

Yoga and Neuroscience

Yogesh chitta-vritti-nirodhah

The Brain

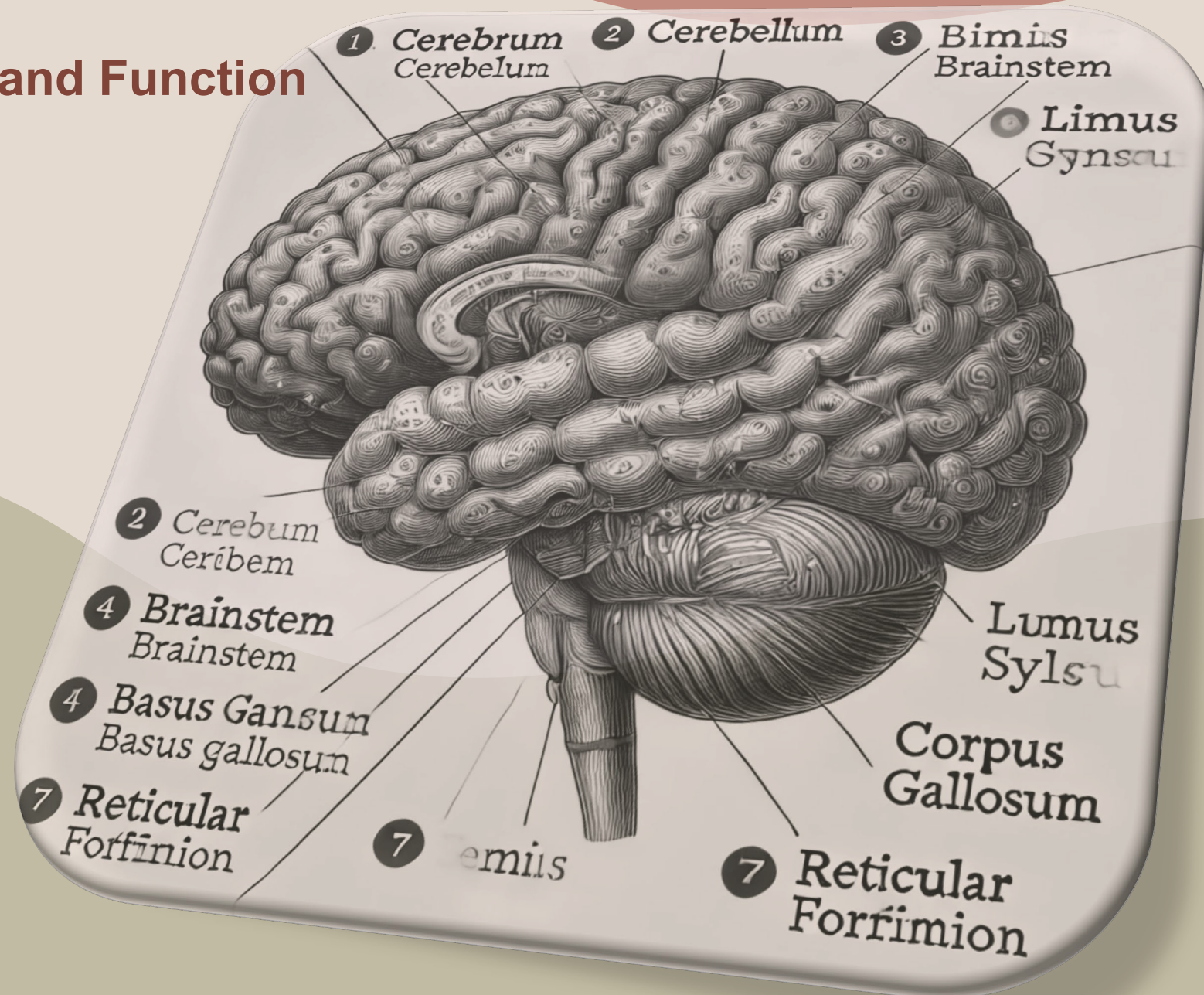
- Weight: 3 lbs.
- Tofu-like consistency
- 20-25% of our energy is for the brain
- Neurons: 86 billion
- Synapses: 100 trillion

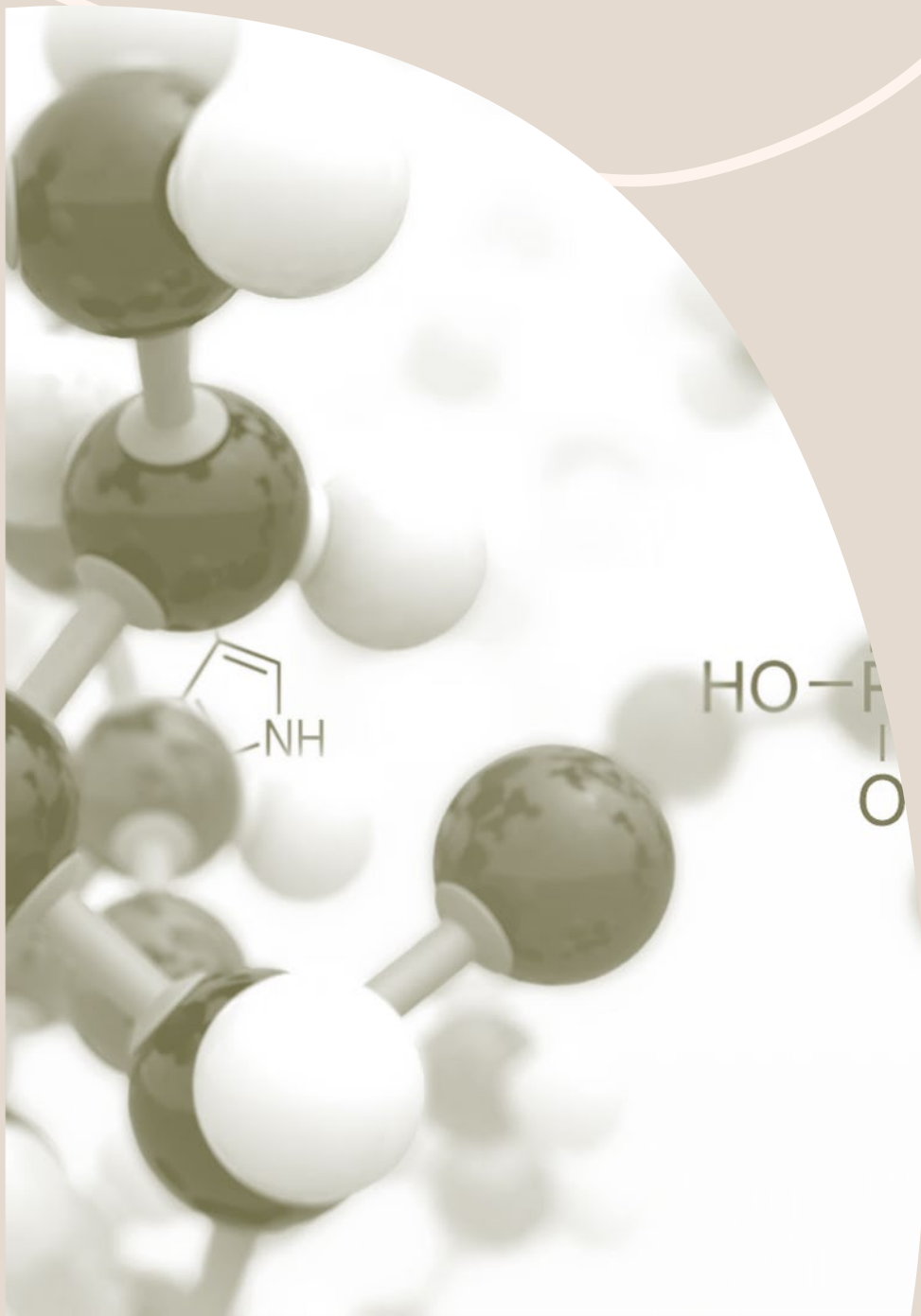
Atoms in the Universe: 10 to the 80th power

The brain has more neuronal activity than the number of atoms in the universe



Brain Anatomy and Function





Neurotransmitters

- Excitatory: dopamine (reward/pleasure)
- Inhibitory: GABA
- Modulatory: serotonin (mood, appetite, sleep)



Types of Brain Waves

Delta Waves (0.5 - 4 Hz): deep sleep, healing, and regeneration.

Theta Waves (4 – 8 Hz) creativity, intuition, and deep relaxation

Alpha Waves (8 - 14 Hz): calmness, relaxation, balanced mind state

Beta Waves (14 - 30 Hz); active thinking, focus, problem-solving

Gamma Waves (30 - 100 Hz): heightened perception, cognitive processing, and consciousness

Gamma waves are the holy grail.

Gamma Waves

Significance of Gamma Waves in the Brain

- Cognitive Processing and Intelligence
- Consciousness and Perception
- Neuroplasticity and Adaptability
- Emotional Regulation and Well-being
- Lucid Dreaming and Mystical States

The Mind

Abstract, Conscious Experience

- **Non-physical** aspect of cognition: **thoughts, emotions, perception, intelligence, and self-awareness**
- **Emergent property of brain activity**
- Some theories suggest that the mind extends beyond the physical brain, influencing behavior through abstract reasoning, beliefs, and emotions.










Nirodhah: Intentional Mind Regulation

1. Pharmacological
2. Neurofeedback and Brain Stimulation
Transcranial Magnetic Stimulation
3. Behavioral and Cognitive
Cognitive Behavioral Therapy
AND.....

Yogis have more Gamma Activity



- Meditation Enhances Gamma Waves
- Increased Brain Synchronization
- Neuroplasticity and Resilience
- Altered States of Consciousness
- Emotional Mastery and
- Compassion

- 
- A Buddhist monk with a shaved head, wearing maroon robes, is sitting in a meditative posture on a grassy field. He is looking slightly to his left. The background consists of lush green trees and foliage. A semi-transparent dark grey box is overlaid on the left side of the image, containing a list of bullet points.
- Gamma Wave Activity at an Unprecedented Level
 - Structural and Functional Brain Changes
 - Reduced Fear and Anxiety Response
 - Rapid Mental Shifts During Meditation
 - Neural Coherence

Mingyur Rinpoche <https://www.youtube.com/watch?v=XdBDdGi1Gbs>

Meditation Types

Mindfulness

Loving-Kindness

Focused Attention

Transcendental (TM)

Open Monitoring

Body Scan

Yoga Nidra

Mantra



A stylized, dark grey leaf graphic with several pointed leaves, located in the top left corner of the slide.

Loving-Kindness (Metta)

- May you be happy
- May you feel strong
- May you be free from suffering

Start with easy-to-love and move up to more complex relationships until you reach the Universe.



Open Monitoring (Dzogchen)

Tibetan Monks exhibit the highest levels of Gamma practicing Dzogchen.



Focused Attention (Samatha)

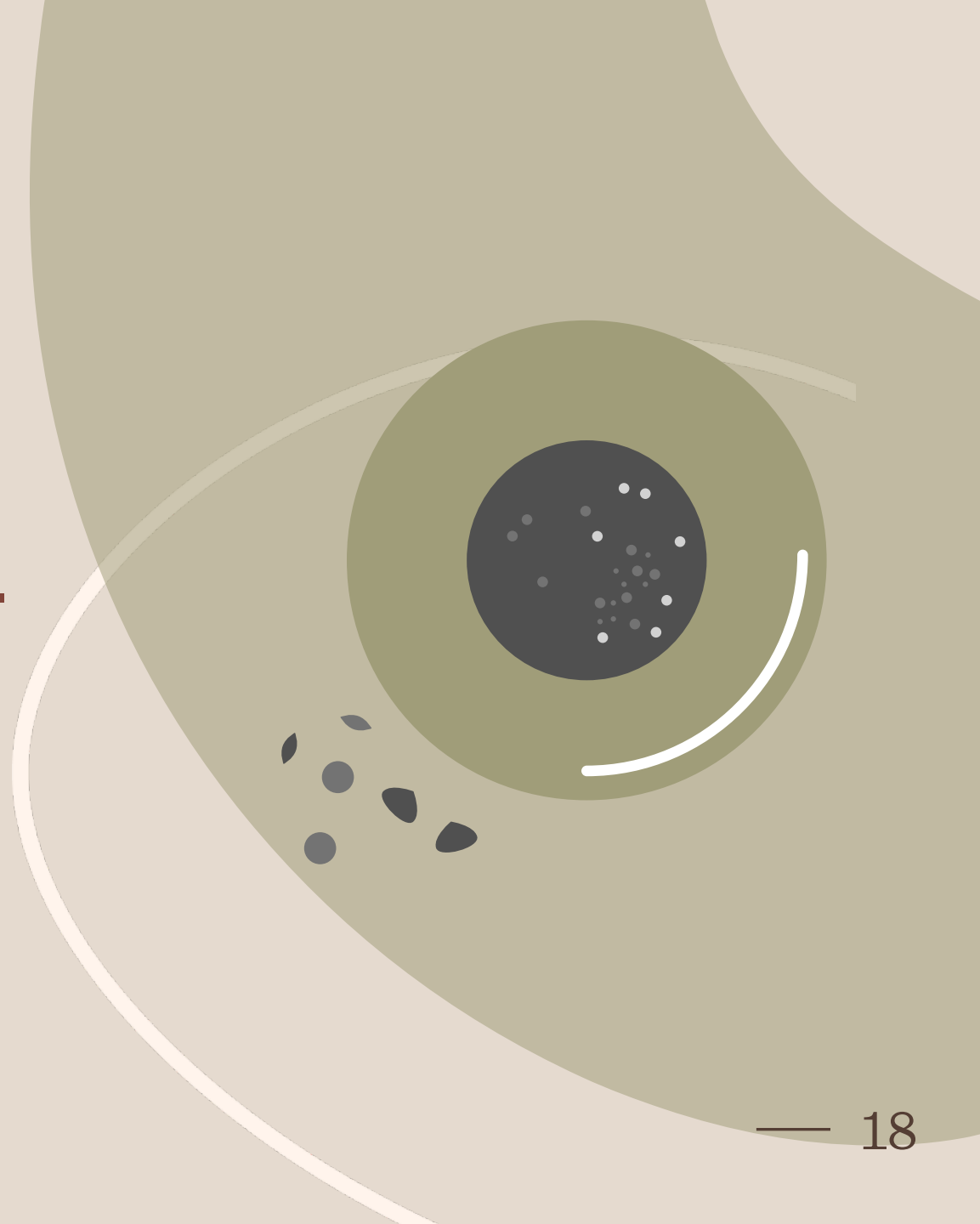
- Strengthens PFC, ACC,
- Improves WILLPOWER
 - Emotional benefits
 - Improves attention
 - Improves self-control
- Boosts memory and learning

A stylized, dark grey leaf graphic with several pointed leaves, located in the upper left corner of the slide.

Transcendental or Mantra

- Silently repeat a **mantra**
- Let the mantra effortlessly
- Resonate in your mind, practice **twice daily for 20 minutes.**

Master your mind. Master your life.



Key Differences in Brain Function

Feature	Interoceptive Meditation	Exteroceptive Meditation
Focus	Internal body sensations (breath, heartbeat, emotions)	External sensory input (sight, sound, touch, smell)
Primary Brain Region	Insular Cortex, ACC, Somatosensory Cortex	Sensory Cortices, Prefrontal Cortex, Occipital Lobe
Cognitive Effect	Enhances body awareness, emotional regulation	Enhances attention to surroundings, reduces internal rumination
Emotional Effect	Can increase introspection and self-awareness	Can reduce anxiety by shifting focus outward

Feel Internal Sensations

01

Bring awareness to the feeling of air on your skin.

02

Notice the temperature and the sensation of clothing against your body.

03

If seated, feel the weight of your body against the chair or floor.

04

Run your fingers over a surface nearby—notice its texture, temperature, and resistance.

Interoceptive Meditation (Internal Awareness)

Focus: Internal bodily sensations (breath, heartbeat, muscle tension, temperature).

Brain Regions Activated

- Insular Cortex (Insula): The primary hub for interoceptive awareness; responsible for sensing bodily states such as heartbeat and breath.
- Anterior Cingulate Cortex (ACC): Plays a role in emotional regulation and body-state monitoring.
- Somatosensory Cortex: Processes internal bodily sensations and proprioception (body position awareness).
- Medial Prefrontal Cortex (mPFC): Involved in self-referential processing and emotional integration.

Effects on the Brain

- Increases **body awareness** and emotional regulation.
- Strengthens the connection between bodily sensations and conscious awareness.
- Can improve sensitivity to internal cues, which may help with stress management but could also increase anxiety in those overly attuned to bodily states.

Feel External Sensations

01

Bring awareness to the feeling of air on your skin.

02

Notice the temperature and the sensation of clothing against your body.

03

If seated, feel the weight of your body against the chair or floor.

04

Run your fingers over a surface nearby—notice its texture, temperature, and resistance.

Exteroceptive: reduce mind wandering

Focus: Sensory perception of the external environment (sight, sound, touch, smell).

Brain Regions Activated

- **Primary and Secondary Sensory Cortices:** Process external stimuli such as visual, auditory, and tactile sensations.
- **Dorsolateral Prefrontal Cortex (dlPFC):** Enhances attention and cognitive control over sensory experiences.
- **Occipital Lobe & Visual Cortex:** Engaged when focusing on external visual elements.
- **Posterior Parietal Cortex:** Helps shift attention between different sensory inputs and spatial awareness.

Effects on the Brain

- **Strengthens focus** on the present environment, reducing mind-wandering.
- Can help counteract excessive interoceptive sensitivity, reducing an anxiety response or too much awareness of internal sensations.



Namaste'



Appendix

Meditation Types and Benefits



Mindfulness

Key brain changes

increases PFC, hippocampus

Emotional benefits

reduces stress, improves focus

Brain waves

alpha, theta



Loving-Kindness

Key brain changes

increases anterior cingulate cortex,
insula

Emotional benefits

enhances compassion, reduces
depression

Brain waves

gamma



Focused Attention

Key brain changes
strengthens PFC, ACC

Emotional benefits
improves attention, self-control

Brain waves
beta



Transcendental (TM)

Mantra Repetition

Practitioners silently repeat a specific sound or mantra, which helps the mind settle into a state of deep rest and alertness.

Effortlessness

Unlike some meditation techniques that require focused concentration, TM is practiced in a natural and effortless way.

Practice Routine

It is typically practiced for about 15–20 minutes twice a day while seated comfortably with the eyes closed.

Benefits

Research suggests that TM may help reduce stress and anxiety, enhance cognitive function, and improve overall well-being.

Brain Waves

Alpha, theta



Open Monitoring

Key brain changes

enhances DMN regulation, insula

Emotional benefits

reduces overthinking, improves self-awareness

Brain waves

theta, gamma



Body Scan

Key brain changes
increases somatosensory cortex, reduces amygdala

Emotional benefits
reduces tension, improves pain management

Brain waves
theta



Yoga Nidra

Key brain changes
reduces cortisol, improves hippocampus function

Emotional benefits
enhances deep relaxation, sleep quality

Brain waves
delta



Mantra Meditation

Key brain changes
strengthens auditory/language regions, hippocampus

Emotional benefits
reduces anxiety, enhances spiritual connection

Brain waves
alpha, theta

Meditation Types Summary (page 1)

Type	Key Brain Changes	Emotional Benefits	Brain Waves
Mindfulness	Increases PFC, hippocampus	Reduces stress, improves focus	Alpha, Theta
Loving-Kindness	Increases anterior cingulate cortex, insula	Enhances compassion, reduces depression	Gamma
Focused Attention	Strengthens PFC, ACC	Improves attention, self-control	Beta
Transcendental (TM)	Strengthens PFC, reduces amygdala activity	Deep relaxation, lower stress	Alpha, Theta
Open Monitoring	Enhances DMN regulation, insula	Reduces overthinking, improves self-awareness	Theta, Gamma

Meditation Types Summary (page 2)

Type	Key Brain Changes	Emotional Benefits	Brain Waves
Body Scan	Increases somatosensory cortex, reduces amygdala	Reduces tension, improves pain management	Theta
Yoga Nidra	Reduces cortisol, improves hippocampus function	Enhances deep relaxation, sleep quality	Delta
Mantra Meditation	Strengthens auditory/language regions, hippocampus	Reduces anxiety, enhances spiritual connection	Alpha, Theta