

Module 3 Your Brain in Action: Electromyography

- Brain Spikes! SEE and HEAR how neurons communicate (45min-1hr)
 - Students will record (see and hear) electrical activity from their muscles.
 - Students learn that the brain activates muscles by sending messages to them in the form of electrical signals (action potentials).

Background

When your brain decides to move a muscle, neurons in the motor cortex of your brain send electrical signals that travel along neurons until they reach the muscle. These electrical signals are also called *action potentials*. Action potentials can be recorded using EMG (electromyography).

Materials (per group)

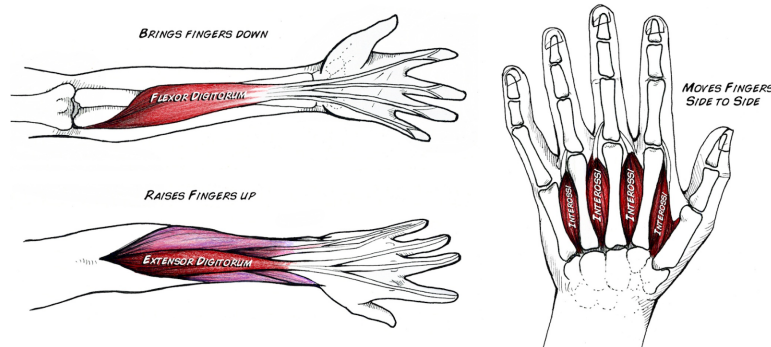
- EMG Spiker Box
- Cable
- Computer, tablet, or smartphone
- Two popsicle sticks with brass fasteners attached
- Conductive Gel

Before working with students:

Take some time to learn how to use the spikerbox before working with students. Download the Spike Recorder app on any device (smartphone, tablet, computer) that you will be using and take some time to test out the device so you know how to use it.

Opening Discussion

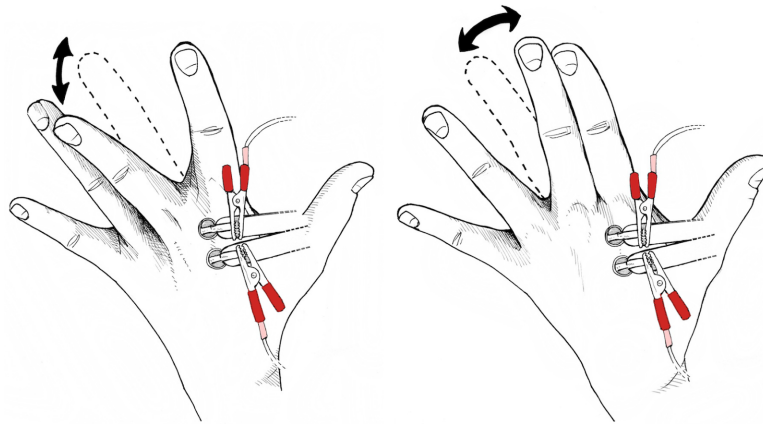
- How does the brain activate muscles? [The brain sends an electrical signal that is relayed through neurons all the way from the brain, along the spinal column, to the muscle cells]
- Which muscles are used to move your fingers? [Up and Down movement of you fingers is controlled by muscles in your forearm. Side to side motion is done by smaller muscles in the back of your hand.]



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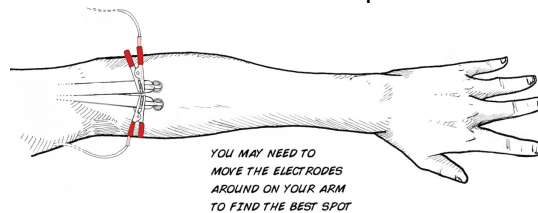
Part I: Electromyography

1. Download the Spike Recorder app from Backyard Brains, and open it on your computer, tablet, or smartphone. <https://backyardbrains.com/products/spikerecorder>
 - a. **For computers:** The Spike Recorder App defaults to using the sound input from the microphone on your computer, so we need to change this. Click on the gear symbol in the Spike Recorder app. Under 'Select port:' click on 'Muscle SpikerShield,' then click 'connect'.
 - b. **For tablets or smartphones:** the app will need access to the microphone, so select yes when it asks.
2. Set up your Spiker Shield by connecting the wires and power: Plug in the orange wire (with 3 clips attached) to the orange port on the Spiker Shield. The 3 clips will be used to measure the EMG signal on the subject's arm. A light green LED on the top center of the Spiker Shield will light when it has power.
 - a. **For computers:** use the blue cord (USB-A to USB-B) to plug into a USB on your computer, and the yellow marked port on the Spiker Shield. (no need for batteries attached to the spiker Shield since the USB provides enough power for the device)
 - b. **For tablets or smartphones:** use the green data cable, which plugs into the audio jack of the phone or tablet. Plug in one 9V battery to the black barrel connector on the lower piece of the Spiker Shield.
3. Connect a red clip to the back of each of the electrodes (the brass brads attached to the wood stick). The black clip is the ground for your electrical circuit, and needs to be touching the person whose muscles are being recorded- they can clip it to a metal ring or bracelet, or just hold it in their hand.
4. Put a little bit of electrode gel on the two round heads of the brass brads (you will likely only see a noise signal if you don't have electrode gel!)
5. You are ready to look for the electrical signals of the muscles used to move your fingers side to side! Put the two electrodes on the back of your hand and move your finger side to side. When the SpikerShield detects an electrical signal in your muscle, you should hear a clicking sound and see the the LEDs on the SpikerShield lights up. Look at the screen of the device you have hooked up to your SpikerShield- there should be a signal associated with the electrical signal associated with thie muscle movement. You may have to adjust the signal you see on the screen:
 - a. **For computers:** Adjust the amplitude of the signal by clicking on the + or -
 - b. **For tablets or smartphones:** pinch with 2 fingers vertically to adjust the amplitude of the signal on the screen. Pinch with 2 fingers horizontally on the screen to adjust the time (you will want somewhere between 1 and 3 seconds).



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6. Challenge: Can you locate the muscles that control the up and down motion of your finger?



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7. Challenge: Can you locate the muscles that control the movement of your wrist?
8. Once students locate the muscles that controls wrist movement (on the underside of their forearm), have a friend move their hand (so it has the same motion, but they aren't using their muscles). What kind of EMG signal do they see? [they should not see one]

PART II: Neuroprosthetics

1. Discuss: What is neuroprosthetics? How could people use neuroprosthetics to help them?
2. Time to hook up The Claw!
 - Connect the Claw motor wire to the top of the SpikerShield, making sure the yellow side is towards the center of the SpikerShield (order of the wire is important).
 - Plug in both 9V batteries to the two black barrel connectors.
 - The rest of the wires from Part I of this activity should remain the same.
3. Experiment with The Claw! It may take a little trial and error to get the claw working. You should be able to make the claw open/close each time you contract the muscle.
 - Try using different muscles
 - The white button changes between high and low sensitivity
 - The red button switches between default open or closed
4. If time allows, have the students come up with a simple game that requires teamwork between the person controlling the movement of the claw pincers and the person that is holding the claw.