UNIT 4: THE NERVOUS SYSTEM

QUESTION #4.1: What is the basic unit of the nervous system?

The **neuron is a single nerve cell**, and you have billions of them. There are three basic types of neurons: association, afferent, and efferent. The association neurons comprise the central nervous system (**CNS**) that is the brain and spinal cord. The **afferent neurons** are also known as the **sensory** neurons: they bring the stimuli from the sensors (e.g., skin, eyes, ears) to the CNS. The **efferent neurons** are also known as **motor** neurons: they bring the responses from the brain to the muscles and the glands. An analogy for afferent and efferent neurons is that they are like one-way streets: on a given neuron the traffic can only travel in one direction: to or from the CNS.

Here is how to remember the difference between afferent and efferent neurons. *A* comes before the letter *E* in the alphabet. The stimulus must come before the response. The afferent neuron must bring the stimulus to the CNS before the efferent neuron can bring the response from the CNS.

Most neurons are long, thin cells. One neuron stretches from the tip of your big toe to the base of your spine. At the beginning of the cell are the **dendrites** that pick up the stimulus from the sensor (or impulse from another neuron). At the other end are the terminal fibers, which end at another neuron (or at a muscle or gland). Between the two ends is the long middle, the **axon**. Here is a diagram not to scale. If it were more to scale it would look like a piece of dental floss, with the two frayed ends representing the dendrites and terminal fibers, respectively.

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                        direction of impulse
                      =========================>

             \ ------------------------------------ /
  dendrites -                 axon                   - terminal fibers
             / ------------------------------------ \
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Surrounding the axon is a sheath of **myelin, a white, fatty substance that insulates** the neuron much as the black plastic coating insulates an electrical wire. Myelin increases the speed at which a neural impulse passes through a neuron.

About a century ago, Santiago **Ramon y Cajal** determined that individual memories are not stored in individual neurons, but in networks of neurons.

QUESTION #4.2: How are neural impulses conducted and transmitted?

Conduction is when a neural impulse goes from one end of the neuron to the other. Neural impulses involve an electro-chemical spike that is conducted along the axon from the dendrites to the terminal fibers. This has a speed of several hundred meters per second, somewhat faster in a thick, fully myelinated neuron.

Neural impulses have a fairly constant voltage, a difference of electrical potential of about a tenth of a volt. Each time a neuron conducts an impulse, this is an **all-or-nothing** event: the neuron either conducts the impulse or it does not. When a stimulus is below the threshold for triggering an impulse, no impulse is sent.

So, the brain has no way of knowing about the intensity of the stimulus based upon the voltage of the incoming impulse. Whether it was a major pain or a minor tickle, the voltage of the neural impulse will be the same, due to the all-or-nothing nature of conduction. The only way that the brain can distinguish the intensity of stimuli is to look at the frequency with which the impulses arrive: the more intense the stimulus, the greater the number of impulses sent. A very painful stimulus might result in eight hundred impulses per second being conducted.

Transmission is the process of getting the impulse from one neuron to another. Unlike two electrical wires, the two neurons are not in direct contact, but there is a microscopic gap between them. The **synapse is the gap between the two neurons.** This gap stretches from the terminal fibers of the sending neuron to the dendrites of the receiving neuron. The impulse must pass over this gap before it is to get to the next neuron. This is a relatively slow point in the process of getting the message to or from the brain.

direction of impulse (stimulus to brain)

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                     ========================>
                          transmission

S      conduction                  S      conduction           B
E  --------------------------\   Y   \---------------------   R
N   AFFERENT (sensory) NEURON  }  N    }  ASSOCIATION NEURON   A
S  --------------------------/   A   /---------------------   I
O                                  P                           N
R                                  S
                                   E
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direction of impulse (response from brain)

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                    <==========================
                          transmission

M      conduction                  S       conduction          B
U   -------------------------/   Y   /---------------------   R
S    EFFERENT (motor) NEURON {    N  {    ASSOCIATION NEURON   A
C   -------------------------\   A   \---------------------   I
L                                  P                           N
E                                  S
                                   E
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Neurotransmitters are chemicals that work in the synapse to transmit the impulse from the sending neuron to the receiving neuron. The terminal fibers of the sending neuron have vesicles containing these chemicals. As the impulse arrives in the terminal fibers, the vesicles release the chemicals into the synapse. The chemicals then go across the microscopic synaptic gap and are received by tiny receptor sites in the dendrites of the receiving neuron. When a sufficient number of receptor sites have been filled, the receiving neuron then conducts the neuron impulse down its axon to its terminal fibers.

Importance of neurotransmitters

Neurotransmitter	**Role**	**Affects**	**Disorders**
Acetylcholine	Excitatory	Arousal, attention, memory, motivation, movement	Low in Alzheimer's
Dopamine	Inhibitory	Attention, learning, movement, pleasure	High in schizophrenia, low in Parkinson's
Serotonin	Inhibitory	Anxiety, dreaming, eating, sleep, mood, pain	Depression (Prozac, Paxil and Zoloft increase serotonin levels)
Noradrenaline Norepinephrine	Excitatory	Activity, alertness, eating, heart rate, learning, memory, mood, sleep	Depression (cocaine and amphetamines increase norepinephrine levels)
Gamma-amino-butyric acid	Inhibitory	Eating, sleep	Anorexia, bulimia
Endorphins Enkephalins	Inhibitory	Pain	
Substance P	Excitatory	Pain	

Dopamine is one example of a major neurotransmitter. When levels of dopamine are low, the individual might have difficulty sending out responses to the limbs or tongue. In one neurological disease, Parkinsonism, dopamine levels are low, and patients stutter in their speech, and their hands may tremor. A medication for Parkinson's, Levodopa, temporarily increases the levels of dopamine, and the patient can speak, walk, and write in a more normal fashion. However, right after receiving a daily dosage, Parkinson patients might have such abnormally high levels of dopamine that their neurons start transmitting information from the senses even though there is no physical stimulus, resulting in an hallucination.

Case Study: Mr. G was a retired real estate developer in Silicon Valley. He was diagnosed with Parkinson's Disease in his early fifties.

As it worsened, his dosage of Levodopa was increased. Although he lived in a well constructed house (that he himself had built) on a large lot in a quiet neighborhood of an exclusive suburb, he began to complain about the racket that the neighbors were making. He thought that one neighbor was using power tools working on a boat, playing music loudly, and using foul language. His wife could hear none of this. The neurologist concluded that that these morning auditory hallucinations were a side effect of his Levodopa dosage, and recommended a divided dosage. Then the reports of hallucination subsided both in frequency and intensity.

Schizophrenia is a serious mental disorder characterized by symptoms such as auditory hallucinations. Some of the older anti-psychotic medications (e.g., chlorpromazine) given to schizophrenics controlled symptoms such as hallucinations by reducing levels of dopamine. Unfortunately, prolonged use of these medications meant that some patients developed Parkinson-like symptoms.

Case Study: Ms. R is now in her sixties. She was initially hospitalized for schizophrenia in her mid twenties and has spent most of her life in mental institutions. She receives regular doses of anti-psychotic medications to reduce her hallucinations and disruptive behavior. Now her hands show an obvious tremor. Her eyes roll involuntarily. She tends to drool and her tongue frequently juts out, as if she were a frog trying to catch a fly. These extrapyramidal symptoms, such as **tardive dyskinesia**, are probably the side effects of long-term use of the medication, and its depletion of her dopamine levels.

Norepinephrine and serotonin are neurotransmitters that are generally in low levels in depressed patients. Medications like Prozac and other Selective Serotonin Reuptake Inhibitors **SSRIs** are usually effective in alleviating symptoms of depression in about four weeks.

Other important neurotransmitters are the catecholamines which can transmit arousal or inhibitory messages, and the endorphins which go into the opiate receptor sites and give the kind of natural high you get after a good physical workout.

Anything that affects the body's chemistry can impact the neurotransmitters and alter a person's mood, behavior, or mental performance. This would include legal drugs like caffeine (from tea and coffee), nicotine (from tobacco), and alcohol, as well as illegal drugs. Even fluctuating levels of **hormones** (the chemicals associated with sex) and the **endocrine** glands (e.g., pituitary, thyroid, adrenals) can cause such changes.

Case Study: Ms. H was a fourteen year old freshman at an exclusive girls' boarding school. She was from a relatively stable, intact family of financial means. During her first semester, she was a model student, earning a 3.5 GPA. After Christmas, her grades plummeted and she became a disciplinary problem in the dorm and during her frequent weekend visits home. Her parents suspected that she was getting in with the wrong crowd or using drugs. The school counselor suggested that she be given a thorough physical exam by her regular pediatrician during the upcoming spring break. The exam revealed that Ms. H was suffering from hyperthyroidism, making her moody, agitated, and unable to concentrate.

When she was given the proper medication, she returned to her old self. She exhibited no more disciplinary problems. Her academic success resumed.

Case Study: Ms. K is now in her mid forties and in the midst of menopause. Her hormonal levels are fluctuating rapidly. This is giving her physical symptoms, such as night sweats, and moodiness similar to an agitated depression. She gets angry or weepy for no apparent reason. When she was started on hormone replacement therapy to guard against loss of bone mass (osteoporosis) an added benefit was that her mood stabilized.

QUESTION #4.3: What is the role of the autonomic nervous system?

The **autonomic nervous system (ANS)** is part of the peripheral nervous system that either gets the body ready for action, or slows it down to conserve resources. The ANS governs such organs as the heart (speeding up or slowing down circulation) lungs (speeding up or slowing down respiration), and the release of glucose.

Autonomic nervous system		
	Sympathetic	**Parasympathetic**
Pupils	Dilate	Constrict
Glands stimulated	Sweat	Salivary, Tear
Heartbeat	Accelerates	Slows
Bronchial tubes	Dilate	Constrict
Digestion	Inhibited	Stimulated
Urine	Volume decreases	Bladder contraction
Liver glucose release	Stimulates	Inhibits
Digestion	Inhibits	Stimulates

The **sympathetic nervous system** activates the body's resources for the **fight or flight** response. When you suddenly see some danger, or are getting ready for a major athletic contest, you can feel the adrenaline kick in. Your respiration and heart rate increase. Your blood clots more readily. Nutrients are being released and sent to the major voluntary muscles so that you can run or engage in physical combat.

The **parasympathetic nervous system calms down the body** by inhibiting the aforementioned activities. This serves to conserve the body's scarce resources during times of injury or exhaustion. Here is how to remember the difference between the two: when you are injured, you need to call the PARAmedics. Think of the PARAsympathetic nervous system as the body's own paramedic.

Biofeedback is a way of monitoring the response of the ANS. Normally, the muscles and glands of the ANS are involuntary: we cannot consciously trigger the sympathetic or parasympathetic responses. However, with the technology of biofeedback, individuals can gradually learn to control these activities, achieving a greater degree of activation or relaxation. This can be of practical application in controlling such psychophysiologic disorders as asthmatic bronchial constriction or migraine headaches.

Diagram of the complete nervous system		
Central nervous system	Brain	Hindbrain
		Midbrain
		Forebrain
	Spinal cord	Ascending
		Inter-neurons
		Descending
Peripheral nervous system	Somatic division (voluntary muscles)	Sensory nerves
		Motor nerves
	Autonomic nervous system (involuntary)	Sympathetic
		Para-sympathetic

QUESTION #4.4: How can scientists study the brain?

Lesions are points of damage to neural tissue. In research on brain injuries, the site and scope of the damage would be the independent variable, and the resulting changes in behavior and emotion would be the dependent variable. Damage to the **CNS (central nervous system)** is serious because neural tissue (compared to say, skin cells) is less likely to regenerate. That is why cases of brain damage and spinal cord injury may involve permanent losses. When speech therapy or physical therapy helps these patients recover lost functions it is usually because they have been taught to use other parts of their brains to take over for the lost functions.

Case Study: In 1848, a railroad worker named Phineas Gage survived a horrible accident. While setting an explosive charge, it went off prematurely, sending a heavy tamping iron through his cheek and up through the front part of his brain. The most amazing thing is that Gage survived. Prior to the accident he was mild mannered and hard working. After the accident, for the rest of his life, he was cantankerous and belligerent, given to using profanity and alcohol. After he died, the physicians who examined his brain injury inferred that those parts of his injured brain (the frontal lobe) must have a major impact on human emotion.

While the location of brain injuries is an important factor in behavioral disturbances, there is no scientific credibility to the theories of **phrenology**, a pseudoscience which claimed that a person’s character could be inferred by examining the bumps on his head.

A comprehensive study of brain injuries was done by German neurologist Kurt **Goldstein**. In the wake of the First World War, he examined thousands of patients with brain injuries. While he agreed that there was a moderate correlation between where the injury occurred and the resulting behavioral changes, Goldstein noted a great degree of individual variation in terms of how well the patients succeeded in their rehabilitation. The nature of the brain injury was only one influence. Other important factors (independent variables) in successful outcome (the dependent variable) were the patient's age, social support, and pre-morbid personality.

ESB (electronic stimulation of the brain) is used in animal research. An electrode is implanted to a certain part of the brain, and this serves to directly stimulate that region (and constitutes the independent variable). The resulting changes in mood or behavior would constitute the dependent variable.

EEG (electroencephalography) is a technique for studying the electrical activity of the brain, the "brain waves." This technique involves placing electrodes on the scalp. It has been around since the 1930s. Electroencephalography can look at the entire brain, or evoked potentials for specific regions or neurons. It can identify a person's level of sleep or indicate if the person is undergoing a convulsion, such as epilepsy.

Brain scanning techniques involve computerized technology that has only been around for just over thirty years. **CAT** or CT (computerized axial tomography) assembles a three dimensional picture of the brain from thousands of separate x-rays. This is useful in detecting abnormalities of mass, such as tumors. It can also detect the later stages of some chronic brain syndromes, such as Alzheimer's Disease. Nuclear resonance magnetic imaging (**NMRI**) uses a powerful magnetic field to generate an even more detailed picture of the brain. **PET** (positron emission tomography) scans look at the metabolic function of different organs, including specific regions of the brain. Newer techniques of single photon emission tomography (SPECT) and brain electrical activity mapping (BEAM) offer hope for greater precision, validity, and reliability in looking at specific brain functions.

Electronic techniques for studying the brain

Acronym	***Complete term***	***What it measures***
ESB	Electronic stimulation of the brain	How brain responds to electrical stimulation of specific parts
EEG	Electro encephalography	Electrical wave activity
CT, CAT	Computerized axial tomography	Scans with x-rays, creates three dimensional image
PET	Positron emission tomography	Scans for metabolism
NMRI	Nuclear magnetic resonance imaging	Scans using magnetic fields instead of x-rays

QUESTION #4.5: What is the limbic system?

The **limbic system is a part of the brain that deals with emotions**, drives, and the internal organs. The limbic system includes the amygdala, hypothalamus and hippocampus. The amygdala is the center for sexual arousal, the aggressive drive, and fear. Experiments with lesions in animal brains indicate that damage to the amygdala can reduce aggressiveness. On the other hand, ESB experiments in animals indicate that stimulating the amygdala can produce aggressive or sexual behavior even when sufficient environmental cues might be lacking. After ESB stimulated his amygdala, one tomcat tried to mount females who were not in heat.

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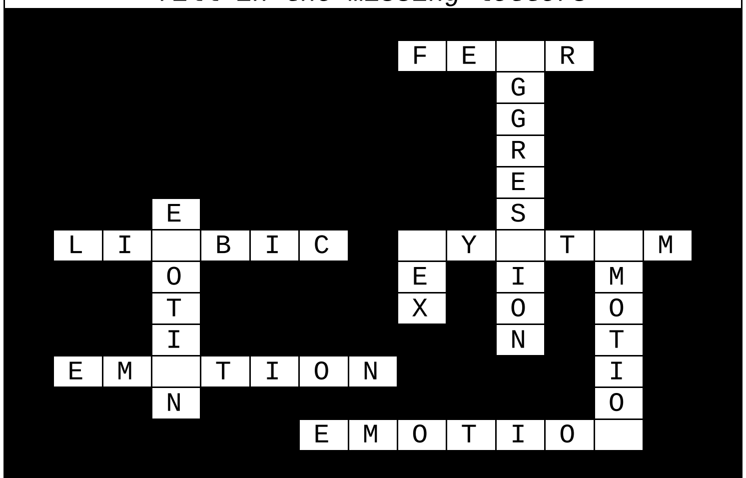

For an important part of the brain

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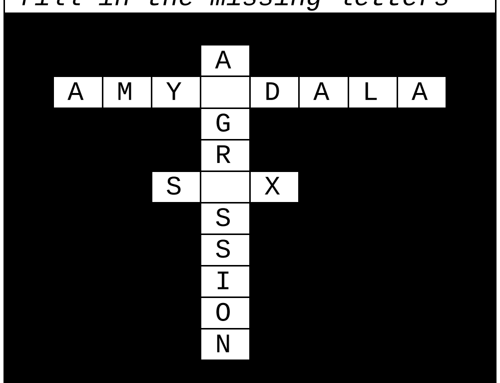

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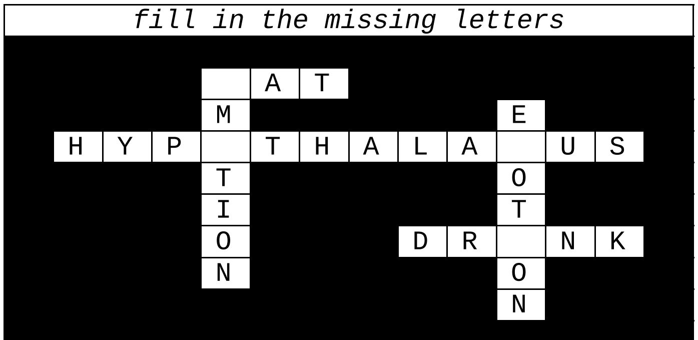


for a part of the brain

The **hypothalamus** also deals with emotions, as well as the drives for **hunger and thirst.** There is one part of the hypothalamus that initiates eating or drinking behavior by telling the organism that it is hungry or thirsty. There is a different part of the hypothalamus that tells the organism that it has had enough, and can stop eating or drinking. Lesions on the first part, the initiation center, can greatly reduce eating or drinking behavior. Lesions on the second part, the satiety center, can cause the organism to keep on eating or drinking to the point where the stomach can simply take no more.

The **hippocampus is primarily concerned with memory**, specifically with encoding memories for long-term use. We will discuss it more thoroughly in unit 7, on memory.

QUESTION #4.6: What is the role of the cerebrum?

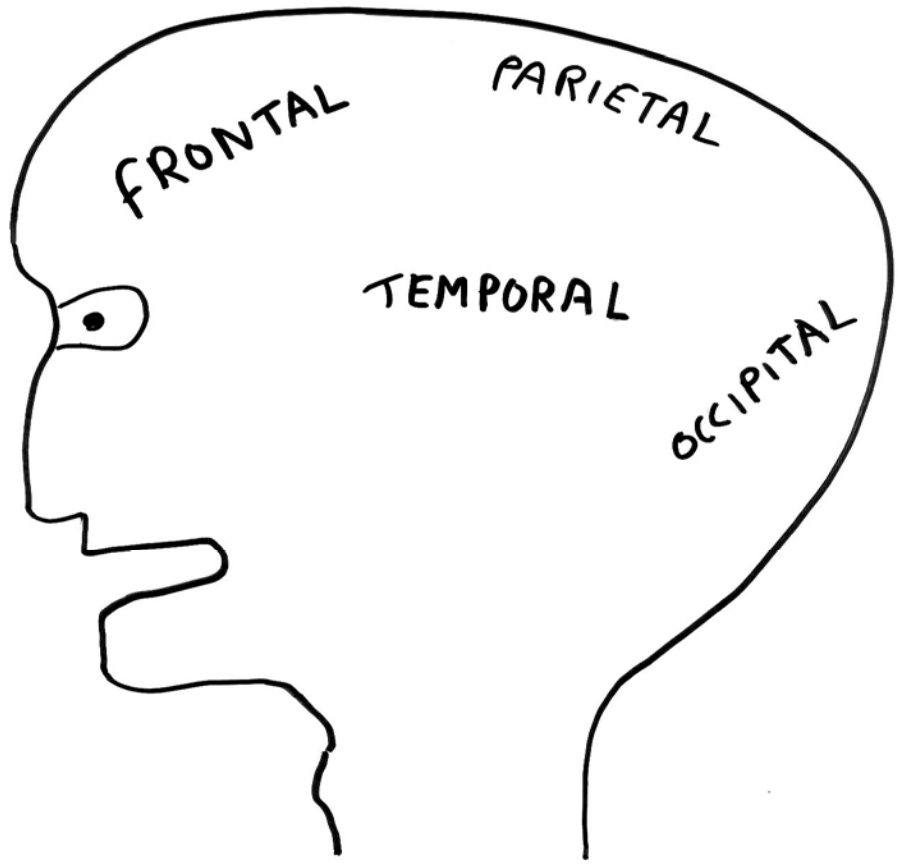
The cerebrum is the top most part of the brain. The **cerebrum deals with thinking**, voluntary muscles, and perception of stimuli. The cerebrum is the largest part of the human brain, but this is not the case with lower species. Invertebrate, fish, amphibian, and reptile brains have small cerebra. Birds, such as the parrot, have a larger cerebrum, and most mammals have one even larger. Whales and elephants have very large cerebra, but in proportion to their total body size, it is not nearly as large as the human cerebrum. Only dolphins are in the same league with humans: about two percent of body weight in the cerebrum.

Each part of the cerebrum, whether it deals with incoming sensory stimuli or outgoing motor responses, is highly specialized. The area of the brain devoted to a specific function is related to the complexity of the function. So, more of the cerebrum is devoted to the control of the tongue or thumb than to the leg because the tongue and thumb are much more complex in their activity. Specialized areas such as **Wernicke's** and **Broca's** are associated with language skills. Lesions to those areas can greatly reduce a patient's ability to understand or produce speech.

The **cerebral cortex is the outermost layer** of the cerebrum. Its primary function is to **process new information**. Cortical atrophy can lead to disorientation in place or time.

The lobes are the four main areas of the cerebrum, as they are divided by various fissures. Each lobe tends to specialize. The frontal lobe is just behind the forehead. The **frontal lobe** deals with the control of **emotion**. Just below the frontal lobe is the **thalamus, which acts as a relay station** of neural impulses from the limbic system to the frontal lobe. Damage to this area (as seen in the case of Phineas Gage) may make the individual less able to control emotional expression. On the other hand, other types of damage in this area may serve to blunt the individual's overall level of emotionality. Indeed, one particular psychiatric treatment developed in the 1930s was a brain surgery known as pre-frontal **lobotomy**, which severed the connective tissues between the thalamus and the frontal lobe with the expressed purpose of reducing the patient's emotions of fear, anger or sadness.

Lobes of the cerebrum



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for a part of the brain

Parts of the brain		
Part	**Location**	**Function**
Medulla	Hindbrain	Controls autonomic system activity, breathing
Pons	Hindbrain	Bridge connecting other parts of brain
Cerebellum	Hindbrain	Coordinates muscular movements
Reticular formation	Midbrain	Controls level of arousal, alertness
Corpus callosum	Forebrain	Connects hemispheres
Cerebral cortex	Forebrain Cerebrum	Processes new information from the senses, motor response
Frontal lobe	Forebrain Cerebrum	Emotions
Occipital lobe	Forebrain Cerebrum	Vision
Temporal lobe	Forebrain Cerebrum	Hearing
Parietal lobe	Forebrain Cerebrum	Other senses
Left hemisphere	Forebrain Cerebrum	Logic, math, language
Right hemisphere	Forebrain Cerebrum	Spatial relations
Broca's area	Forebrain	Language
Wernicke's area	Forebrain	Language
Limbic system	Forebrain	Emotions
Hippocampus	Forebrain	Memory
Thalamus	Forebrain	Connects limbic system and frontal lobe of cortex
Hypothalamus	Forebrain	Emotions, hunger, thirst
Septal area	Forebrain	Processes cognition into emotion
Cingulus	Forebrain	Processes cognition into emotion

The temporal lobe is just in from the ears, on either side of the head. The **temporal lobe** processes the sense of **hearing.** Lesions on the temporal lobe can create hearing loss, even when there is nothing wrong with the ear or auditory nerve.

T E M P O r a l   tempo of the music you hear

The occipital lobe is in the back of the head. The **occipital lobe** processes the sense of **vision.** Lesions on the occipital lobe can result in blindness, even when there is nothing wrong with the eyes or optic nerve.

O ***C C*** **I** P **I** T A L   two I's (eyes) help you CC (see, see)

The **parietal lobe** is at the top of the head, just about where many fifty year old men get a bald spot. The parietal lobe processes the **other senses**, such as those coming from the skin.

Do not confuse the cerebrum with the cerebellum. The cerebellum is located just below the occipital lobe. It is much smaller than the cerebrum, about the size of your fist. The **cerebellum is concerned with posture, balance and coordinated locomotion**. The cerebellum will be highly developed in species that must run, jump or fly fast.

QUESTION #4.7: What is the role of the left and right hemispheres?

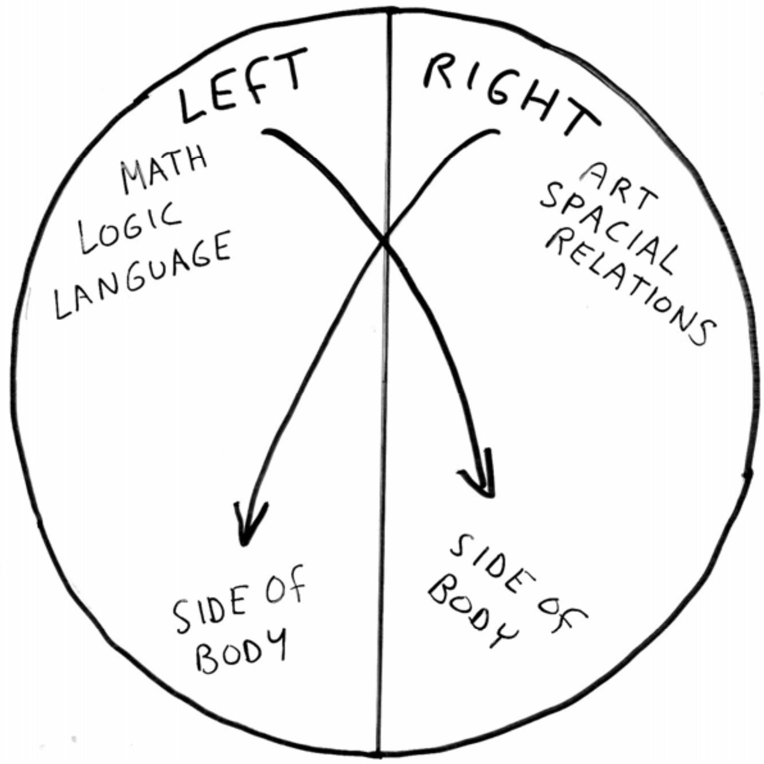
Although the brain appears to be symmetrical, the left and right halves (hemispheres) are somewhat specialized. Each one controls the other side of the body, which is why an injury to the left side of the brain (or a stroke) can result in paralysis on the right side of the body.

The right hemisphere is more concerned with spatial processing.

Case study: Mr. T was a 61 year old man who suffered a stroke in the right hemisphere, occipital lobe. When he awoke in the hospital, and his wife entered the room to see him, he did not recognize her until she spoke. His ability to recognize faces had been lost.

The left hemisphere is more concerned with skills such as language, mathematical computation, logical and sequential thinking.

Case Study: When Mr. J was a young boy in Mexico, he was shot in the head. The small caliber bullet entered his left hemisphere at about the hairline, and exited just above the occipital lobe. He almost died from the wound, and for a year he could not walk or talk. Gradually, he regained both of these abilities, but only as other parts of the brain could learn to take over the lost functions. Before the accident, he was right handed, but since then his right arm and leg have been weaker than his left. Before the accident, he attended school and was a very good student in reading, writing, and arithmetic. After the accident, he was unable to read or write, use a digital watch, or perform the most simple calculations.

Role of the cerebral hemispheres


Research on cerebral hemisphere specialization	
Researcher	Gazzaniga
Subjects	Patients who had undergone surgery to diminish seizures: the corpus callossum was severed so that the left and right hemispheres were no longer connected
Independent Variable	Visual stimuli (objects) were presented either on the right or left sides
Dependent Variable	What the subject reported was seen
Results	When shown objects on the left side, the subject could identify the objects by pointing to them, but could not verbally name them
Conclusion	Objects on the left side were interpreted by the right hemisphere, which has less of a verbal ability

Handedness is the preference to consistently use one hand for a particular task, such as writing or throwing a ball. Only about ten percent of the population is thoroughly left handed, while about four fifths are right handed in everything they do. The remaining small percent have what is sometimes known as cross-preferences, and may write with one hand, yet throw with the other. There are low to moderate correlations between left-handedness and artistic interest.

QUESTION #4.8: What are the main diseases of the brain?

Several psychiatric conditions are due entirely to major disturbances of brain function, even when the individuals have been entirely normal throughout their lives.

Delirium is a disturbance in the brain's metabolic function. The delirious patient is usually seen in hospital emergency and intensive care units, rather than the private practice of a clinical psychologist. The delirious patient is going in and out of a fitful sleep. He is probably hallucinating, and may be talking incoherently. If he could be assessed for orientation, he would be found disoriented for place and time.

Delirium is due to an acute brain syndrome that has disturbed metabolism. This can be something as simple as exposure to industrial chemicals (e.g., lead, mercury), illegal drugs, or the interactions of prescription medications. Deficiencies of B vitamins or minerals such as potassium can lead to delirium, especially in the aged. Extreme fever or dehydration can produce delirium (e.g., travelers wandering in the desert, sailors on a raft, patients suffering from diarrhea).

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DISORDER: delirium

OLDER TERMS: acute brain syndrome

CLASSIFICATION: organic (old term)

SYMPTOMS: confusion, disturbed sleep, hallucinations

CAUSES: dehydration, exposure to toxic substances, medication interactions and side effects

TREATMENT: correcting the underlying medical condition

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The key to treating delirium is to remove the underlying cause: detoxification, rehydration, vitamin supplements, etc. The prognosis is that the patient will probably make a full recovery to his pre-morbid state of functioning, or die if the conditions that resulted in the delirium are not corrected. Indeed, many dying patients go through a delirious state on their final death trajectory as various organ systems shut down, disturbing the brain's metabolism.

Dementia is a loss of mental capacity in adulthood (especially later life when it is known as senile dementia). While the vast majority of cases of dementia occur in later life, it is an ageist stereotype to think of old people as having reduced mental capacity. Only ten percent of people over age 65 have clinically relevant dementia, which is different in degree and quality from the benign forgetfulness associated with the normal processes of aging.

symptoms	**NORMAL AGING**	**DEMENTIA**
Vulnerable memories	Recent past	Recent past
Scope of forgetting	Details of event	Entire event
Remembers later	Sometimes	Rarely
Follows instructions	Usually	Increasingly difficult
Can use memory aids	Usually	Increasingly difficult
Belligerence	Rare	More frequent as disorder progresses

The initial dementia symptom is a loss of short term memory. As the condition worsens, the patient may lose orientation in time, and not remember what day of the week it is. The ability to follow instructions diminishes. At this early stage, minor depression and paranoia may arise. At a more advanced stage, the patient may lose orientation for place, and get lost, even in familiar territory. At a later stage, the patient may not be able to recognize family members, or even put a sentence together. About this time, the parts of the brain that govern the bowels and bladder may go out, yielding incontinence. The patient may be unable to dress or feed himself. Later he may choke on food, or his own saliva. The part of the brain governing respiration may become impaired, and he may require a ventilator to keep breathing. Eventually, the parts of the brain governing the heartbeat will go out, and heart failure will ensue.

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DISORDER: dementia

OLDER TERMS: chronic brain syndrome

CLASSIFICATION: organic (older term)

PREVALENCE: 10 - 20% of people over age 65

SYMPTOMS: loss of short term memory, emotional instability, loss of social skills

AGE OF ONSET: more prevalent after age 65

CAUSES: Alzheimer's disease, vascular (multi-infarct), alcoholism, general paresis

TREATMENT: memory training, some medications may slow progression

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decline in Alzheimer's disease

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l       |
e       |
v       |
e       |
l       | * *  confusion about time
        |     *
o       |        *
f       |           *
        |              *  confusion about place
f       |                *
u       |                  *
n       |                    *  confusion about person
c       |                      *
t       |                         *
i       |                            * language loss
o       |                               *  cannot feed self
n       |                                  *  chokes on food
i       |                                     *
n       |                                        * needs respirator
g       |                                            * death
        ---------------------------------------------------------
        0       1       2       3       4       5       6       7

                years since diagnosis
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decline in vascular (or multi infarct) dementia

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l       |
e       |
v       |
e       |
l       | * *  confusion about time
        |     *
o       |      * confusion about place
f       |      *  * *  *
        |              *  confusion about person, language loss
f       |              *  *  *  *  *
u       |                          *
n       |                          *
c       |                          *
t       |                          *
i       |                          *
o       |                          *
n       |                          *
i       |                          *
n       |                          *
g       |                          * death
        ---------------------------------------------------------
        0       1       2       3       4       5       6       7

                years since diagnosis
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Case Study: Ms. T, at age 81 went to live with her grandson and his wife. The reason for the move was that Ms. T was getting too confused and frightened living alone, and was no longer capable of getting money out of the bank or paying her bills. Physically strong, Ms. T would spend most of the day working outside in the large yard, quickly filling up each of four garbage cans with clippings. Her grandson told her to leave one can empty for the garbage coming from the house. She could not remember this and still filled up all four cans. A reminder note was written on one of the cans, but she either did not understand it, or decided not to follow the instructions. One garbage can had to be chained closed so that she could not get into it. The same thing happened in the kitchen. She was told that she was not supposed to use the stove, but used it anyway, ignoring written notes. Finally, a baby fence was put up between the kitchen and the dining room. She kept on getting the mail from the mailbox, and then putting it down somewhere and could not remember where. A new mailbox with a lock was purchased to keep her out. Six years later, Ms. T started wandering off and getting lost outside, and getting violent during bath time. Then the grandson's wife decided that it was time to have Ms. T go to a nursing home.

Dementia can be caused by over fifty different chronic brain syndromes. Many of these are treatable, such as adult hydrocephalus (“water” on the brain) in which an operation can implant a ventricular shunt for reducing the pressure of cerebral spinal fluid on the cortex. If the dementia is due to a cerebral vascular insufficiency, then carotid artery surgery might improve blood flow to the brain in some cases.

Unfortunately, the vast majority of the cases of late life dementia are due to chronic brain syndromes that are not reversible. At least half of all cases of late life dementia are due to **Alzheimer's disease**. We are not certain what the cause of this disease is, and we have no way to cure it. At best, some medications can slow its advance. Psychotherapy and memory training can help patients and their caregivers cope with the gradual advance of this debilitating disorder.

	DELIRIUM	**DEMENTIA**
Organic brain syndrome	Acute	Chronic
Most common cause	Medication interaction	Alzheimer’s
Other common causes	Dehydration, fever, poison, vitamin deficiency	Stroke, vascular
Type of disturbance	Metabolic	Usually lesions
Onset	Rapid	Gradual
Memory Impairment	Yes	Yes
Disorientation	Yes	Yes
Prognosis	Recovery or death	Slow decline
Sleep disturbance	Usually	Occasionally