

## **The Dancing Cockroach Leg: An Introduction to the Electrical Properties of Neurons**

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*Video credit to Jenn Wilhelm*

### **Grade Level this resource is appropriate for:**

The method described below is for use in an undergraduate classroom. At the end I have described how I used a similar demonstration in a middle school class.

### **Type of Teaching Resource:**

Video

Lesson Plan

### **Pedagogies:**

Active learning/discovery learning

Cooperative/small-group learning

Critical analysis/critical thinking

Student-centered instruction

Demonstrations

### **Description of the resource:**

On the first day of my upper level undergraduate Neurophysiology course I have the students watch the following video and tell them to make sure to pay attention to everything that is going on in the video:

<http://www.youtube.com/watch?v=fr7Vra9Ok9c>

(You can email me at [katherine.wilkinson@sjsu.edu](mailto:katherine.wilkinson@sjsu.edu) if you would like the original video file)

I then have them work in groups of ~4 to determine what is happening in the video. I like to have them start discussion without any more information. Usually after about 3 or 4 minutes I stop everyone and ask if they have figured out what is going on. Students generally guess that something on the cockroach leg is sensing the music. I then explain that the setup used in this demonstration includes an iPhone hooked up to a splitter with one end connected to speakers and the other to pin electrodes placed into a cockroach leg (see <http://backyardbrains.com/Experiments/microstimulation> for a nice schematic) and let them discuss the video again. By this time they have usually gotten that the electrical signal from the iPod is going directly into the cockroach leg.

We then discuss the following questions as a group:

- 1) Why does the cockroach leg move?

*The electrical signal from the iPod is causing a motor neuron in the cockroach leg to fire an action potential, which then causes the leg muscle to contract.*

- 2) When does the cockroach leg move the most?  
*During the beats (low frequency, high amplitude waves) or higher volume portions of the song.*
- 3) Why doesn't the cockroach leg move during the first 30 sec of the song?  
*The woman is singing in a higher pitch (high frequency, low amplitude waves), which is not sufficient to bring the motor neuron to threshold and cause the motor neuron to fire an action potential.*
- 4) What do you think would happen if you increased the volume of the song?  
*The cockroach leg may move more (more motor neurons could be brought to threshold). It may also move during parts of the song it may not have moved before (now the motor neurons are brought to threshold).*
- 5) What parts of the cockroach leg are involved?  
*Motor Neuron and leg muscle. This is a good time to introduce the idea of motor control if you like.*
- 6) Why does the cockroach leg remain upright during the rap portion of the song?  
*There is a tetanic/sustained contraction in the leg muscle because this portion of the song stimulates the motor neuron to fire repeatedly at a high enough frequency that the muscle does not relax (this portion of the song is fairly loud and the person is singing in a low pitch).*

I wrap up by explaining that nerves carry their information very similarly to electrical wires. They open channels on their membranes to allow ionic current to flow and pass the signal down their axons.

**Alternative ways to do this demonstration and where to go for more information:**

You could also do this demonstration in person by using the Backyard Brains Spiker Box ([www.backyardbrains.com](http://www.backyardbrains.com)). They also have a nice microstimulation lesson plan that includes a more systematic look at microstimulation and some of the history behind electrical stimulation of neurons (<http://backyardbrains.com/Experiments/microstimulation>).

I have also done this demonstration to middle school students as part of a science day. I approach the lesson similarly, but do not expect them to be able to explain things in as much detail. I explained that the wires carried electricity that could activate the motor neurons and cause the muscles on the cockroach legs to contract. The students really loved hooking up their own iPods or phones and seeing the cockroach leg dance to their favorite song.