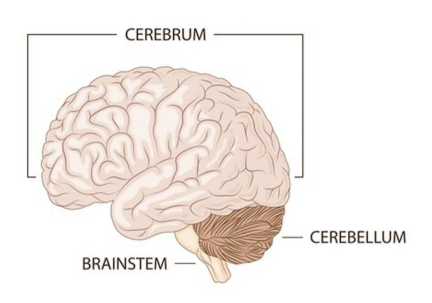
Central Nervous System

The Brain	Receives and processes sensory information, initiates responses, stores memories, and generates thoughts
Spinal Cord	Conducts signals to and from the brain, controls reflex activities.

The Brain Structure

Cerebrum	The largest part of the brain, made up of the *cerebral cortex* and other structures. The cerebrum is divided into *two hemispheres.*
Cerebellum	Coordinates movement by combining information from the eyes, ears, and muscles.
Brainstem	Connects the *cerebrum* and *cerebellum* to the *spinal cord.* The brainstem controls unconscious processes like sleep.

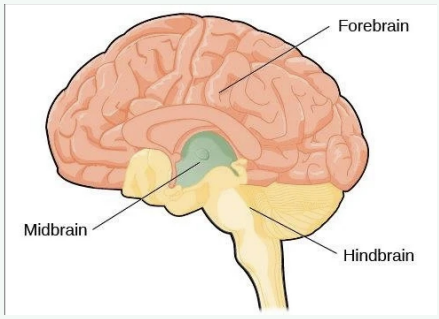
The Brain Structure Visual



Divisions of the Brain

Forebrain	Processes sensory information, helps with reasoning and problem-solving, and regulate autonomic, endocrine, and motor functions
Midbrain	Helps to regulate movement and process auditory and visual information
Hindbrain	Helps regulate automatic functions, relay sensory information, and maintain balance and equilibrium

Divisions of the Brain Visual



The Limbic System

Limbic System	(Primitive brain), regulates emotions (basic survival instincts), influences memories/learning, and motivation (basic drives).
Thalamus	Sensory relay center, receives input from all our senses except olfaction, critical in the perception of pain

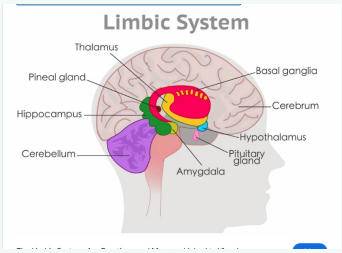
The Limbic System (cont)

Hippocampus	Stores memories, consolidation of conscious memories, stores new information and events as lasting memories
Amygdala	Processing fearful and threatening stimuli. Includes threat detection and activation of fear-related behaviors.
Hypothalamus	Maintains the body's homeostasis, (regulates temperature, hunger, thirst, sleep-wake cycle). Produces hormones that stimulate or inhibit the release of hormones from the pituitary gland.
Corpus Callosum	Connects the brain's left and right hemispheres, allowing them to communicate
Basal Ganglia	Motor learning, executive functions and coordination of movement, posture, inhibitory (allows us to be still)
Olfactory Bulb	is a part of the brain that processes smell

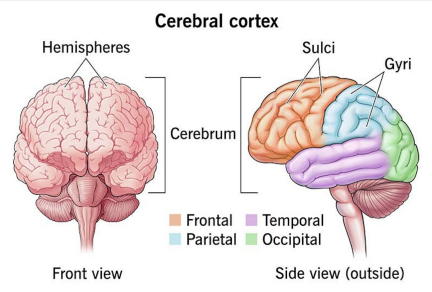
The Limbic System (cont)

Cingulate gyrus	Involved in regulating emotions, processing pain, and regulating autonomic motor function.
Pineal gland	Helps control the circadian cycle of sleep and wakefulness by secreting melatonin.
Suprac-hiasmatic Nucleus (SCN)	Controls the body's circadian rhythms

The Limbic System Visual



The Cerebral Cortex Visual



The Cerebral Cortex

Cerebral Cortex	Involved in many high-level functions, such as reasoning, emotion, thought, memory, language and consciousness.
Frontal Lobe:	the largest portion of the brain (about ⅓ of the entire brain) divided into ***prefrontal cortex,*** *premotor area,* and *motor area*
Parietal Lobe:	Primary sensory areas that process somato-sensory information, sensations of touch, pain, heat, and proprioception.
Temporal Lobe:	Auditory processing, memory information retrieval, and involved in emotional behavior. Connected to limbic system (hippocampus, amygdala, etc).
Occipital Lobe:	Visual perception, visual interpretation, and reading

Frontal Lobe

Left Frontal Lobe:	language, speech, and cognitive tasks. Includes ***broca's area***
Right Frontal Lobe:	non-verbal communication (facial recognition) and enviro-nmental awareness
Prefrontal Cortex (PFC)	Integration center for all sensory information and executive functions (decision making, planning, working memory, personality expres-sion, social behavior, speech and language). *Personality center*
Broca's area	Controls the muscles that produce speech and language comprehension

Parietal Lobe

Left Parietal Lobe:	Directing attention, visual & spatial skills
Right Parietal Lobe:	Motor routines and linguistic skills (reading, writing)

Temporal Lobe

Left Temporal Lobe:	Verbal memory and language comprehension. Includes ***wernicke's area.***
Right Temporal Lobe:	Visual memory

Temporal Lobe (cont)

Wernicke's Area	Language comprehension = receives auditory signals from the ear and processes them to understand the meaning of spoken words

?

How does the SCN interact with the Pineal Gland?

> The SCN sends messages to the pineal gland, which triggers the release of melatonin at night and triggers the release of cortisol and other hormones to help you wake up in the morning.

Peripheral Nervous System (PNS)

Somatic Nervous System:	Sends and receives sensory messages that control voluntary motor movement of the skeletal muscles
Automatic Nervous System:	Controls automatic or involuntary bodily functions of the smooth muscles and glands

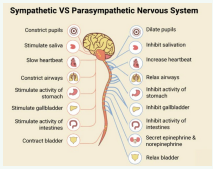
Automatic Nervous System (ANS)

Primary Function:	Maintain homeostasis (e.g., digestion, heart rate, & breathing)
Sympathetic Nervous System (SNS)	The Body's mobilizing system. Prepares the body for stressful or energetic activity (e.g., fight or flight)

Automatic Nervous System (ANS) (cont)

Parasympathetic Nervous System (PNS)	Dominates during rest state, directs maintenance activities (e.g., rest and rumination)

Sympathetic & Parasympathetic Effects



Myelination of the Vagus Nerve

Vagus Nerve	A major nerve in the parasympathetic nervous system that helps regulate heart rate, digestion, and emotional responses.
Myelination	The process of covering nerve fibers with myelin, which improves the speed and efficiency of nerve signaling.

Social Connection & Nervous System Development:
Safe Connection with Another Mammalian Nervous System:
This suggests that **social interactions,** particularly safe and supportive relationships, help stimulate and develop the vagus nerve.

Neuro Disorders

Brain Locus of Neurological Disorders

Type	*Disorders/ Description*	*Locus of the Brain*
Movement disorders	tics/OCD/-tourettes	Basal Ganglia
Speech deficits		left frontal broca's; left temporal Wernicke's
Sleep disorders		hypothalamus; pineal gland; SCN
Memory		
Wernicke's aphasia	problems understanding speech	left temporal lobe
Broca's aphasia	inability to express language	left frontal lobe

Brain Areas for Neurological Disorders

Delirium

Alzheimer's Disease (AD)

Parkinson's Disease

Huntington's Disease (Chorea)

Pseudodementia

Major Frontotemporal Neurocognitive Disorder
Major Neurocognitive Disorder Due to HIV Infection
Neurocognitive Disorder due to Traumatic Brain Injury

Wernicke's Encephalopathy (WE)

Most often arises in people with **AUD**

Symptoms:	Paralysis of the eye muscles, ataxia, confusion

Caused by thiamine deficiency (vitamin B1)

Other causes:	severe malnutrition, prolonged vomiting, extended IV nutrition, cancer, immunodeficiency, liver disease, hyperthyroidism, and severe anorexia.
Risk:	If left untreated, **WE** can lead to **Korsakoff syndrome (KS)**

Wernicke-Korsakoff Syndrome

The disorder is associated with patients fabricating stories in the setting of clear consciousness. Confabulations can be spontaneous or provoked

Cause:	Severe brain disorder caused by a deficiency of thiamine (vitamin B1)
Symptoms:	Memory disturbances in which there are significant deficits in **anterograde** and **retrograde memory**

Immediate memory is maintained, but short-term memory is diminished with intact sensorium.

Parkinson's

Features:	Movement disorder with tremors, rigidity, bradykinesia, shuffling gait, and neuropsychiatric symptoms (e.g., depression, neurocognitive disorder).

Parkinson's (cont)

Brain Locus:	Caused by the gradual loss of dopaminergic neurons in the **Substantia Nigra** (part of the **Basal Ganglia**, which regulates voluntary movement).

Treatment & Psychopharmacology

Levodopa (L-Dopa) -	Dopamine precursor to improve movement
Carbidopa -	Reduces Levodopa side effects (e.g., nausea, hypotension) and enhances its effectiveness.
Dopamine Agonists -	Stimulate dopamine receptors
Enzyme Inhibitors -	**MAO-B** and **COMT inhibitors** slow dopamine breakdown.
Amantadine -	Helps reduce involuntary movements
Anticholinergics -	Reduce tremors and muscle rigidity
Deep Brain Stimulation (DBS) -	Surgical treatment for severe cases

Alzheimer's Disease (AD)

Definition:	The most common major neurocognitive disorder (NCD), accounting for up to 80% of cases.

Alzheimer's Disease (AD) (cont)

Prevalence:	Affects 1 in 8 people over 65, more common in women due to longer life expectancy.
Neuropathology:	**Acetylcholine deficiency**, affecting learning and memory; **Amyloid plaques & neurofibrillary tangles**; Damage to the **hippocampus and amygdala**
Disease Progression:	Begins **up to 20 years** before symptoms appear. 1: pre-clinical (no symptoms), 2: MCI, 3: dementia due to AD

Symptoms

Early:	Memory loss, apathy, depression
Progressive:	Disorientation, confusion, impaired judgment, behavioral changes, motor and gait issues
Late:	Loss of communication, failure to recognize loved ones, bedridden

Types of Dementia

Alzheimer's disease:	The most common type, characterized by the accumulation of **amyloid plaques** and **tau tangles** in the brain

Types of Dementia (cont)

Vascular dementia:	Caused by **damage to blood vessels** in the brain, which reduces blood flow and oxygen to the brain
Lewy body dementia:	Characterized by the presence of abnormal protein deposits called **Lewy bodies** in the brain.
Fronto-temporal dementia:	Affects the **frontal** and **temporal lobes** of the brain, leading to changes in *behavior, **personality**, and language*
Mixed dementia:	A combination of two or more types of dementia

Dementia VS. Pseudo-dementia

Pseudo-dementia	Cognitive impairment in older adults due to **depression**, mimicking a neurocognitive disorder (NCD).

Key Differences

Dementia (NCDs)	Pseudodementia
Progressive cognitive decline	Slower processing speed, difficulty with concentration and attention, psychomotor retardation
Patients often **deny** memory issues	Patients **acknowledge** memory loss
Irreversible deteri-oration	Cognitive function **improves** once depression is treated

Sleep Patterns Over the Lifespan

REM sleep decreases with age:	**Newborns:** 50%; **5-year-olds:** 20–25%; **Older adults:** 18%
Functions of REM Sleep:	*Psychological restoration;* **Memory consolidation** & *emotional processing; Brain development; Dreaming* (often bizarre and illogical)

Movement Disorders

Originates in the:	**Basal Ganglia**
Definition:	Abnormal repetitive movements
Basal Ganglia:	also the reservoir of our over-l-earned motor patterns, like riding a bike, automatic daily habits, backing out of the driveway, etc.
Hyperk-inetic	Excess or involuntary movements *(e.g., huntington's disease/chorea, tremors, tics/ tourette's syndrome)*
Hypoki-netic	Slow or reduced movements *(e.g., parkinson's disease, dementia with lewy bodies)*

Huntington's Chorea

Cause:	Genetic disorder causing degeneration of **basal ganglia neurons**
Symptoms:	Choreiform (jerky, **involuntary movements)**; **Speech** outbursts; Progressive **cognitive decline**

Huntington's Chorea (cont)

Onset:	Typically **40–50 years;** often passed down before symptoms appear
Treatment:	No cure available

Parkinson's Disease

Cause:	Damage to the **Substantia Nigra, caudate nucleus, and putamen**, dopamine-rich brain areas essential for movement and mood regulation
Symptoms:	**Movement difficulties** (tremors, rigidity, slowed initiation); **Depression, psychosis** in severe cases
Possible Cause:	Bacterial infections (e.g., from foodborne pathogens) may travel via the **Vagus nerve**, leading to inflammation and degeneration
Preval-ence:	Increasing significantly (e.g., Michael J. Fox as a well-known case)

Treatment

L-Dopa (dopamine precursor)	helps temporarily replenish **dopamine** and **slow symptom progression**
Music Therapy	may aid **movement** and **mood regulation**

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Not published yet.
Last updated 9th March, 2025.

Tourette's Syndrome

Brain Area:	basal ganglia, frontal lobes and cortex
Comorbidities:	OCD; ADHD; Anxiety

Five A's of Neurologic Symptoms

Ataxia	Impaired coordination, balance, and speech
Common Cause:	Damage to the **cerebellum** or motor areas
Apraxia	Inability to perform skilled movements or gestures (e.g., difficulty winking)
Common Cause:	**Parietal lobe damage**
Aphasia	Impaired speech or language comprehension
Types & Causes:	Receptive aphasia; Expressive aphasia; Conduction aphasia
Receptive Aphasia	Damage to **Wernicke's area (left temporal lobe)**; speech is not understood
Expressive Aphasia	Damage to **Broca's area (posterior frontal lobe)**; difficulty producing speech
Conduction Aphasia	Damage to neural pathways connecting these areas, affecting verbal repetition
Anomia	Difficulty naming objects, people, or terms
Common Cause:	Likely damage to the **hippocampus, thalamus**, or *other memory retrieval areas*

Five A's of Neurologic Symptoms (cont)

Agnosia	Inability to recognize objects, people, or sensory stimuli
Common Cause:	Brain damage from **strokes, injuries, dementia**, or *neurological disorders*
Subtype of Agnosia:	Prosopagnosia ("Face Blindness")
Prosopagnosia	Difficulty recognizing faces

Brain injuries

Traumatic Brain Injuries & Concussions

External Trauma:	Direct blow to the head, often blood vessels are torn so blood flow is blocked, tissue dies
Internal Trauma:	stroke (either clot or brain bleed) ,aneurysm, or brain tumor (internal trauma)
Aftereffects of **Head Trauma:**	Can cause memory impairments (post-traumatic amnesia, persistent memory deficits), executive functioning disturbances, and personality changes

Traumatic Brain Injuries & Concussions (cont)

Phineas Gage Case (1848):	The most well-known case of frontal lobe dysfunction. His injury led to drastic personality changes, later associated with **"frontotemporal dementia."**
Aftereffects of **Concussions:**	May result in a short-term loss of consciousness, anterograde amnesia (difficulty forming new memories), and retrograde amnesia (loss of past memories)
Common symptoms:	Dizziness, headache, fatigue; Difficulty concentrating, memory deficits; Irritability, anxiety, insomnia; Heightened sensitivity to noise and light; Hypochondriacal concerns

Location of Brain Trauma & it's Impact

Aphasia:	Loss of Speech or Language Comprehension

Location of Brain Trauma & it's Impact (cont)

Receptive Aphasia *(Wernicke's Aphasia)*:	Damage to the **left temporal lobe** *(Wernicke's area)* impairs *language comprehension*. The person may *speak in gibberish* but remain unaware of their incoherence. Temporal lobe damage can also affect *semantic and long-term memory*.
Expressive Aphasia *(Broca's Aphasia)*:	Damage to the posterior **frontal lobe** *(Broca's area)* affects *speech production*. The person understands language and knows what they want to say but *struggles to verbalize it,* causing frustration.
Conduction Aphasia:	Damage to the neural pathways connecting **Wernicke's & Broca's areas** disrupts communication between *comprehension and speech production*. The person *cannot effectively repeat verbal phrases.*

Location of Brain Trauma & it's Impact (cont)

Global Aphasia:	Widespread damage affecting both *comprehension and speech production*, severely impairing *communication.*

Current Neuro-Imaging Options

PET Scan:	Quick, cost-effective images of basic structures, very useful as first-line assessment in emergencies to identify brain issues that need emergent care (brain bleeds, etc). **Uses radio**
MRI:	More expensive, detailed images possible with enhanced soft-tissue resolution to pick up more subtle structural issues. **Uses magnetic resonance**
CT Scan:	Detailed metabolic picture of brain function. Can give info about low (Alzheimer's, stroke/blood vessel damaging affecting function) or high (brain tumor or other inflammatory or cancer-related process). **Uses radioactive dye**

Memory/Types of Amnesia

Retrograde Amnesia:	Occurs after head trauma, such as a blow to the head. The person **cannot recall events leading up to the injury, sometimes spanning weeks or months before the event.** However, the ability to form new memories remains intact.

Memory/Types of Amnesia (cont)

Anterograde Amnesia	Seen in conditions like Alzheimer's disease, where **working memory fails, preventing the formation of new memories.** The person **struggles to learn new information,** making daily functioning difficult. Remote (long--term) memory, particularly music memory, is often preserved. Linked to damage in memory-related brain structures, such as the **hippocampus.**
Psychogenic Amnesia	Caused by **psychological factors** rather than physical brain damage. Follows different patterns from neurological disorders. *Short-term memory and the ability to form new memories remain intact. Long-term autobiographical memory is affected,* leading to loss of personal details (e.g., name, birthdate). Unlike *neurological amnesia,* where long-term memory tends to be retained.

Psychogenic Amnesia /(Psych) = Only one that long-term is affected

Differentiate Types of Seizures

Types of Seizures:	Generalized & Focal Seizures
Generalized Seizures **(Gran & Petit Mal)**:	Affect **both hemispheres** of the brain from the start and often cause loss of consciousness. *(grand mal & petit mal)*
Gran Mal:	Sudden loss of consciousness and stiffening (tonic activity), followed by clonic activity (rhythmic jerking). **Most well-known type.**
Petit Mal:	Brief episodes of staring, often mistaken for daydreaming. Occur most frequently in children. Last 0-30 sec
Focal Seizures **(Partial Seizures):**	Originate in a specific area of **one hemisphere** of the brain. They may or may not cause loss of awareness. *(simple partial & complex partial)*

Differentiate Types of Seizures (cont)

Simple Partial:	Person **remains conscious** and aware. Characterized by **abnormal movements** that begin in one group of muscles and **progress to adjacent groups of muscles** in a **slow** wave of seizure activity per location in the back of the **frontal lobe** motor area.
Complex Partial:	Person has **impaired consciousness** or awareness. May involve **staring, repetitive movements (lip-smacking, hand rubbing)**, or **confusion.** The person may not remember the seizure after it ends. Often a manifestation of **temporal lobe epilepsy**

Next Two Are Focal Seizures

Differentiate Types of Seizures (cont)

Jacksonian Seizure:	A type of focal seizure that originates in the **primary motor cortex** of the brain (part of the **frontal lobe**) and progresses in a characteristic pattern. Begins with localized **muscle twitching** (jerking movements) in a small part of the body, such as a finger, toe, or corner of the mouth. **Spreads gradually** to larger areas of the body *(e.g., from hand → arm → face)*.
Temporal Lobe Epilepsy (TLE)	A type of focal seizure. Originate in the **temporal lobes** of the brain. Common Symptoms Before: **Déjà vu.** Can turn into *tonic-clonic (grand mal) seizure.*

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Not published yet.
Last updated 9th March, 2025.

Neurotransmitter Functions & Effects

Neurotransmitter	Behaviors or Diseases Related
Acetylcholine (ACh)	Learning and memory; **Alzheimer's Disease's** muscle movement in the peripheral nervous system. + ACh = spasms. - ACh = paralysis
Dopamine (DA)	Reward circuits; Motor circuits involved in **Parkinson's disease; Schizophrenia**
Norepinephrine (NE)	Arousal; Depression
Serotonin (5HT)	**Depression,** Aggression; **Schizophrenia** behavior.
GABA	**Anxiety** disorders, **Epilepsy**; Major **inhibitory neurotransmitter** in the brain
Glutamate	Learning; Major **excitatory neurotransmitter** in the brain
Endogenous Opioids	Pain; Analgesia (inability to feel pain); Reward

KEY TERMS:
Mania: arousal, aggression
ADHD: learning, memory
Addiction: reward

Specific Disorders & Neurotransmitters

Alzheimer's disease	*Acetylcholine,* due to it's role in the development of memory of the hippocampus
(Repetitive) Movement disorders	*dopamine,* due to it's role in movement
Depression	Low *serotonin* and low *norepinephrine*
Mania	Low *serotonin* and high *norepinephrine*
Anxiety	Too little GABA.
Schizophrenia	Excess *dopamine; GABA & Glutamate* imbalance
Autism	Too much *serotonin; GABA & Glutamate* imbalance
Substance use disorder	

(Repetitive) Movement disorders: Parkinsons, tics, OCD

Glutamate and GABA

Maintain a homeostatic balance

Glutamate & GABA have a seesaw relationship

When *glutamate* is **high**, *GABA* is **low**

Children with **autism** and related disorders tend to lean towards **excess glutamate** and **low GABA**

Balance must be maintained for their bodies and nervous system to function properly

Excessive Levels of Glutamate: Can lead to excitotoxicity (overstimulation of neurons), contributing to neurodegenerative diseases (e.g., Alzheimer's, epilepsy, anxiety, stroke).

Deficiency in GABA: Can lead to excessive excitability, associated with anxiety, seizures, and insomnia.

Excessive Levels of GABA: Sedation, cognitive slowing, motor impairments.

Disorders Related to this Imbalance: ***Epilepsy*** (excess excitation, insufficient inhibition). ***Schizophrenia*** (dysfunction in both systems). ***Anxiety disorders*** (GABA deficiency).

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Disorders

Depression

Impact on the Brain:	Can lead to **brain shrinkage**
Neurotransmitter Imbalances:	*Serotonin, dopamine, and norepinephrine.* All of which are interconnected
Glutamate:	Profoundly out of balance

Depression (cont)

Treatment: *Mild to Moderate Depression*	Regular exercise can be as effective as antidepressants; Psychotherapy (CBT) to help address negative thought patterns
Treatment: *Moderate to Severe Depression*	Antidepressant medications may be necessary, though it can take time to find the right one. Side effects (e.g., sexual dysfunction, weight gain, emotional blunting) can be a challenge
Treatment: *Electroconvulsive Therapy (ECT):*	Used for severe or treatment-resistant depression, particularly when rapid symptom relief is needed (e.g., in cases of suicidality or catatonia).
Emerging & Alternative Options	
Ketamine therapy:	Research suggests it may rapidly reduce depressive symptoms, particularly in treatment-resistant cases

Depression (cont)

Transcranial Magnetic Stimulation (TMS):	A non-invasive treatment using magnetic pulses, effective for depression, OCD, and other conditions.

ADHD

Bipolar Disorder: Tx & Considerations

Mood Stabilizers:	Used to manage **mood swings** in bipolar disorder, preventing both **manic** and **depressive** episodes
Common Meds:	**Lithium; anticonvulsants** (e.g., valproate & lamotrigine); **atypical antipsychotics**
Electroconvulsive Therapy (ECT)	Typically used for **severe cases** of bipolar disorder or treatment-resistant depression; Involves brief **electrical stimulation** of the brain while the patient is under anesthesia. **Effective** for acute mood episodes but usually considered after medication and therapy have failed.

Psychotic Disorders

Medications that **block dopamine** can help reduce psychotic symptoms, particularly hallucinations and disorganized thinking, known as **"positive" symptoms** of *psychotic disorders*

However, **"negative" symptoms** *(e.g., apathy, low motivation, and reduced activity)* may be less responsive to treatment

Due to side effects, **medication adherence** is often a challenge for individuals with *psychotic disorders*

Panic Disorder

ECT Treatment

ECT involves a brief **electrical stimulation** of the brain while the patient is under anesthesia

Used in patients with **severe major depression** or **bipolar disorder** that has *not responded to other treatments*

Side effects:	**Memory loss** (retrograde amnesia) is a significant concern; Patients may experience **gaps in memory** from weeks to months before treatment; If ECT is repeated over time, **cumulative memory loss** can become disruptive

retrograde amnesia - an individual is unable to recall events that occurred before the onset of brain injury/ trauma, but ability to form new memories is intact.

Psychopharmacology

Antidepressants Classes

Drug Class	Function
SSRIs	Blocks reuptake of serotonin from space between neurons
SNRI	Block serotonin & norepinephrine reuptake
NDRI	Block reuptake of norepinephrine & dopamine
TCAs	Tricyclic antidepressants affects serotonin & norepinephrine
MAOIs	Block recycling of serotonin, norepinephrine, & dopamine
Others	Affect serotonin/ norepinephrine in other ways

SSRI Danger Warnings

Increased Youth Suicide Risk

Serotonin Syndrom

Neuroleptic Malignant Syndrome

Risk with Anticholinergic Agents

Seniors:	Anticholinergic agents interact with many common medications taken by older people
Risk of dementia:	Increased risk of dementia in people who used them for longer than a few months

Antipsychotics

Movement/Memory Medications

Sleep/Mood Medications

Neuroleptic Medications Side Effects

Tardive Dyskinesia

Serotonin Syndrome

Mild	Moderate	Life Threat-ening
Mydriasis (dilated pupils)	Altered Mental Status (e.g., agitation, disori-entation, excite-ment)	Delirium
Shiver-ing/Sw-eating	Autonomic Hyperactivity (e.g., rigidity, tachyc-ardia, hypert-hermia)	Hypert-ension/ Hypert-hermia
Tachyc-ardia (mild)	Neuromuscular Abnormalities (e.g., tremor, clonus, hyperrefl-exia)	Muscle rigidity/ Tachyc-ardia
	Management Stages:	
Observe for at least 6 hrs	Admit to hospital; Cardiac monitoring	Intensive Care Unit; cooling meaures
Benzod-iazepines	**Cyproheptadine**	Sedation; SkM paralysis; ventil-ation