The Incredible Edible Excitable Neuron

Cassia Cearley, Priya Patel, Pete Zornes

April 4th, 2003

Abstract:

Knowing about neurons is critical for understanding brain function. Neurons are the fundamental units of the brain and through them impulses form the basic means of communication. The structure of the neuron is important when considering function; the processes protruding form the cell body being optimal for communication purposes. For the kids judge fair we decided to teach students about the structure of the neuron using a large neuron that we constructed out of various material and also by having the students make their own neuron out of marshmallows, straws, and fruit by the foot. Throughout our presentation we discussed the functions of the various parts of the neuron with the students. We quizzed the students at the end of the presentation and found that some of them had learned from our discussion, the students voted us second when comparing us to other groups, and also made comments on how they thought the presentation was. This was a good experience and with certain changes to the setup of the event we think that the students might enjoy themselves more and be able to learn more as well.

Introduction:

Knowing about neurons is critical to understanding the brain. For our project we chose to model the basic structure of the neuron in hopes that it would help students better understand neuroscience in general. The neuron doctrine states that individual neurons are the fundamental signaling units of the nervous system. Ramon y Cajal was crucial to the development of our present concept of the neuron. He developed a stain making it possible to see individual neural cells therefore proving that that the brain is made of a network of discrete cells (Cajal, 1908). Neurons are the basic means of communication throughout the brain and the structure makes it optimal for this function. Nerve cells receive stimuli and send electrical impulses to other parts of the system. Several neurons come together in a chain-like fashion sending impulses from one part of the system to another. There are specialized contacts between neurons called synapses that provide for the transmission of information from one neuron to the next.

The various parts of the neuron all have their own function. The cell body is the metabolic center of the neuron and contains the nucleus and organelles that maintain the nerve cell. The organelles within the cell body include the mitochondrion, endoplasmic reticulum, Golgi apparatus, lysosomes, microtubules, and vesicles among others. Processes extending from neurons include dendrites and axons. Usually, neurons only have one axon which transmits stimuli to other neurons or to effector cells. Action potentials flow down the axon from the cell body to the axon hillock. Dendrites made contacts with other neurons and are able to receive stimuli from these nerve cells.

Axons of neurons in the central nervous system may have a myelin sheath which provides insulation for that axon and increases the speed of propogation of the action potential (Waxman, 1975). The myelin sheath is made of layers of Schwann cell membrane wrapped around the axon. The Schwann cells are arranged sequentially along the axon and the junction where the Schwann cells meet does not have any myelin. The areas of the myelinated neuron where no myelin exists are called the node of Ranvier. Action potentials going down the axon jump from node to node (England et al., 1996).

Since the neuron is so vital for brain function, we chose to model the brain for the Brain Awareness Day Kid's Judge fair. In order to help explain nerve function we created a model neuron and also had the students create their own neurons. We discussed the function of the neuron with the students and then quizzed them at then end to see what they had learned.

Methods:

We created a large model of a neuron using Styrofoam, toilet paper rolls, wire, string, and clear plastic cylindrical pieces (see fig. 2). The Styrofoam ball was representative of the neuron cell body and there were dendrites protruding out from the cell body in the form of metal wires. The axon was constructed from toilet paper rolls, which represented the myelinated axon, and there were also clear, plastic, cylindrical pieces between the toilet paper rolls which represented the nodes. A string was attached to the cell body, went through the axon, and was tied to another piece of Styrofoam which was the end of the axon or axon terminal. When we shook the string it caused the string to move within the axon and the students could see the string move only in the clear pieces, or nodes. We made it this way so that the students could see that action potentials, represented by the moving string, occurred only in the nodes, since these were the only places that the children could see the string moving.

The miniature neurons that the students created consisted of a marshmallow for the cell body, toothpicks for the dendrites, a straw for the axon, and fruit by the foot with which was wound around the ‘axon’ to create myelin (see fig. 3). As the students made there own neurons we explained the function of each part. At the end of the construction process we quizzed the students to see what they had learned and did a short review of the different parts of the neuron.

The poster used pictures found from Pinel (2000), and also used a Styrofoam ball, and a Styrofoam axon terminal. These two things were cut in half exposing the internal organelles which were represented by different candies. For the cell body organelles; a malted milk ball was the cell nucleus, jellybeans were the mitochondria, gummy worms were the endoplasmic reticulum and licorice strips represented the golgi complex. For the cell terminal; M&M’s were the synaptic vesicles, mitochondrion were again represented by jellybeans and endoplasmic reticulum were again licorice strips. The pictures were scanned and then pasted to the poster so that the students could look at them if they wanted to learn more about the subject.

At the end the students were given evaluation forms to fill out where they were asked a series of questions. Questions included: 1. Could you understand what the presenters were trying to tell you? 2. Were the presenters friendly? 3. Was the exhibit fun? 4. Would you like to learn more about this topic? 5. What was your favorite part about this exhibit? 6. What did you learn from the exhibit?

The evaluation forms were then examined and it was determined what the average view of the students was. This average was compared to other groups' averages to yield a graph representing the student's view of the presentations as a whole.

Results:

The students seemed to like the model and the poster. They really seemed to enjoy constructing the neuron, mainly because there was food involved. When quizzed at the end there were a few students that knew the answers right away while others had to be reminded. Not many students asked questions, but that may have had to do with the time constraints. A couple students asked what the different functions were for the different parts of the neurons, so we explained that to them.

The average score that we got on the evaluation questions was 4.52 out of 5.0 possible. For a graph of our scores compared to other groups' scores; see figure 3 (our scores are in red). For question 1 we received an average score of 4.5, for question 2 we received a score of 4.5859, for question 3 we received 4.6667, for question 4 we received 3.9231. The students gave a number of answers when asked what their favorite part of the exhibit was including: "making brain cells," "fruit by the foot," "the candy and the building," "I learned a lot more about neurons," and "the display." The students also gave a variety of answers as to what they learned from the exhibit including: "about axons," "your brain carries signals fast," "how the neuron works," and "myelin is on the axon." When the students judged the projects we placed second.

Discussion:

A few of the students commented that they didn't learn anything, perhaps they already knew everything we were telling them, though a more likely possibility might be that they couldn't hear or were too distracted by the other projects. The tables seemed very close to one another and I notice that the students were often looking at other projects while we were giving our demonstration. It was also very hard for the students to hear and a couple students commented that they couldn't hear, whenever we heard such comments we tried to position them in a better place so that they could hear, but that was not always possible. We were next to the presentation with the speakers, which likely contributed to the students not being able to hear our presentation. There was not enough room around our table for us to present and all the students to actually see what we were doing, many students could not see and we tried to re-position these students as well to no avail. We definitely felt rushed throughout the presentation and were not able to go through as many of the explanations about function as we had planned. This may have also been a factor as to why some students commented that they did not learn much, perhaps we were not able to fully explain so they did not understand. We had been hoping to describe in greater detail the functions of the organelles but for the sake of simplicity decided to leave that part out. Many things had to be left out of the presentation, the students didn't really even have time to see the poster and we didn't have time to mention anything included on it. We were able to show them the large model of the neuron and show them how action potentials occur at the nodes, but were not able to help them fully understand action potentials so this may have been a loss. The students did enjoy making their own neurons and I think that it helped that we described what each piece was and went over the functions of the different parts of the neuron at this time. The quiz that we gave at the end of the presentation was a good indicator as to how much the students actually did learn and it was encouraging that a few students remembered the answers to some of the questions.

There are many things that could have been done to make this a better learning environment. Each presenter should be given ample space so that all the students are able to see and hear what is being presented. We included too much information on our poster and it would have been more simplistic and easy to understand had we just focused more on the general structure and only included figures of that. If each group had 15 minutes to present that would be sufficient to teach the students, as it was; there didn't seem to be enough time for the students to actually learn what we were trying to explain.

The presentations were a good experience and helped not only the students learn valuable information about neuroscience, but also the presenters learned how to teach under pressure, which could be useful later in life.

Figures:

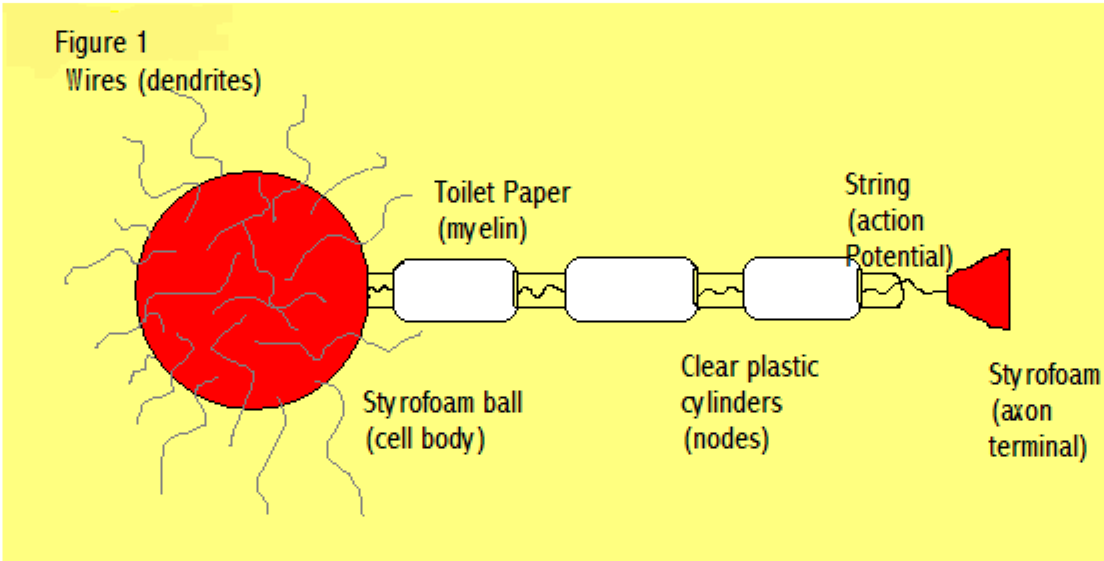


Figure 1
Wires (dendrites)
Toilet Paper
(myelin)
String
(action
Potential)
Styrofoam ball
(cell body)
Clear plastic
cylinders
(nodes)
Styrofoam
(axon
terminal)

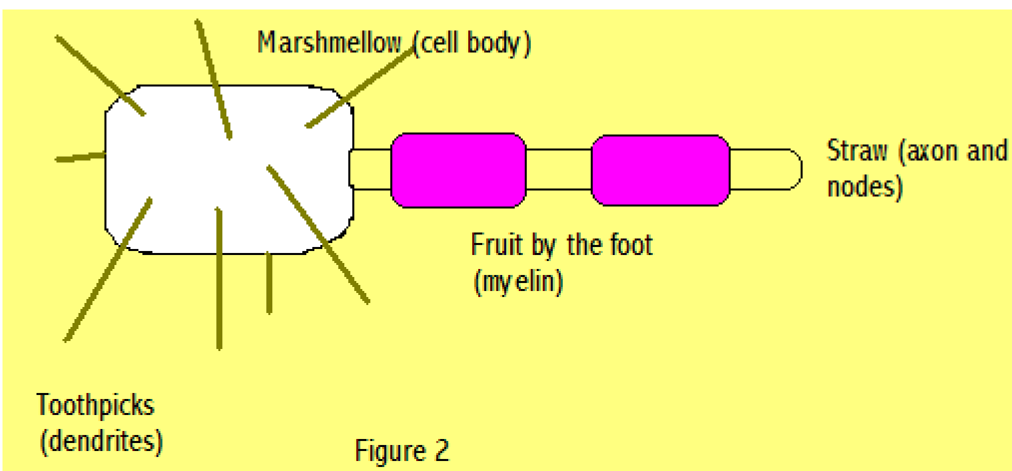
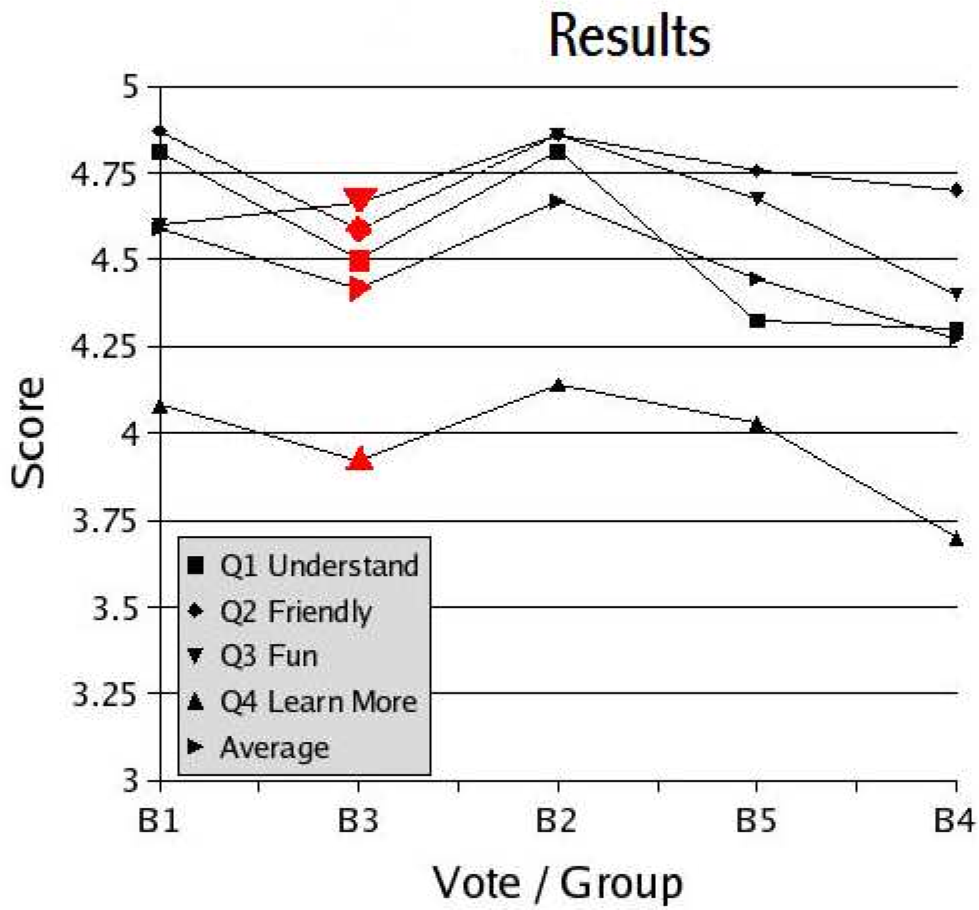

Marshmellow (cell body)
Straw (axon and
nodes)
Fruit by the foot
(myelin)
Toothpicks
(dendrites)
Figure 2

Figure 3


Results
5
4.75
4.5
4.25
4
3.75
3.5
3.25
3
Score
Q1 Understand
Q2 Friendly
Q3 Fun
Q4 Learn More
Average
B1
B3
B2
B5
B4
Vote / Group

References:

England JD, Lenvinson SR, Shrager P. (1996). Immunocytochemical investigations of sodium channels along nodal and inter nodal portions of demyelinated axons. Micros Rec Tech 34(5): 445-51

Pinel, J.P.J. 2000. Biopsychology. Allyn and Bacon.

Ramon y Cajal S. [1908] 1954. Neuron Theory or Reticular Theory? Objective Evidence of the Anatomical Unity of Nerve Cells. MU Purkiss, CA Fox (transl). Madrid: Consejo Superiour de Investigaciones Cientificas Instituto Ramon y Cajal.

Ross, MR (1995). Histology: A text and atlas, 3rd ed. Williams and Wilkins.

Waxman SG. (1975). Integrative properties and design principles of axons. Int Rev Neurobiol 18: 1-40