text

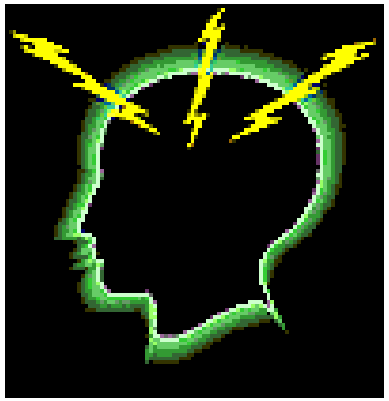
Turk D., Heatherton T., Kelley W., Funnell M., Gazzaniga, M. Macrae C., 2002,
“Self-recognition in a split-brain patient”,
***Nature Neuroscience*, 5,** 9

What is a split brain patient?

A patient whose corpus callosum has been severed

to treat his epilepsy

What is epilepsy?



The brain uses electrochemical energy

Neurons in the cerebral hemispheres misfire and create abnormal electrical activity.
People with epilepsy have seizures that are a bit like an electrical brainstorm

The seizure prevents the brain from:

- interpreting and processing incoming sensory signals (like visual, somatosensory and auditory information)

-controlling muscles. That is why people with epilepsy may fall down and twitch

Treatment for epilepsy

Medication → when it fails → surgery

Temporal Lobe Surgery:
removes part of the cortex of the temporal lobe, hippocampus and amygdala

Corpus Callosotomy (split brain operation):
It prevents the spread of the seizure from one side of the brain to the other

Hemispherectomy:
removal of one cerebral hemisphere

Treatment for epilepsy

Epilepsy is a fairly common neurological disorder. It occurs in about 1 in every 100-200 people. Throughout history there have been many famous people who have had epilepsy

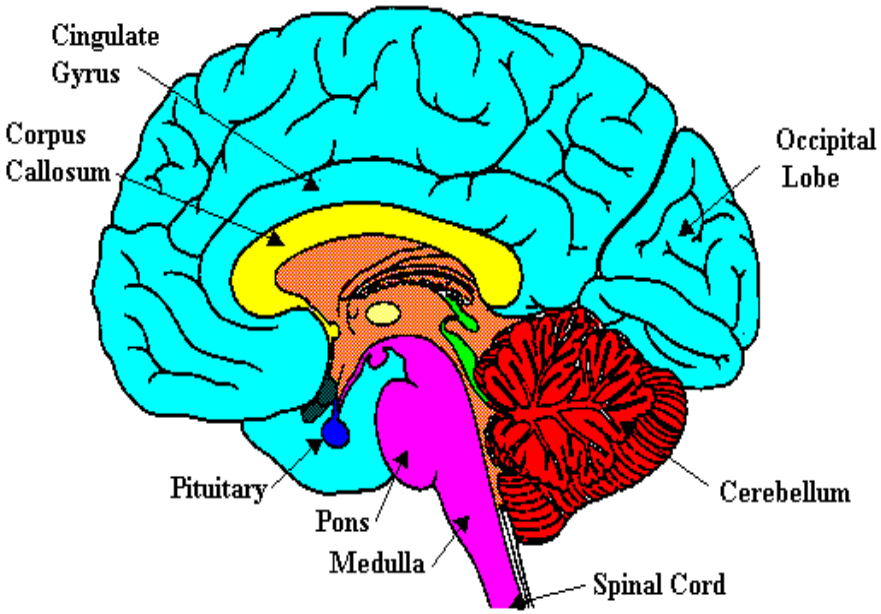
Famous People with Epilepsy

Julius Caesar – Roman Statesman (100-44 B.C.)
Napoleon Bonaparte - Emperor of France (1769-1821)
George Frederick Handel - Composer (1685-1759)
Vincent van Gogh - Painter (1853-1890)
Fyodor Dostoevski - Writer (1821-1881)
Pius IX - Pope (1792-1878)
Peter the Great – Russian Czar (1682-1725)
Lord Byron - Poet (1788-1824)

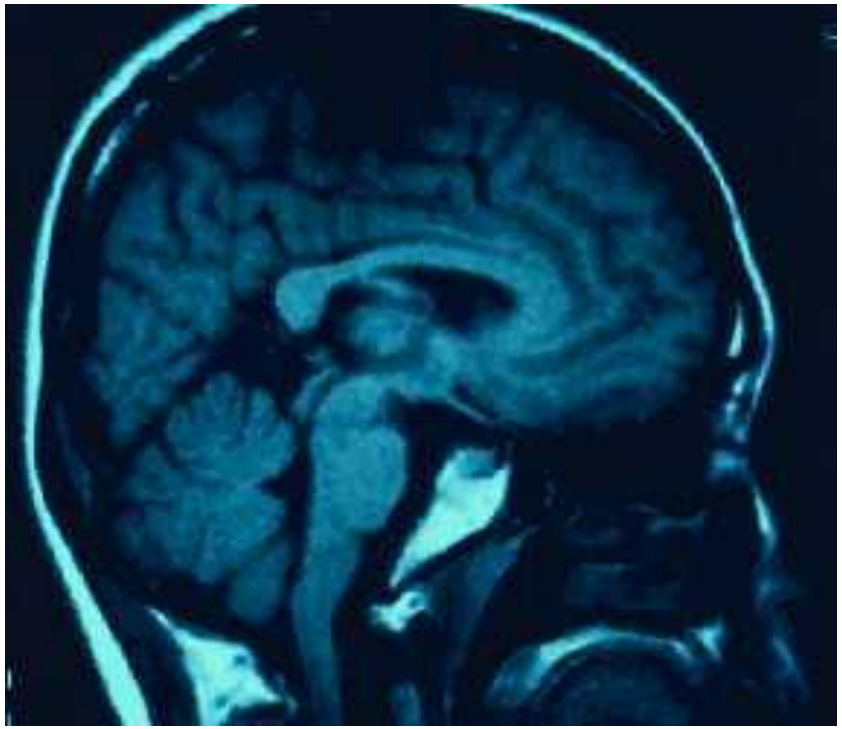
Did you know?

Saint Valentine is the patron saint of epilepsy

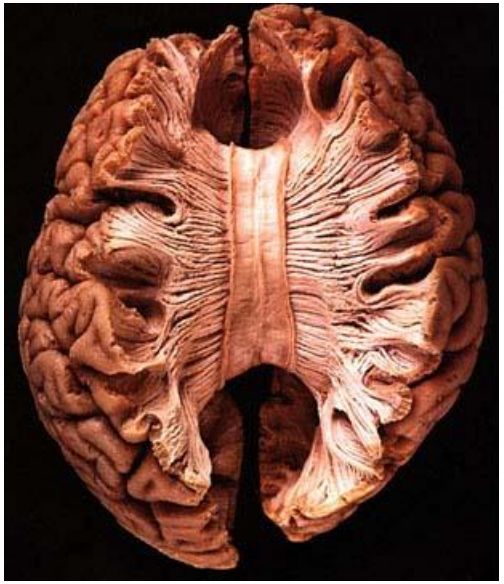
Split brain patients: Corpus callosum severed



Mid sagittal section



MRI sagittal section



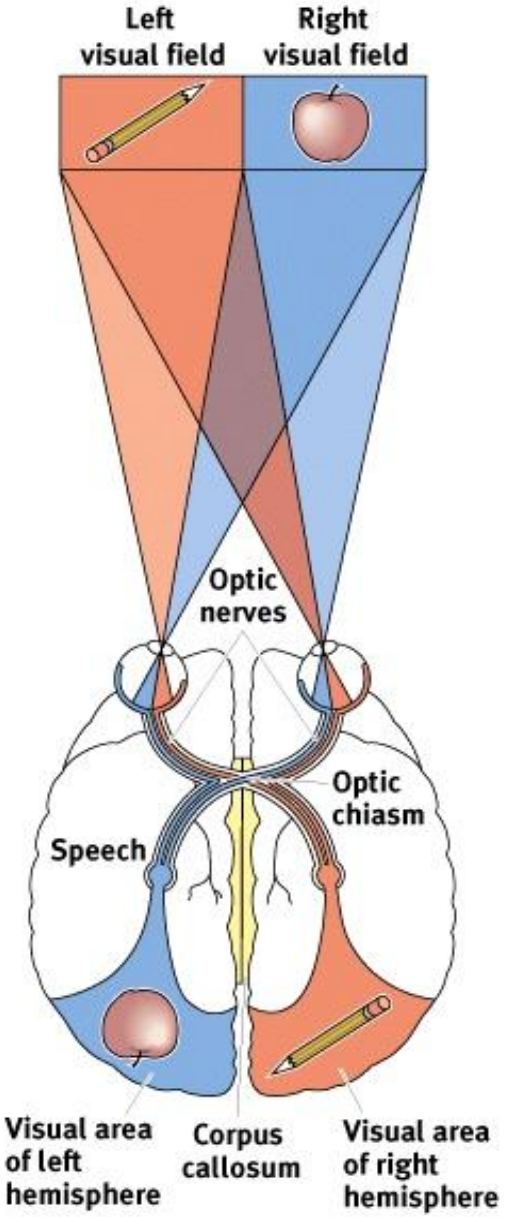
- Each hemisphere is responsible for the opposite side of the body.

- Left hemisphere receives information from right field of view and vice versa

- Work with split brain patients helped to identify **differences in function of the two hemispheres of the brain.**

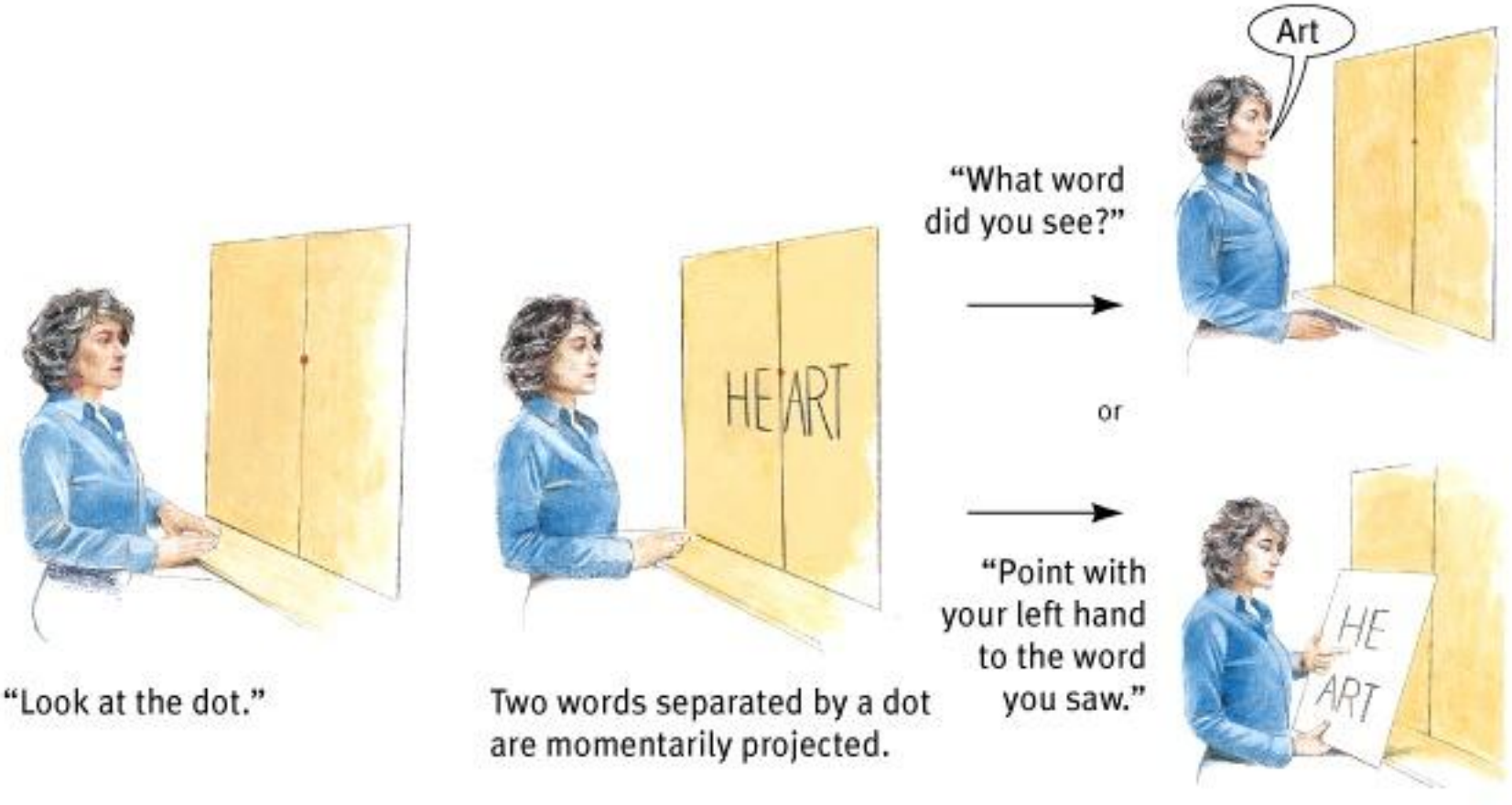
- Hemispheric specialisation is also linked with handedness, in that **right handed** people have a dominant **left hemisphere** and so on.

Central visual pathways

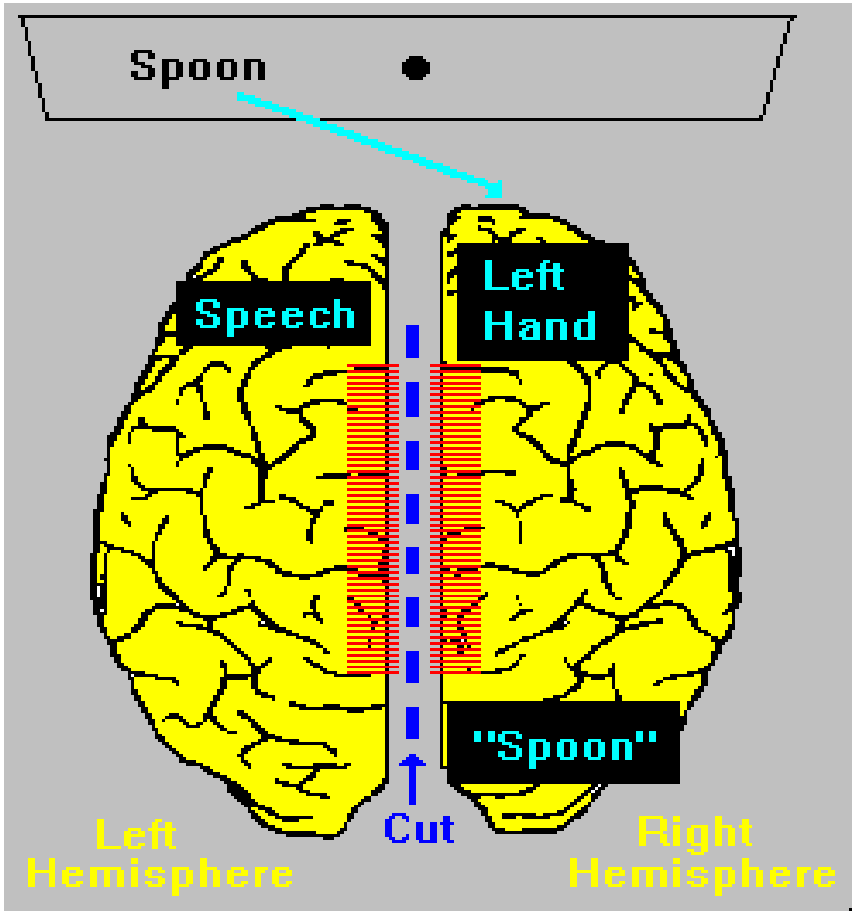


Crossed connections

Testing the Divided Brain



Tachistoscopic experiments



Tachistoscopic experiments

Chimeric figures

Text

Rationale

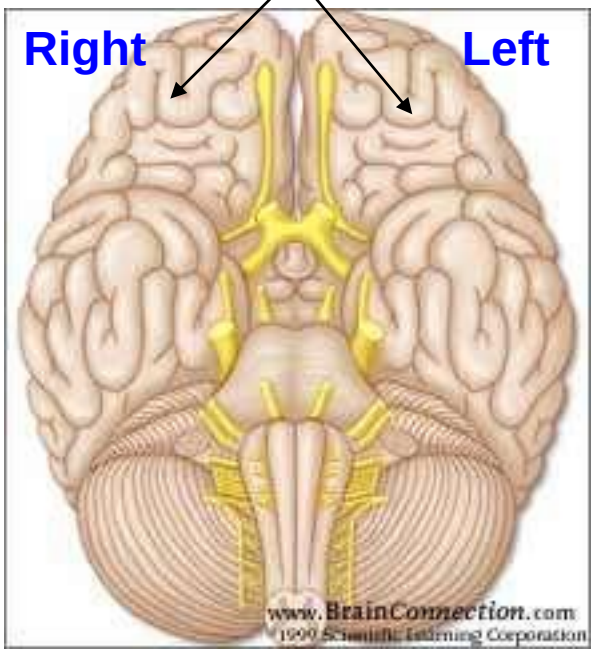
Summarise part A

Cerebral dissociation between self-recognition and recognition of others? Evidence from a split brain patient

Find the right figure

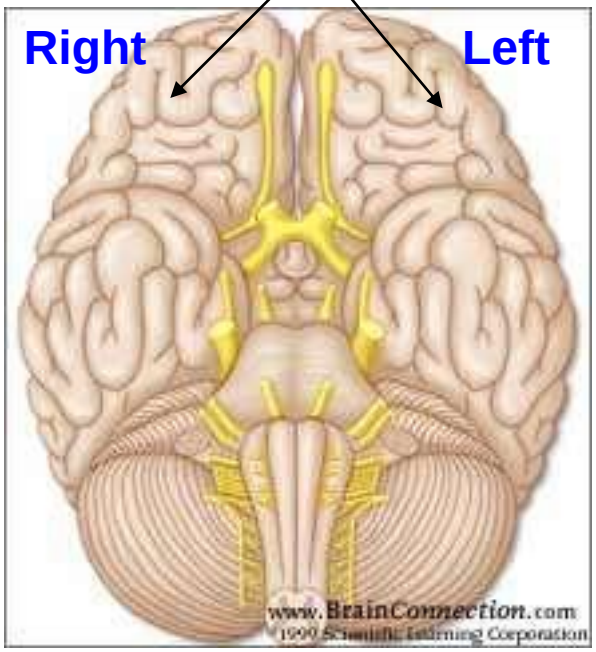
Own face

Familiar faces



Familiar faces

Own face

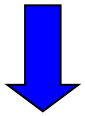


Text

Rationale

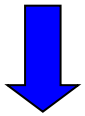
Summarise part B

Ability to recognise oneself



Cognitive capacities

Functional imaging & lesions studies



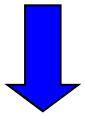
Face recognition **Right hemisphere**

Text

Rationale

Summarise part C

Right hemisphere specialised for facial recognition



specialisation for self-recognition?

Evidence from Wada test

Wada test

1st step: a catheter is introduced Into the right artery at the groin

2nd step: the catheter is threaded into arteries leading to the brain

3rd step: amobarbital is injected into the right carotid artery

4th step: the right hemisphere is « put to sleep » / anaesthetized

Wada test

Neuropsychological testing methods

Language & memory

Language: 5 linguistic tasks

Expressive language counting

Comprehension

Denomination

Repetition

Reading

Wada test

Complete these sentences

When LH is anaesthetised

The patient is……., paralysed on the ……. side, unable to …….. in the …….. visual field. His speech is ……

When RH is anaesthetised

The patient is ……., paralysed on the …….. side, unable to …… in the …… visual field. His speech is ……

Wada test

Neuropsychological testing methods

Language

When LH is anaesthetised

The patient is *conscious*, paralysed on the *right* side, unable to *see* in the *right* visual field. His speech is *interrupted*

When RH is anaesthetised

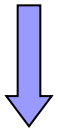
The patient is *conscious*, paralysed on the *left* side, unable to *see* in the *left* visual field. His speech is *flat, toneless*

Text

Rationale

Summarise part D

Brain imaging studies **memories of one's own face**



Left hemisphere

Hypothesis

Facial recognition of others → **RH**

Self recognition → **LH**

Text

The experiment

summarise the main result

JW's left hemisphere → recognition bias for self

JW'S right hemisphere → recognition bias for familiar others

Text

Discussion

What is SMS?

Self Memory System (a model of social cognition)

Conway (2005) proposed the self-memory system to explain auto biographical memory

autobiographical memory comprises themes that span a range of ages:
School theme
Family theme
relationship theme
Work theme

At each age within each theme are specific episodic memories.
These form a coherent life story that makes up our sense of self

Video

Watch the 1st part (0.48)

Who are the different characters?

Mike Gazzaniga, the neurosurgeon, the journalist, Joe, the patient

Pick up information concerning Joe

Epileptic patient, he met Gazzaniga 15 years ago, when he had a brain surgery because of his seizures. He could have 2 or 3 seizures a day.

Describe the surgery 0.48-1.08

The connections between the two halves of the brain were severed. cutting the corpus callosum prevented the spread of the electric activity that caused the seizures. But the left and Right hemispheres are totally separated and can't communicate with each other.

Video

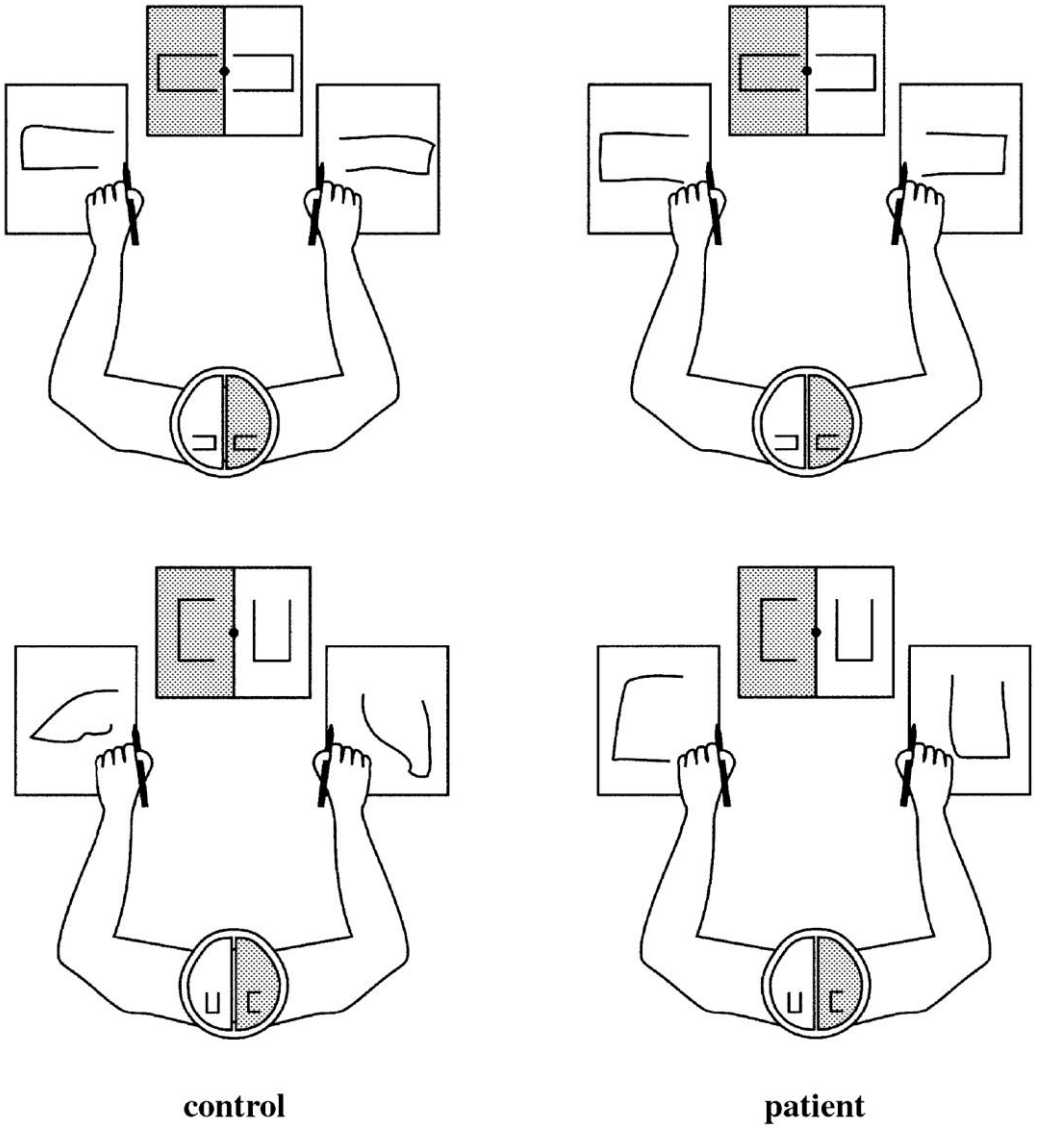
How does Joe live ?

He works in an egg farm. He lives quite normally. He says there is no difference (I've got a back up brain- joke)

First experiment (1.38-2.45)

Left hand controlled by right brain and right hand by left brain, for the journalist, it is impossible to draw 2 different shapes at the same time because signals sent from the right brain to the left brain and vice versa are confusing.
For Joe, it's easy since each brain receives a separate instruction. His left brain is unaware of the instructions flashed in his right brain

The disconnection between the spatial maps of the two hemispheres in split-brain patients is illustrated in this paradigm.



Subjects are shown two figures, one in each visual field, and asked to draw the stimuli with both hands simultaneously. Neurologically normal subjects are able to perform this bimanual task when the two stimuli are identical or mirror-reversed but not when the stimuli result in incompatible spatial maps. Split-brain patients, however, show no deficit in this latter condition and their performance is strikingly better than that of normal subjects. The split-brain patient is able to carry out conflicting motor programmes, indicating that the spatial representations of movements are clearly maintained and isolated to each hemisphere (adapted from Franz *et al*., 1996

Gazzaniga M S Brain 2000;123:1293-1326

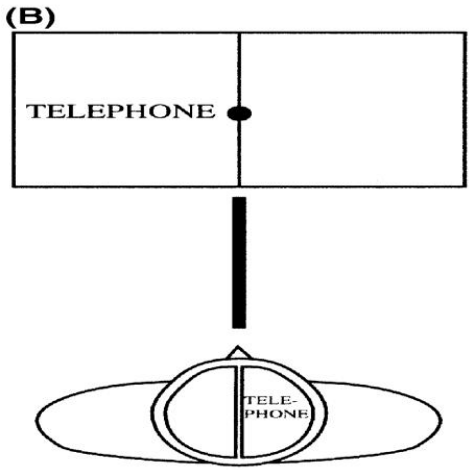
BRAIN A JOURNAL OF NEUROLOGY

Video

2nd experiment 2.47-4.

He can read aloud words flashed into his left brain. When words are flashed into his right brain, he says he sees nothing, but he's able to draw the word "phone" with his left hand. When the drawing is over, he can see it with his left brain and says "oh phone".

Four examples of how the left brain tries to interpret the actions of both hemispheres.



(**B**) In another instance of the interpreter at work, patient J.W. was flashed the word `telephone' to the right hemisphere. He said, `I'm not sure I got that one. I think it's clap—that wouldn't be right, would it?' He was then asked to draw what he had seen and with his left hand he drew a telephone. When he was finished he said `Telephone. I don't know where I got clap out of telephone'. He was then asked, `You said clap but you drew a phone. Do you know why you drew a phone?' He responded `No. Too many pills—it makes me feel high'.

Gazzaniga M S Brain 2000;123:1293-1326

Video

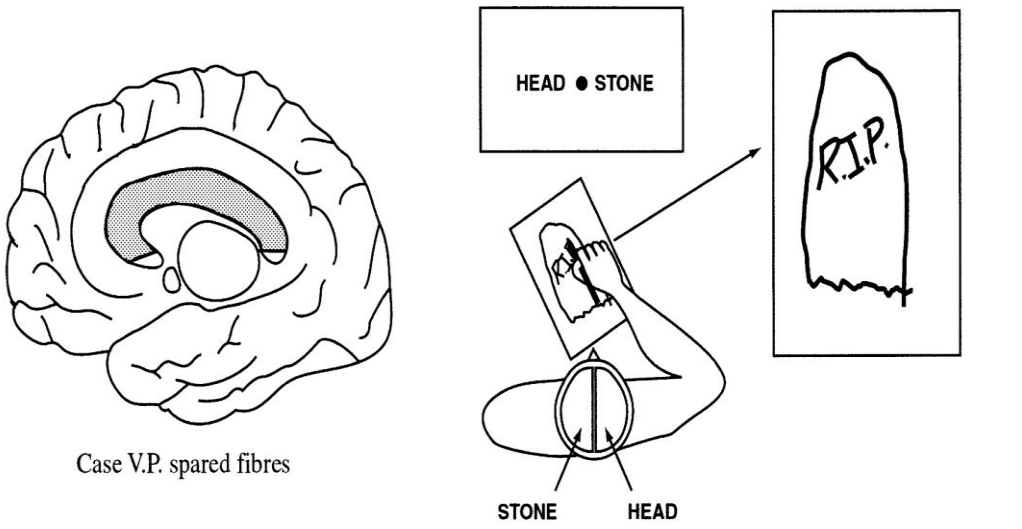
Conclusion of the 2nd experiment 4.-4.20

The ability to speak resides almost exclusively in the left hemisphere

3rd experiment (4.50-5.45)

2 words are flashed, each in each hemisphere. His left hand draws a toad, and then a stool… If there were connections between his 2 hemispheres he would have drawn a toadstool.

Patient V.P., who has spared fibres at both ends of the corpus callosum, is able to integrate words presented to both visual fields to create a concept that is not suggested by either word.



Case V.P. spared fibres

Case J.W. full split

Patient V.P., who has spared fibres at both ends of the corpus callosum, is able to integrate words presented to both visual fields to create a concept that is not suggested by either word. For example, when presented with the words `head' and `stone' she combines the information presented in the separate fields into the integrated concept of a tombstone (top panel). In contrast, patient J.W. (bottom panel) is unable to integrate information from the two visual fields. When presented with the words `sky' and `scraper' he simply draws a picture of the sky and of a scraper in serial order

Gazzaniga M S Brain 2000;123:1293-1326

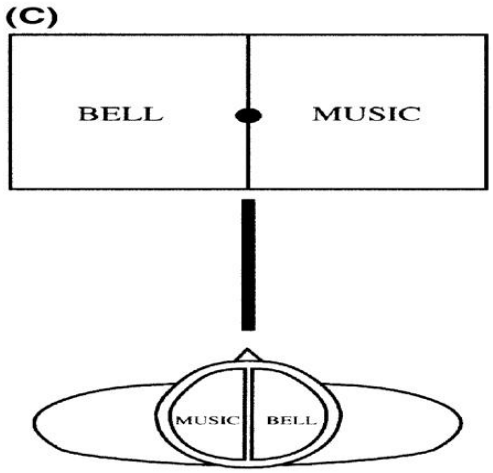
Video

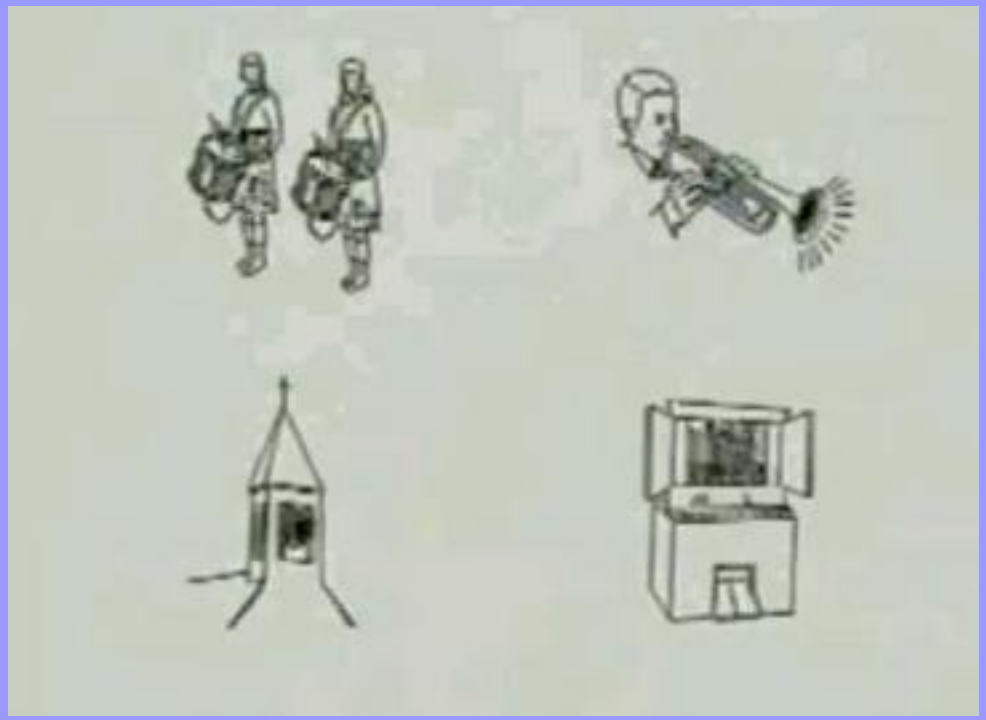
4th experiment (5.45-6.30)

2 words are flashed, each in each hemisphere. Music to his left brain, bell to his right brain.
He wants (or his left hemisphere) to give an explanation. He said he pointed to the picture of a bell because last time he heard music was from the bells of the church near there.

Four examples of how the left brain tries to interpret the actions of both hemispheres.

(**C**) Patient J.W. was flashed the word `bell' to his silent right hemisphere and the word `music' to his left hemisphere. Again, each hemisphere was free to choose related pictures from a group. J.W. pointed to a picture of a bell, and when asked why said `Music—last time I heard any music was from the bells outside here, banging away'. J.W. was referring to the bells that ring regularly from the Dartmouth library.





Gazzaniga M S Brain 2000;123:1293-1326

Video

Conclusion of the 4th experiment 6.30-7

The desire to explain things is a left hemisphere property. The left hemisphere wants to explain why 2 events occur

5th experiment (7.10-2.45)

Drawings from Giuseppe Arcimboldo, Italian painter from the 16th century. He drew faces out of food, meat, flowers…
The idea is to show these paintings to each Joe's hemisphere.

Video

5th experiment (7.10-7.40)

Issue ?

The ability to recognize faces is located in the RH. So Arcimboldo's paintings should look different to each Joe's hemisphere.

Results

When the painting is processed by his RH, Joe pointed to face.
When the painting is processed by his LH, Joe pointed to fruit

Discussion

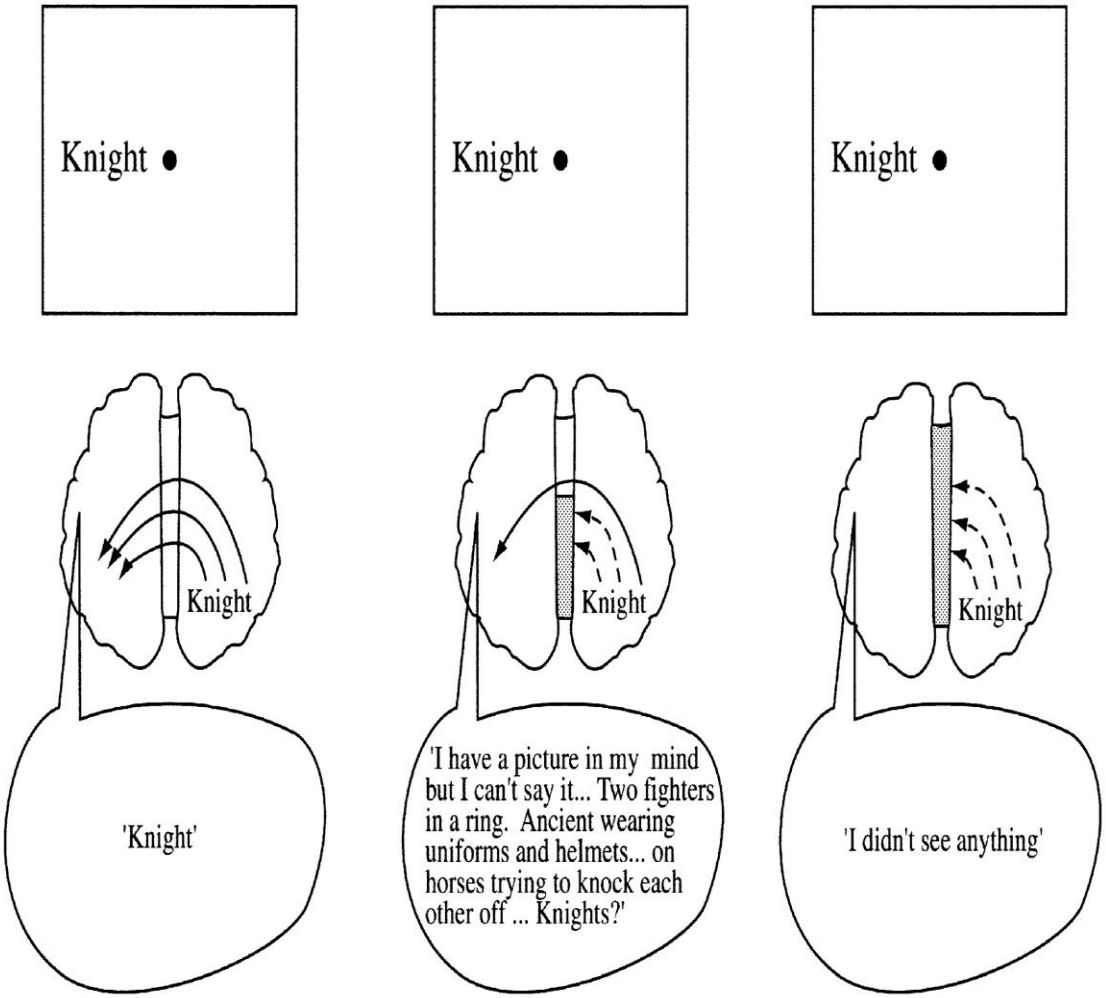
When the painting is sent to his LH, he focused on the elements that made up the face, and answered fruit or potatoes
When the same painting is sent to his RH, he focused on the face and not the elements.
The RH is specialized on faces

Video

what half of the brain would Gazzaniga want to have if he had to pick?

It is the left brain that carries out high level thinking and problem solving. It is the hemisphere that interprets our actions and feelings. The right brain is very poor or unable at these kinds of tasks

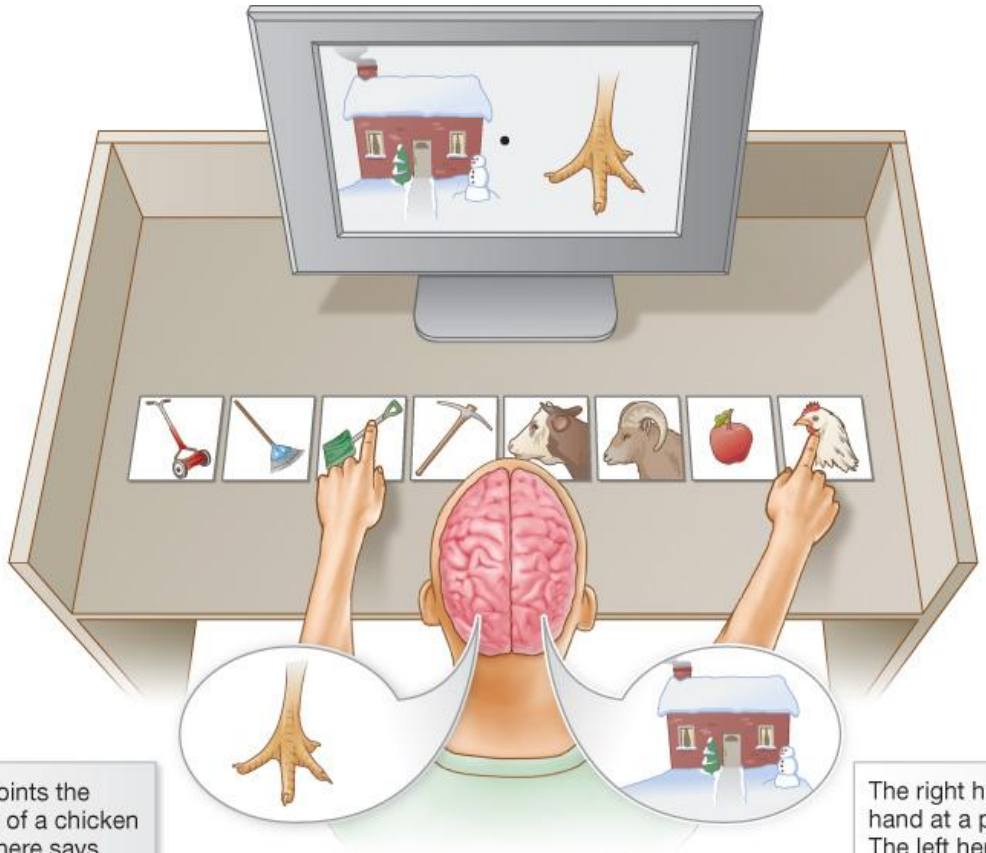
Other experiments



Patient J.W. underwent a staged callosal section in which the posterior half of the callosum was sectioned before the anterior half. Prior to the surgery, J.W. had no difficulty reading words presented to the left visual field (*left panel*). Following posterior callosotomy, he was unable to read these words but could transfer semantic information about them (*centre panel*). After complete callosotomy, he was no longer able to transfer any information about the words (*right panel*). These results are consistent with the notion that anterior regions of the callosum are involved in the transfer of higher-order information

Gazzaniga M S Brain 2000;123:1293-1326

Other experiments



1. A split-brain participant watches as different images flash simultaneously on the left and right.

2. Below the screen is a row of other images.

3. The patient is asked to point each hand at a bottom image most related to the image flashed on that side of the screen.

The left hemisphere points the right hand at a picture of a chicken head. The left hemisphere says that the chicken claw goes with the chicken head.

The right hemisphere points the left hand at a picture of a snow shovel. The left hemisphere decides that the shovel is used to clean up after chickens. (It does not see the house.)

Gazzaniga M S Brain 2000;123:1293-1326

Problems just after surgery

Alien-Hand Syndrome

A fascinating phenomenon has been observed in a number of split-brain patients. For a short time after their surgery, they seem to lose the ability to control their left hands — a problem called alien-hand syndrome

> In one case the patient (W. J.) would repeatedly pick up a newspaper with his right hand and lay it down with his left hand. This would be performed several times until finally the left hand threw the newspaper on the floor.
> Another patient (R. Y.) was described by a physiotherapist: “He was buttoning his shirt with his right hand and the left hand was coming along just behind it undoing the buttons just as quickly as he could fasten them.” …
> *Another patient turned the pages of the book with one hand while the other tried to close it; he shaved with the right hand while the left one unzipped his jacket; he tried to soap a washcloth while the left hand kept putting the soap back in the dish; and he tried to open a closet with the right hand while the left one closed it. (quoted in Wegner, 2002, p. 5)*

Problems just after surgery

Alien-Hand Syndrome

But the same patients … were able to use their left hand in a purposeful and cooperative manner “when not thinking of what they were doing.”
For example, they could pour coffee out of a pot held in the right hand into a cup held by its handle with the left hand. (quoted in Kolb & Whishaw, 1996, pp. 344-45)

What is happening in these cases is that the patients’ left hemispheres, which control the right hand and which also are language-dominant, are confused by the movements of the left hand, which is controlled by the patients’ right hemispheres and which does not contain the language areas.

One would think that, once the hemispheres are disconnected, alien-hand syndrome would be a permanent problem, but it isn’t. There must be changes in the brain soon after surgery that again allows the two hands to work in concert, another example of the brain’s plasticity

Why are split brain studies so important?

- They tell us about hemispheric specialization (the two hemispheres differ in their functions - there are localized functions to each hemisphere)
- When the corpus callosum is severed each hemisphere is shown to process information without awareness of the other side
- However, split brains are not totally split, and lower structures in the brain remain connected, such as the limbic system
- Recent split brain operations only cut ¾ of the corpus callosum.

Ultimately: the left brain tries to explain what the right brain is doing