{slide 2}

In the past section, we looked at how neurons transmit information.

In this section, we look at the role of different brain areas in cognition.

Many of you are familiar with phrenology. A key assumption of phrenologists was that different areas of the brain were associated with different aptitudes. The phrenologists also believed that size of the brain areas was indicative of an individual’s particular level of a certain aptitude. Last, phrenologists thought that the areas of the brain could be measure by inspecting the scalp of a subject.

It turns out that the phrenologists were correct about all but the last assumption.

{slide 3}

The right side of this slide shows in different colors the different areas of the brain.

The left side of this side lists the names of these areas and role they play. The color of the font corresponds to the color of shaded in areas in the figure on the left. 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 the part of the brain that has evolved most recently. Notice how much of this part of the brain is devoted to planning, language, and sight. Not surprisingly, humans are very visual animals that are uniquely gifted in high 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.

{slide 4}

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. Visual information is initially processed in the very back of the brain. This area is known as V1, and it detects the orientation of different lines or curves associated with a stimulus. Processing then proceeds forward in the brain to V2, V3, V4, and V5, where these lines and curves are put together, depth and color is added and movement is represented. Notice that these more complex processes take place neared to the portion of the cortex responsible for planning and judgment.

{slide 5}

Also note that there two pathways through visual processing. There are essentially two things we need to know about an object that we see. We need to know where it is and we need to know what it is. The path migrating long the top of the brain is the dorsal path, as in dorsal fin. 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 note are that: A) The brain did not evolve randomly. Areas of the brain that are responsible for processing similar information are nearer to each other. B) The brain processes information in a very systematic way.

{slide 6}

A particularly interesting area of the brain involved in vision is known as the Fusiform Gyrus or the Fusiform face area. It 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.

In the Brain Area section of Blackboard links to videos that show you people with Prosopagnosia. They are very interesting, and I encourage to take a look at them.

{slide 7}

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 everyone in your household. Thus, the fusiform face area is located toward the middle of the brain near the hippocampus.

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Researchers have learned a lot about the roles of different brain areas by studying the behavior of people with brain damage.

Dissociations are phenomena in which one brain function is implicated in the performance of certain task but another is not. They are used to determine what function different regions of the brain perform.

For instance, you are all familiar with the distinction between short-term versus long-term memory, and researchers looking to test this distinction were 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,

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Some rather remarkable dissociations have been documented. For instance, some people are able to name living objects but are unable to name inanimate objects. Others have the reverse condition. People with Prosopagnosia can identify all objects except for faces.

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Another way researcher investigate what different areas of the brain do is to use brain imaging technology.

PET and fMRI are most common.

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They both measure what is known as BOLD, Blood Oxygen Level Difference. The key assumption is that 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 Donders subtraction method.

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Here is 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 complicates aspect of the 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 stimulation in the experimental condition of this experiment.

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Lets 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, they were interested in the 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 presented to the subject, one at a time for various lengths of time.

The circles displays are what was presented in the control condition.

First, a fixation cross was present for 500 ms and it remained displayed for an additional 3000 ms. 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 ms.

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

Results: Enhanced activation in the right prefrontal cortex near area 46.

Conclusions: The right prefrontal cortex is involved in spatial memory.