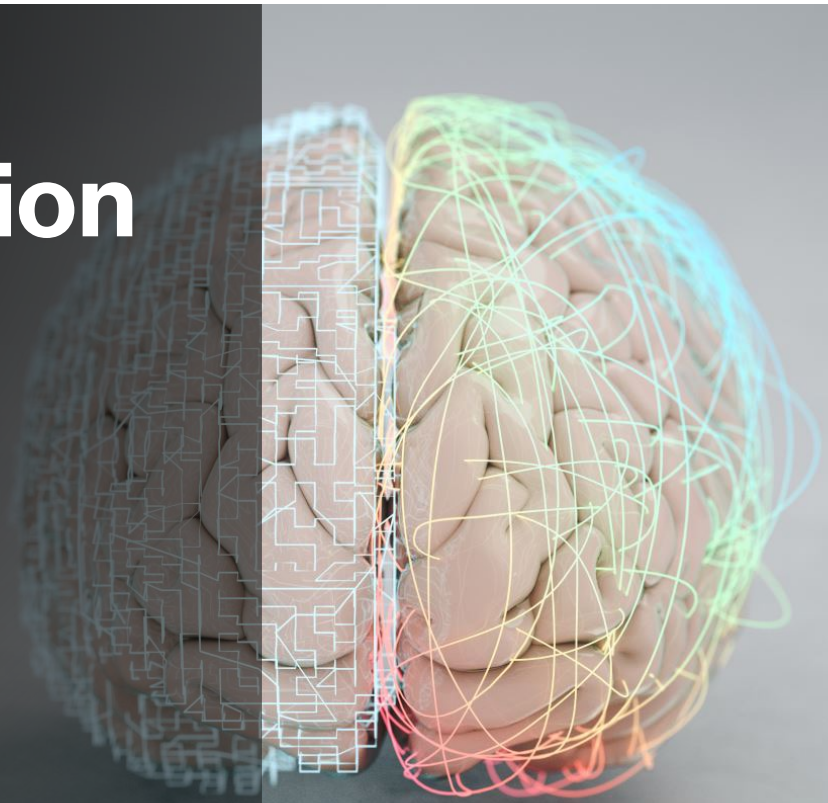
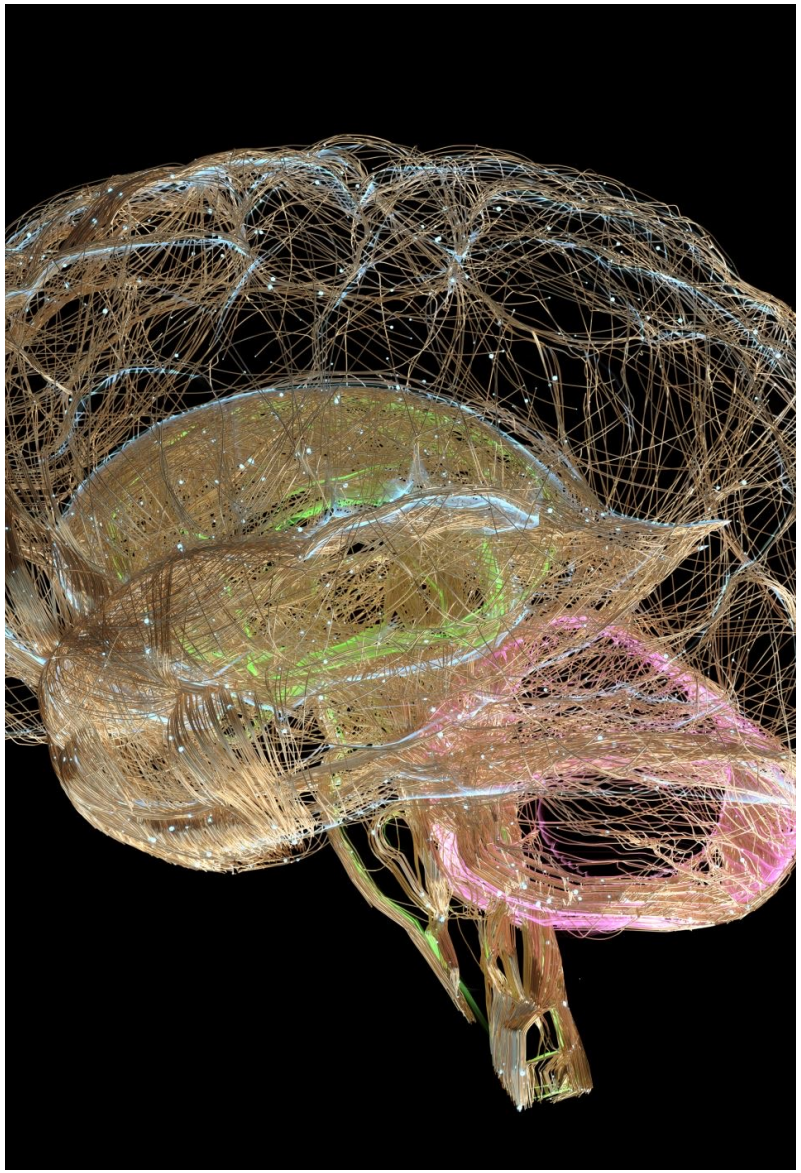
Lateralization of Brain Function



"The brain is asymmetrical in almost everything that can be measured, at many levels, in both its structure and function. Why? (McGilchrist, 2021, p. 35)

Across all mammals including humans and as a result of evolution, the brain has two sides (hemispheres).

What might be the advantage of having two sides of the brain?

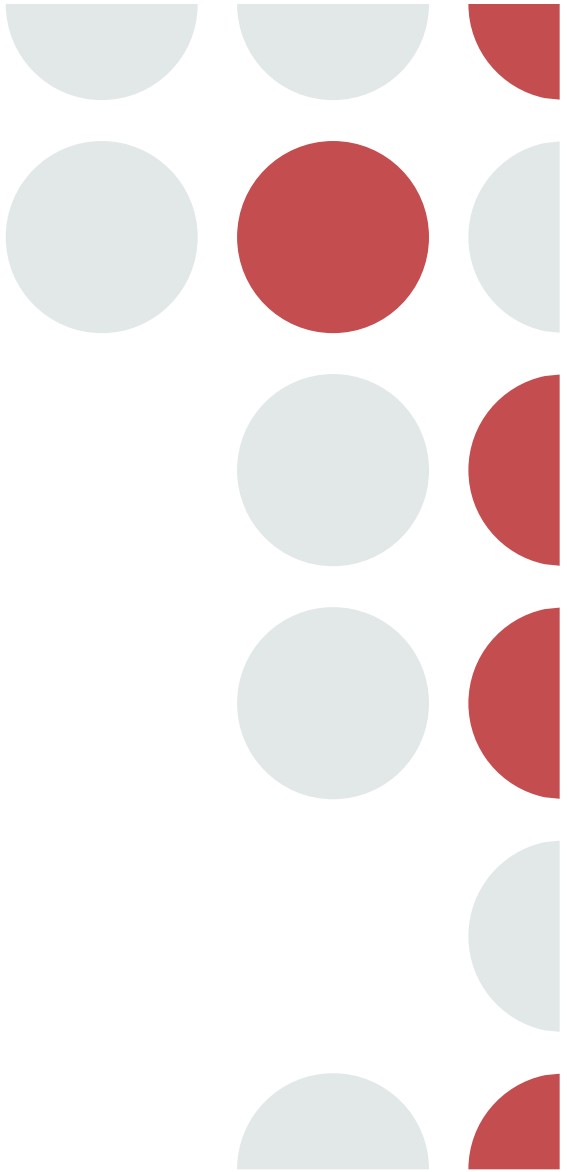


A. The Right and Left Hemispheres

- Each side of the brain (the right and the left hemispheres) has its own work to do: processing incoming stimuli and sending out motor instructions. The work of the brain is divided between the hemispheres which communicate (as we will see below) with each other across the **corpus callosum**.

Contralateral = the **other** side while **ipsilateral** = the **same** side

- **Lateralization**: Refers to those behaviors and cognitive abilities that each hemisphere specializes in. For example, language ability is primarily localized in the left hemisphere.

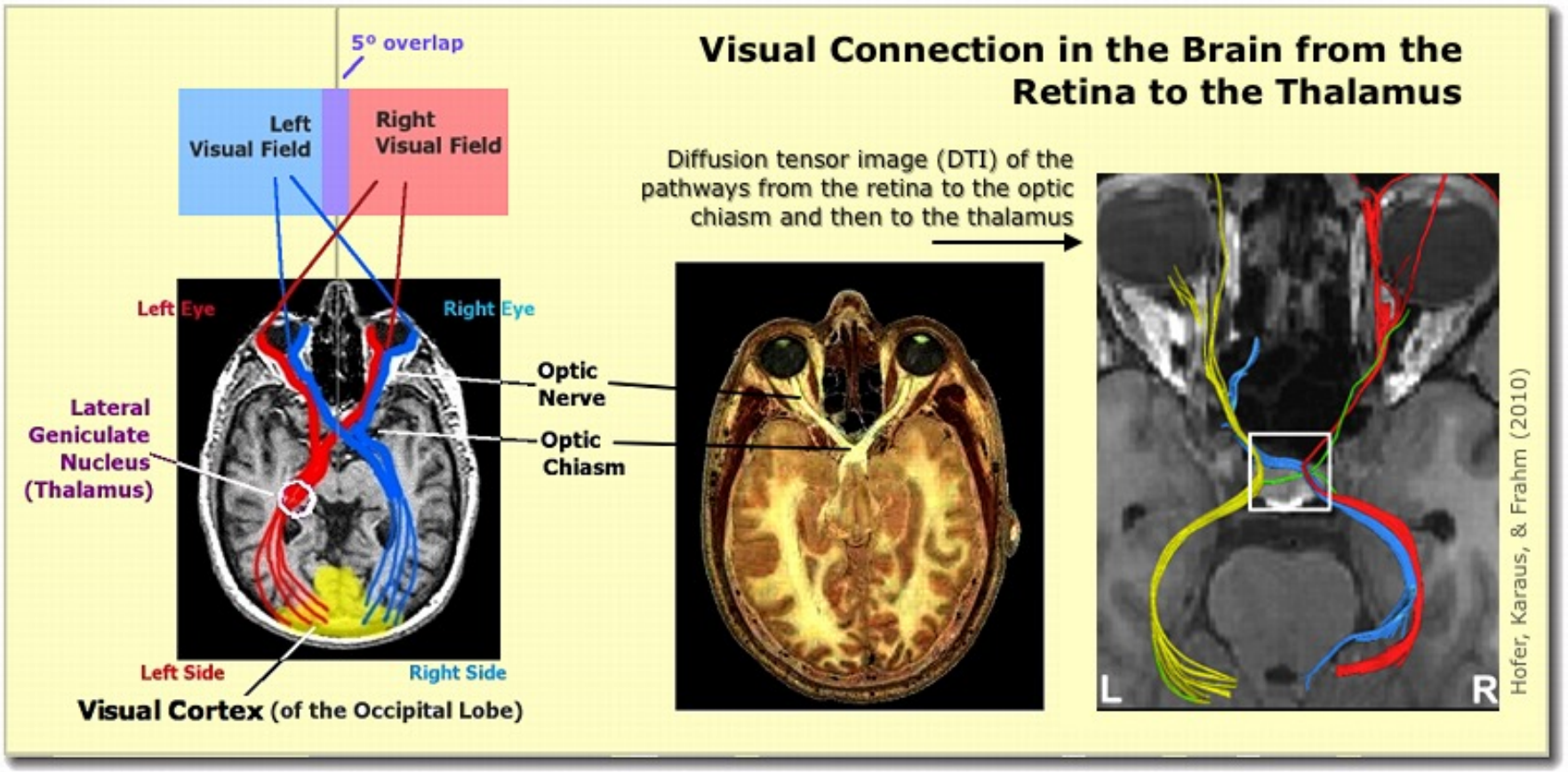


Function	Left Hemisphere	Right Hemisphere
Muscles	Contralateral (right side)	Contralateral (left side)
Skin Receptors	Contralateral (right side)	Contralateral (left side)
Vision (Eyes)	Contralateral (Right visual field of both left and right eyes; see diagram below)	Contralateral (Left visual field of both left and right eyes; see diagram below)
Hearing (Ears)	Information from both ears, but stronger from right ear	Information from both ears, but stronger from left ear
Taste	Ipsilateral (left side of tongue)	Ispilateral (right side of tongue)
Smell	Ipsilateral (left nostril)	Ipsilateral (right side of tongue)
Trunk Muscles & Facial Muscles	Jointly controlled	

B. Visual and Auditory Connections

- ***Visual Processing*.** Our eyes are connected so that visual information from the right and left visual fields are processed on the contralateral side of the brain (see diagram below) with half the optic nerve crossing over at the **optic chiasm**.
- Right visual field = left half of each retina
- Left visual Field = right half of each retina

Visual Connection in the Brain from the Retina to the Thalamus



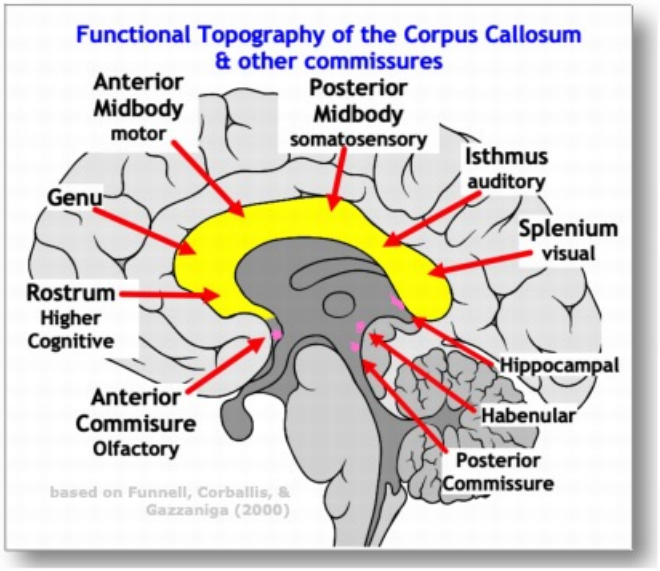
Auditory Processing. Information from each ear is transmitted to both sides of the brain. However, each hemisphere processes the information from the opposite each with greater attention.

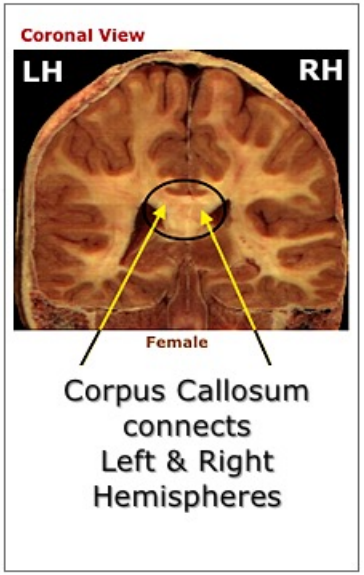
- The reason why each hemisphere receives information from both ears arises from the need to detect where sound is coming from in the outside environment. The brain can compare tiny differences between the information from each ear (e.g., timing or volume differences) in order to figure out where the sound comes from.

C. Corpus Callosum and the Split-Brain Operation

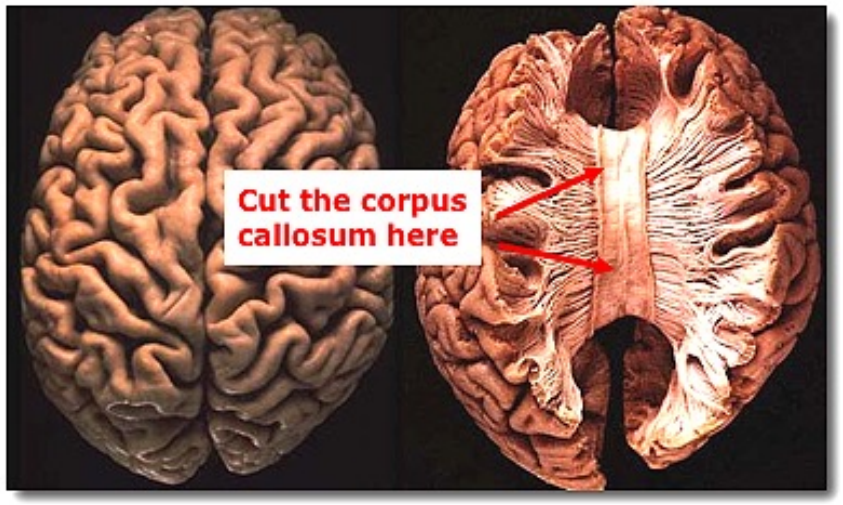
The **corpus callosum** is a massive set of axons which allow the two hemispheres to exchange information with one another. There are an estimated 200 million axons which cross from one side of the brain to the other in this "commissure" (a brain "commissure" is a a collection of axons which link brain areas in each hemisphere).

- Research has shown that a significant proportion of the axons in the corpus callosum (perhaps 1/3rd) are inhibitory, that is, they inhibit activity in the other hemisphere of the brain.





There are two other significant commissures: the **anterior commissure** (located below the corpus callosum near the front of the brain; contains about 3.5 million axons) and the **hippocampal commissure** (located below the corpus callosum near the rear of the brain). These commissures are seen in a diagram on the right. (Note that there are also two other very small commissures: posterior & habenular)



Epilepsy

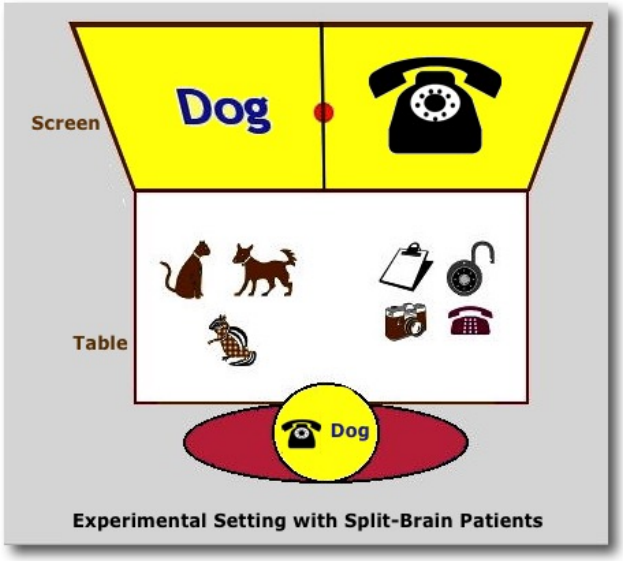
- 1. Severing the corpus callosum prevents the sharing of most information between the brain hemispheres.
- Condition characterized by repeated episodes of excessive synchronized neural activity (i.e., seizure).
- The causes of epilepsy are many including brain trauma, infection, and genetic abnormalities. Most frequently, though, we do no know why someone has epilepsy. Roughly 1-2 % of the population experiences epilepsy.

Most people with epilepsy (90%) can control their condition with medications that suppress seizure activity. Surgery for epilepsy can take two forms. The earliest form sought to remove any **focus** of epileptic activity, that is, a "focus" is a localized site of scar tissue, often on the surface of the cortex, that promotes seizures.

Commissurotomy (also called **corpus callosotomy**). If seizure activity is not controlled by drug therapy or focus removal, a small number of people experience repeated and life-threatening seizures.

Split Brain Patients

- Information is shown in either the left or right visual fields and, thus, is transmitted only to the opposite hemisphere of the brain which processes that visual field.
- So, as shown in the figure, if a telephone is shown in the right visual field and, thus, processed in the left hemisphere, the patient will normally say that they saw a telephone.
- But, if information is projected in the left visual field and processed in the right hemisphere, the patient will report that they saw nothing.
- Why? Speech is processed in the left hemisphere for most people and, thus, the patient's speech can only truthfully report that nothing was presented.



The Hemispheres

Right

The right hemisphere is better than the left at perceiving the **emotions in people's gestures** (non-verbal or paralinguistic information).

b. People with right hemisphere damage speak with **less inflection and expression**, plus they often have trouble interpreting the emotions that other people express through their **tone of voice** (***prosody***).

Left

The **left hemisphere** is more focused on **details** and the **right hemisphere** is better at perceiving **overall patterns**.

	Role of Left Hemisphere	Role of Right Hemisphere
Speech	Production of speech, comprehension of the literal meaning of speech	Emotional inflections, understanding jokes & humor, sarcasm, emotional content of speech
Auditory System	Sounds related to speech	Non-language environmental sounds (e.g., rain) Music
Emotions	Expressions of happiness & anger (= denial of happiness)	Expressions of fear, disgust, sadness; interpreting the emotional expressions of other people
Vision	Details	Overall configuration; spatial processing (e.g., arranging pieces of a puzzle or drawing a picture)
Mode or Style (**How** data are processed)	Details, parts, pieces	Gestalt, overall configuration; global form

Lateralization and Handedness

- 1. **Planum temporale**: A section of the temporal cortex that is larger in the left hemisphere in approximately 65% of the population.

- 2. **Corpus Callosum**. The corpus callosum matures slowly over the first 5 to 10 years of human life. It contains roughly 200 million fibers that cross from one hemisphere to the other.

Agenesis of the Corpus Callosum

- **Anterior commissure**: A very tiny bundle of fibers (about 3.5 million, see image below) that connects the two hemispheres around the anterior parts of the cerebral cortex.
- b. **Hippocampal commissure**: Connects the left hippocampus to the right hippocampus. Its general role is not well understood but may involve recognition memory.

Handedness

Roughly, **90% of population is right-handed** and 10% either left-handed or ambidextrous.

General estimate of **left hemisphere dominance for speech**: roughly 95% of right-handers & 80% of left-handers.

Many left-handers also show greater than normal spatial processing on the left (not right) side.

Right-handers have preference for turning left and left-handers a preference for turning right when confronted with forks in the road.