

Reflecting on Reflexes



Pre-Lesson Quiz

1. What happens when you accidentally touch a hot plate?
2. Name two human reflexes and state how they work.

Pre-Lesson Quiz Answers

1. What happens when you accidentally touch a hot plate?

Sensors on your finger get activated and the information is relayed via nerves to your spinal cord (nervous system), which decides to immediately jerk back the hand by sending a signal to the arm muscles.

2. Name two human reflexes and state how they work.

The patellar reflex is what moves your foot forward when the doctor hits the region of your knee below the patella with a wooden hammer.

The pupillary reflex helps your eyes keep out excessive light by contracting the pupils when too much light is present (in the sunny outdoors) or dilating them when too little light is present (in dim or dark rooms).

Blinking of eyes when something comes towards them; this happens without your thinking to do it, right?!

Question: Have you ever wondered why your leg kicks when a doctor taps your knee with that little rubber hammer?

Answer: It's a reflex.



What Are Reflexes?

- A reflex is an **involuntary body movement** in response to something. You don't even have to think about it.
- Reflexes **protect your body** from things that might harm it.

Examples of Human Reflexes

Knee Jerk Reflex (aka patellar reflex)

- You may have had your knee jerk reflex tested by a doctor as part of a physical exam. For this reflex test, the doctor uses a mallet to hit your knee at a spot just below your knee cap—and your leg kicks out. It is a quick response; it only takes about 50 milliseconds between the tap and the kick!

The patellar reflex is processed before the brain, by the spinal cord. This means that you react *before your brain notices* the stimulus.

Try it out with your partner, using just your hand, as shown in the photo →

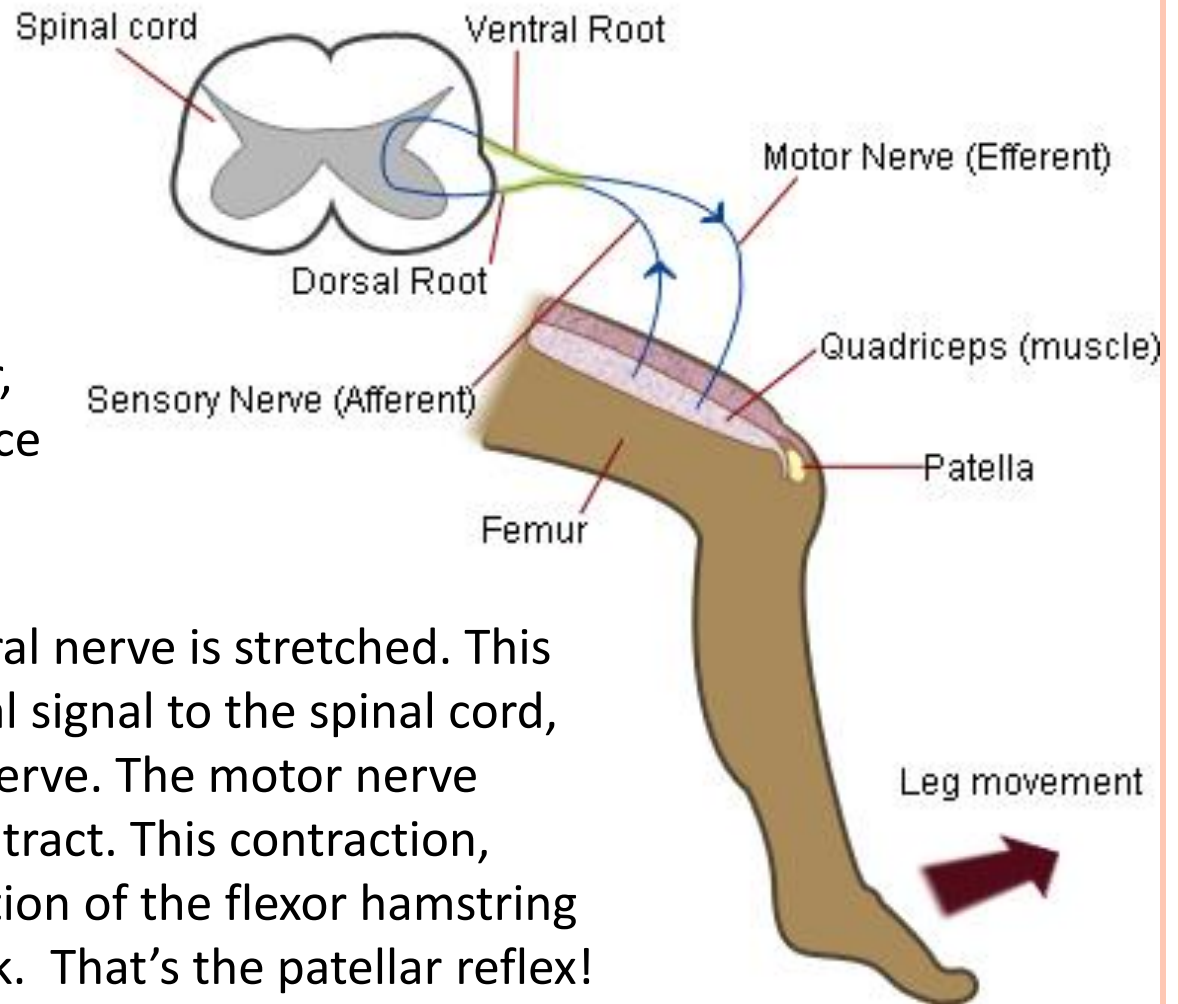


More on Patellar Reflex

Doctors strike the patellar tendon with a tendon hammer just below the patella.

After the tap of the hammer, the leg normally extends once and comes to rest.

The nerve fiber of the femoral nerve is stretched. This stretching relays an electrical signal to the spinal cord, which activates the motor nerve. The motor nerve commands the femur to contract. This contraction, coordinated with the relaxation of the flexor hamstring muscle causes the leg to kick. That's the patellar reflex!



Hands Touching Hot Objects Reflex

Hands Touching Hot Objects Reflex

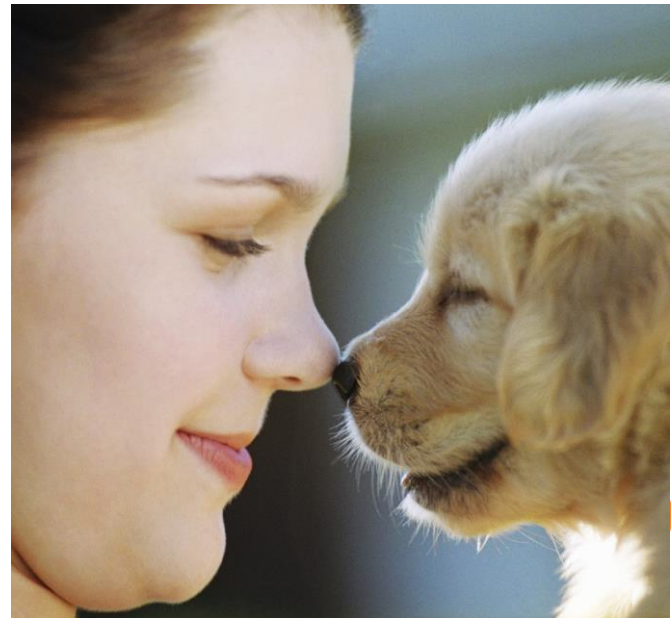
- If your hands come in contact with hot objects (perhaps stove burner, hot plate, hot pan or a hot potato), a reflex causes you to immediately remove your hand before the message, “Hey, this is hot!” even gets to your brain.



How Do Plants and Animals Respond to Stimuli?

Many plants and animals have similar responses to stimuli:

- The Venus flytrap stays open until it senses an insect flying by. Then it shuts its jaws quickly, trapping the insect inside.
- A dog's nose senses the odor from a treat being offered. The signal reaches the brain, which interprets the smell as something good to eat. The dog then responds by salivating and pleading for the treat.

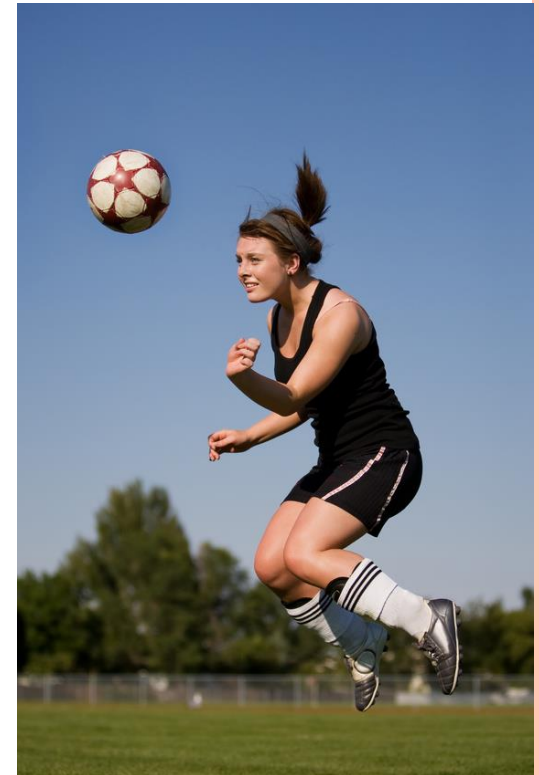


Another Reflex Example: Blinking



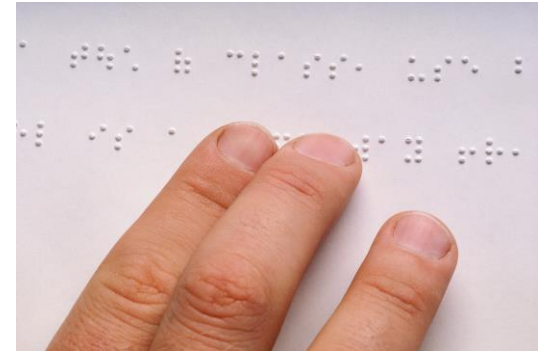
Blinking

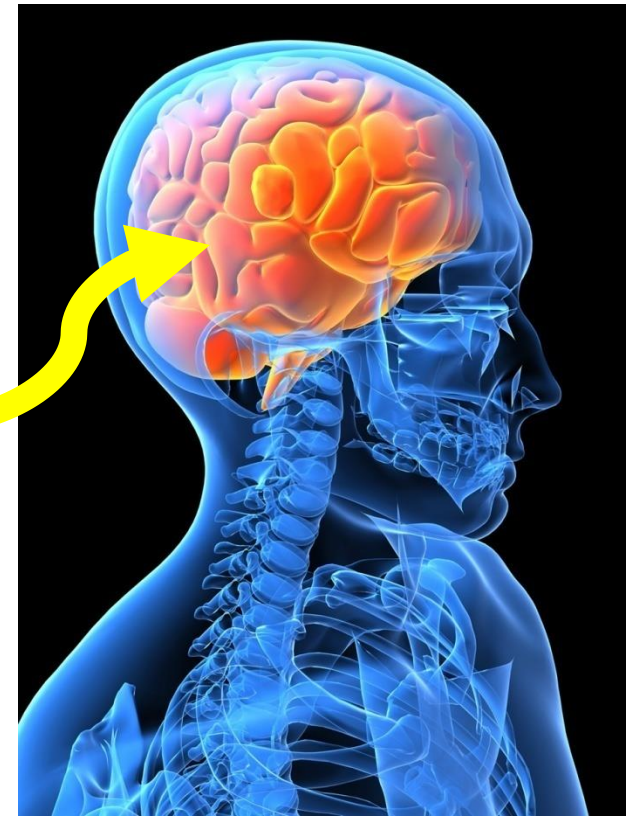
- When something flies toward your eyes, you blink.
- By blinking, your body prevents dust and other particles in the air, or anything else that might be dangerous, from entering your eyes and harming them.



An Important Reflex: Touch

- The sense of touch originates in the bottom layer of the skin called the **dermis**. The dermis is filled with many tiny nerve endings that give us information about the objects that our body comes in contact with.
- The **nerves** carry the information to the spinal cord, which sends messages to the brain where the feeling is registered.
- **Nerve endings** in the skin have many different functions:
 - They can tell you if something is hot or cold.
 - They can also feel if something is hurting you.
 - They can tell if something is applying pressure to you or touching you.



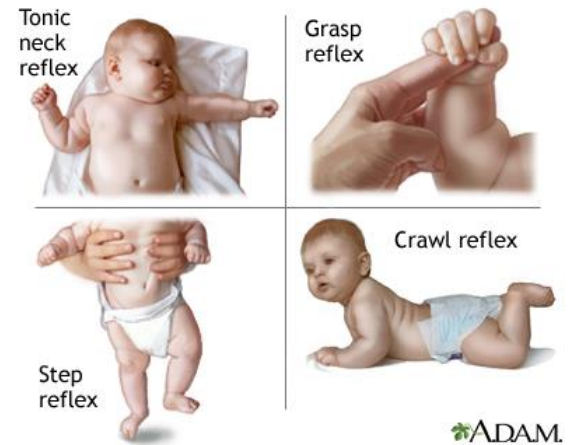


Example: If something hits your back, it causes pain. Nerve endings in the back send information through the spinal cord up to the brain, where information is processed so you “know” about the pain and the event that led to it.

Then your brain decides what to do about it and directs your muscles to move.

Some Additional Human Reflexes

- **acoustic reflex** In response to high sound intensities, contraction of the stapedius and tensor tympani muscles in the middle ear.
- **blushing** A reddening of the face caused by embarrassment, shame or modesty.
- **corneal reflex** Blinking of both eyes when the cornea of either eye is touched.
- **rooting reflex** Turning of an infant's head toward anything that strokes the cheek or mouth.
- **shivering** Shaking of the body in response to early hypothermia in warm-blooded animals.
- **vestibulo-ocular reflex** Movement of the eyes to the right when the head is rotated to the left, and vice versa.



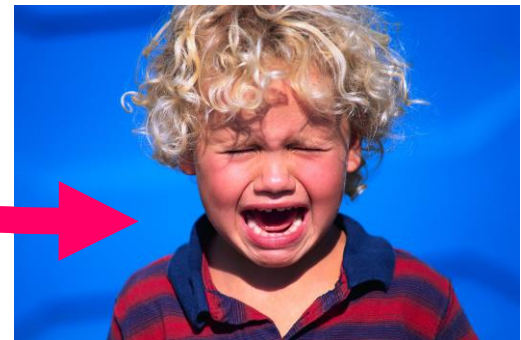
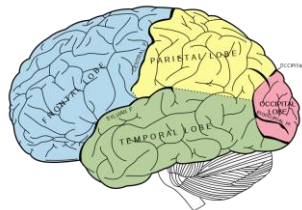
What are all the components that make a reflex happen?

stimulus → sensor → coordinator → effector → response

touch → pain receptor → nervous system → muscle → movement

Looking at this sequence of steps, this is what happens when something sharp touches you on your hand: The **stimulus** is touch, your pain receptor is the **sensor** that senses it and relays it to the nervous system (spinal cord and brain) which is the **coordinator**. The **coordinator** makes the decision of how to react, and then commands the hand muscles (**effector**) to move the hand away (**response**). Thus, we go from stimulus (touch) to response (hand movement).

Assignment: Sketch out how the stimulus to response sequence for any two of reflexes. Identify all the components as in the example above.



Post-Lesson Quiz Answers

1. What are reflexes?

A reflex is an involuntary body movement in response to something. You do not even have to think about it. Reflexes make sure that our bodies are not harmed, that is, they automatically protect our bodies from injury.

2. Provide two examples of human reflexes.

List the “stimulus-sensor-coordinator-effector-response” components of the reflex.

Blinking of eye when something comes toward it. Stimulus –something coming towards the eye; sensor – eye; coordinator – brain; effector – eye muscles; response – blink movement

3. Describe how a robot with sensors can be used to mimic a reflex action.

Using the touch sensor, the robot can be programmed to ‘run’ back quickly when the sensor is activated. This is similar to our hand jerking back quickly after touching a hot object.

Reaction Times & Response Times

- The time taken to respond to stimulus is the response time.
Response time = reaction time + movement time
- Reaction time depends on the stimulus type:
 - * auditory ~ 150 ms
 - * visual ~ 200 ms
 - * touch ~ 700 ms
- Movement time varies considerably, and is dependent on age, fitness etc.
- Given these variables, the time to respond (aka the response time) to a stimulus varies among people.



Engineers Program Robots to Respond in a Similar Manner as Reflexes

stimulus → sensor → coordinator → effector → response
touch → touch sensor → NXT brick → motor → movement

When a touch sensor in a robot is activated, it sends a signal via the wires (nerves) to the NXT computer, which is the coordinator. The coordinator makes the decision of how to react based on what the engineer has put in the program, and then commands the appropriate motor to move.

So, we go from the stimulus (touch) to response (movement of the robot), in a similar manner!

Robot Sensors



○ What do robot sensors do?

- Gather information from the surroundings and send it to the computer brick.
- Robot sensors can only be used if the robot's program asks for information from them!
- Similarly, the robot can only act on information from the sensors if its program tells it to!

○ How do sensors send signals to the computer brick?

- The sensors send information through the wires that connect them to the computer brick, which uses the information to make decisions about what to do next.

How Do Robot Sensors Work?

Touch Sensor

Button-like protrusion. When bumped, it sends a signal to the computer brick saying that it has been touched.



Light Sensor

Works in two different ways:

1. Detects the amount of ambient light and converts it to a numerical value, which it sends to the computer brick.
2. Sends out light and detects how much is reflected by an object. This is to detect brightness of object. Converts amount of reflected light to a numerical value and sends it to the computer brick. If no object is in front of the sensor, it sends a value of zero.



Day 2: Let's Start with a Review

What all are the components that make a reflex happen?

stimulus → sensor → coordinator → effector → response

touch → pain receptor → nervous system → muscle → movement

Looking at this sequence of steps, this is what happens when something sharp touches you on your hand:

The **stimulus** is touch, your pain receptor is the **sensor** that senses it and relays it to the nervous system (spinal cord and brain) which is the coordinator. The **coordinator** makes the decision of how to react, and then commands the hand muscles (**effector**) to move the hand away (**response**).

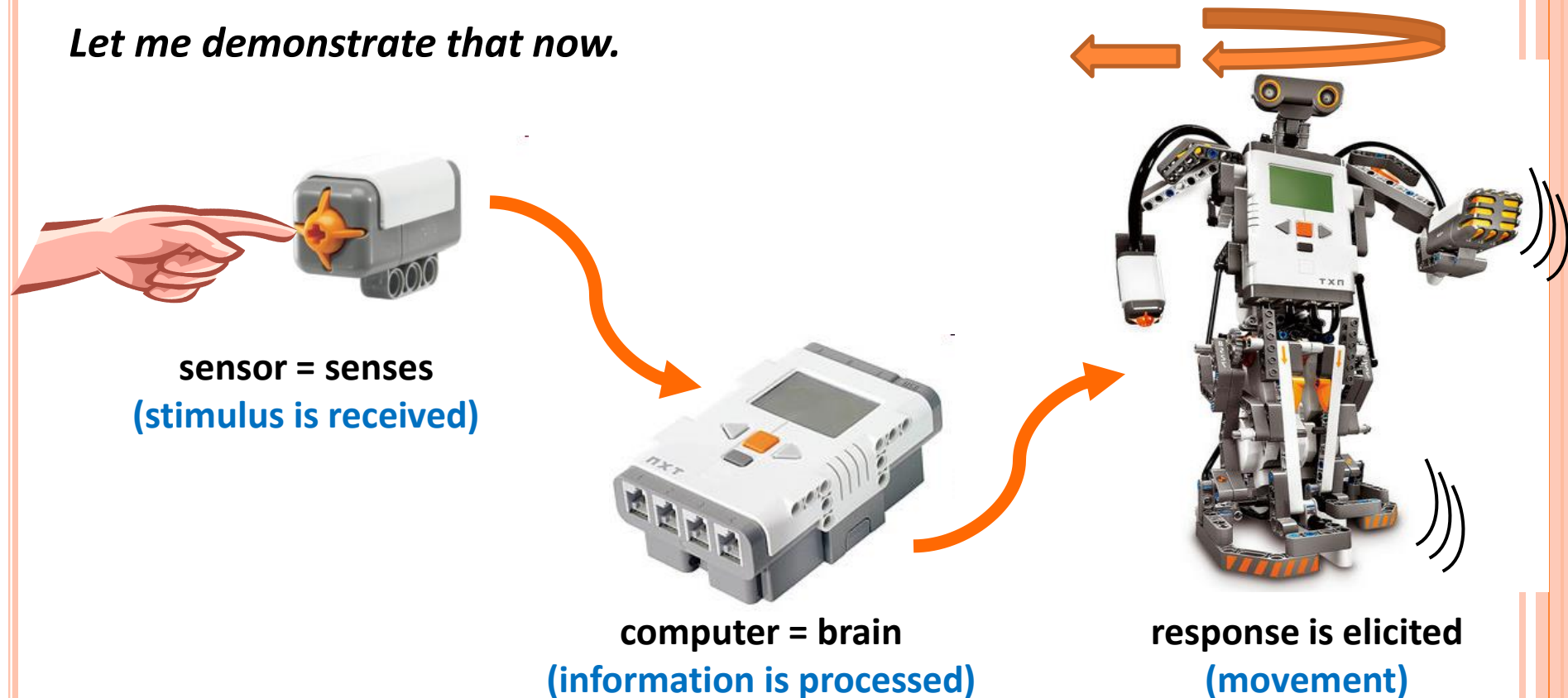
Thus, we go from stimulus (touch) to response (hand movement).

Assignment: Make a sequence of events, as above, for a robot moving back quickly after touching a wall.

Similarly, a stimulus perceived by a robot sensor sends a signal to the robot brain (computer) and an action is performed (movement).

(In a previous lesson/activity) You have programmed the NXT with a touch sensor so that when it was touched, the robot moved backwards.

Let me demonstrate that now.



Post-Lesson Quiz

- 1. What are reflexes?**
- 2. Provide two examples of human reflexes.**
List the “stimulus-sensor-coordinator-effector-response” components of the reflex.
- 3. Describe how a robot with sensors can be used to mimic a reflex action.**

Vocabulary

- reflex** An involuntary body movement in response to something.
- stimulus** Something that causes a response.
- acoustic** Related to hearing.

Can You Name Some Human Reflexes?

knee jerk reflex (or patellar reflex), blinking, blushing, hands touching hot objects, acoustic reflex, corneal reflex, rooting reflex, shivering and vestibule-ocular reflex

