, goals, and purposes they represent—that provide the connective thread that weaves together disparate experiences and events to create a meaningful and coherent whole (Sarbin, 1995).

“The multimedia mind-show occurs constantly as the brain processes external and internal sensory events. As the brain answers the unasked question of who is experiencing the mind-show, the sense of self emerges”

Damasio (1999, p. 112)

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Videos YouTube

An Introduction to Interpersonal Neurobiology by Daniel J. Siegel, M.D.
https://www.youtube.com/watch?v=JeGBhVm13mc

Antonio Damasio: The Brain - Creativity, Imagination, and Innovation / Ross Institute Summer Academy
https://www.youtube.com/watch?v=HUZd66Lu4Y8

Antonio Damasio - Feeling and Consciousness
https://www.youtube.com/watch?v=ilrelFkDYls

Antonio Damasio and Dan Siegel – Mind, Consciousness, the Body, and Relationships
https://www.youtube.com/watch?v=85zFp0bYe1Y

Antonio Damasio: INET Keynote Address entitled Human Decisions
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Daniel Siegel – Interpersonal Connection
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Dan Siegel on Interpersonal Neurobiology
https://www.youtube.com/watch?v=YE4w02hTWco

Dr. Dan Siegel - An Interpersonal Neurobiology Approach to Resilience and the Development of Empathy
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How Our Brains Feel Emotion | Antonio Damasio | Big Think
https://www.youtube.com/watch?v=KsSv1KzdiWU

The quest to understand consciousness | Antonio Damasio
https://www.youtube.com/watch?v=LMrzdk_YnYY

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