In the past section, we looked at how neurons transmit information. In this section, we look at the role of different brain areas and cognition. Many of you are familiar with phrenology.

They key assumption of phrenologists was that different areas of the brain were associated with different aptitudes. The phrenologist also believed that the size of the brain areas were indicative of an individual's particular level of a certain aptitude. Phrenologists also thought that the areas of the brain could be measured by inspecting the scalp of a subject with one's hands.

It turns out that the phrenologists were correct about all but the last assumption. The right side of this slide shows, in different colors, the different areas of the brain. The left side of the slide lists the names of these areas and the roles they play.

The color of the font corresponds to the color of the shaded areas in the figure on the right. For instance, the olive colored area towards the back of the brain is the primary visual cortex. Here we are looking at the outside of the brain.

It is this part of the brain that has evolved most recently. For this reason, it's called the neocortex. Notice how much of this part of the neocortex is devoted to planning, language, and sight. Not surprisingly, humans are very visual animals that are uniquely gifted in higher order thought and language.

The middle of the brain contains the most primitive brain structures, such as the hippocampus and the amygdala. These areas are responsible for learning, memory, and emotion, and are well developed in lower level species such as rats, pigeons, and cats. Let's take a closer look at the part of the brain involved in processing visual information.

Note in this figure that several areas of the brain are involved in vision. Strangely enough, visual information is initially processed in the very back of the brain or the posterior part of the brain. The area of the brain involved in the initial visual processing is known as V1 and it detects the orientation of different lines or curves associated with a stimulus.

Processing then proceeds forward to increasingly anterior brain regions. In V2, V3, V4, and V5 the representations of the lines and curves are put together. Depth and color is added and movement is represented. Notice that these more complex processes take place near to the area of the neocortex responsible for planning and judgment.

Also note that there are actually two pathways through visual processing. There are essentially two things we need to know about an object when we see it. We need to know where it is. And we didn't need to know what it is.

The path migrating along the top of the brain is the dorsal path. It processes the location of the object. The ventral path migrates along the bottom of the brain and it is responsible for identifying the object. The critical things to know are A, the brain did not evolve randomly.

Areas of the brain that are responsible processing similar information are nearer to each other. And B, the brain processes information in a very systematic way. A particularly interesting area of the brain in the ventral visual pathway is known as the fusiform gyrus, or the fusiform face area.

It is the part of the brain devoted to identifying faces. We know this because people who have damage to this area of the brain are unable to identify faces. They can identify everything else just fine.

They are unable to identify faces, even those of close friends and family members. This condition is called prosopagnosia. You can watch a YouTube video entitled, Is That My Brother? Perceptual and Neurobiological, available in this module, to learn more about this concept.

Let's think about this more carefully by considering what we already know about the brain. First, face recognition involves visual processing. So we would expect to find the fusiform face area in one of the two vision processing pathways.

It requires the identification of faces. And therefore, it is not surprising that the fusiform face area is located near the ventral pathway. Last, the ability to recognize faces is present even in lower level animals. For instance, your pet probably recognizes every one in your household.

Thus, the fusiform face area is located towards the middle of the brain near the hippocampus. Researchers have learned a lot about the rules of different brain areas by studying the behavior of people with brain damage. Dissociation are a phenomenon in which one brain function is implicated in the performance of a certain task but another is not.

They are used to determine what function different regions of the brain perform. Some rather remarkable dissociations have been documented. For instance, you're all familiar with the distinction between short-term versus long-term memory.

And researchers looking to test this distinction we're able to identify an important dissociation between subjects who had damage to the frontal versus the temporal lobes of the brain. Patients with frontal lobe damage are impaired in short-term memory but not long-term memory. Whereas patients with temporal lobe damage have the reverse condition.

Some people are able to name living objects but are unable to name inanimate objects. Others have the reverse condition. Another way researchers investigate what different areas of the brain do is to use brain imaging technology. PET and fMRI are the most common.

They both measure what is known as BOLD, blood oxygen level difference. The key assumption is that the brain areas that are very active require more oxygen to operate. Thus, PET and fMRI measure the amount of blood flow in regions of the brain.

Interestingly, both technologies use methods very similar to Donder's subtraction method. Here's an example. There are two conditions in a typical brain imaging experiment. In the control condition, the brain activity is recorded while the subject is at rest or is performing a simple task.

This is illustrated in panel A which shows a small brain activity in the dorsal area of the brain. In the experimental condition, the stimulus may be presented or the subject may perform a slightly more complicated task than in the control condition. Again, the brain activity is recorded.

In order to identify the portion of the brain responsible for processing the stimulus in the experimental condition, or to identify the more complicated aspect of a task, the brain activity in the control condition is subtracted from the brain activity in the experimental condition. Here we see in panel C that the visual cortex and another dorsal area of the brain was responsible for processing the stimulus in the experimental condition of this experiment. Let's look at a real-world example from a paper by Smith and Jonides.

These researchers were interested in what part of the brain was responsible for spatial memory. That is, their interest in what part of the brain is responsible for remembering where something is. What we see in the figure depicts two conditions of this experiment.

In each condition, there were four displays present to the subject one at a time for various lengths of time. The circle displays are what was presented in the control condition. First, a fixation was present for 500 milliseconds.

And it remained displayed for an additional 300 milliseconds. Fixation crosses are shown to the subject simply to direct their attention to the middle of the display. Next, three dots were briefly displayed for 200 milliseconds.

Last, a circle appeared and the subject had to respond yes if a dot appeared in the circle, or no if a dot did not appear in the circle. Notice in the control condition, the subject did not have to remember where the dots were. Everything was the same in the experimental condition except the middle two displays were reversed.

And the subject was to respond yes if a dot appeared in the second display in the same location as a circle. Or no if a dot did not appear in the circle. Thus, using the subtraction method Smith and Jonides were able to locate the area of the brain responsible for spatial memory.

The results showed enhanced activation in the right prefrontal cortex near area 46. Smith and Jonides concluded that the right prefrontal cortex is involved in spatial memory. True or false? Sophisticated advances in brain imaging technology refute all theoretical assumptions of phrenology.

The answer is false. Many of the assumptions of the phrenologists were true. What was not true is that we cannot reveal one's aptitude at a particular task by feeling the scalp of someone's head. True or false? Different areas of the brain perform different tasks.

The answer is true. True or false? The middle part of the brain evolved most recently. The answer is false. The neocortex, or the outside of the brain, evolved most recently. The ventral pathway of visual processing identifies and locates objects. The answer is false.

The ventral pathway of visual processing identifies objects, but the dorsal pathway locates objects. True or false? A dissociation is discovered when one of two parts of the brain take apart stimuli and put them back together.

The answer is false. A dissociation is discovered when one part of the brain performs one function, whereas another part of the brain performs a different function. True or false? Smith and Jonides used a modern version of the savings method to identify the area of the brain responsible for spatial memory. The answer is true.