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Abstract

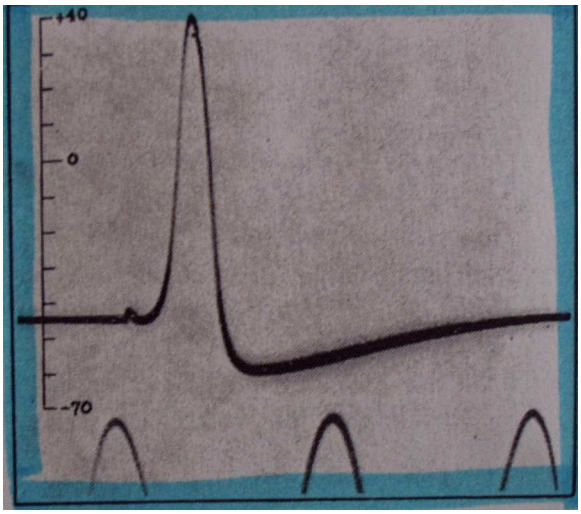
This paper will detail the model we built for brain awareness day from construction to destruction, how the kids responded to our model, and what we might have done to make our model or presentation of our concept better. Our model was based on the concept of synapses, neurotransmitters and the action potentials caused by channels allowing ions in and out of the cell. Nervous messages are invariably associated with an electrical change known as the action potential (Hodgkin, Huxley 1939). I will discuss how it was that we came to build our specific model and what it was that we were interested in teaching the children. An explanation of how our model worked and what the specific parts of our model represented will also be included. A list of materials that were used to build the model and how it was that we came to construct the different parts of the model will be discussed in the methods section.

On brain awareness day the children had a chance to evaluate our model and how we presented it to them. The evaluation sheet also asked the children if they learned anything and if they would be interested in learning more about the topic. The results section of this paper will discuss how the model was received by the children, if they asked good questions, if the children were able to understand the concept, how we placed in the over all rankings and what type of evaluations did we get from the children specifically.

In the discussion section of this paper I will report any issues that we had with the model, what went well with our model, what we might have been able to do to make our model better, and how we had to organize or rearrange our presentation so as to have the children understand and keep it within the time constraint. I think our model and presentation of our model did a good job at allowing the children to understand the concept, but I do believe that if we had more time to find better materials and to build our model it would have looked more aesthetically pleasing.

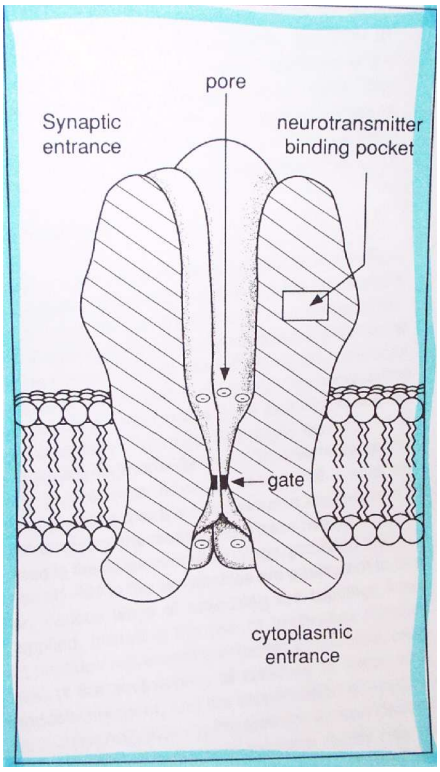
Introduction

Our model consisted of three parts, first there was a poster with the drawing of what an action potential looks like, showing resting potential and containing a key for the second part of our model which was another action potential molded out of wire. Tennis balls were on the wire to represent the different ions, potassium and sodium, and the wire was attached to two boards for stability. This part of the model allowed us to show which ions were moving in which direction at the certain parts of the action potential. Our drawing and our wire model were based off of the figure shown below (Hodgkin, Huxley 1939):



ATION POTENTIAL RECORDED BETWEEN INSIDE AND OUTSIDE OF AXON. TIME MARKER, 500 CYCLES/SEC. THE VERTICAL SCALE INDICATES THE POTENTIAL OF THE INTERNAL ELECTRODE IN MILLIVOLTS, THE SEA WATER OUTSIDE BEING TAKEN AT ZERO POTENTIAL

The third part of our model was two buckets that represented nerve terminals, one was the post-synaptic cell and the other was the pre-synaptic cell. One was covered by a plastic sheet that contained holes, which represented fused synaptic vesicles; this one was the pre-synaptic terminal. The other bucket contained a piece of cardboard which had ten smaller holes in it, representing binding pockets of ligand-gated ion channels; this bucket was the post-synaptic terminal. Ligand-gated ion channels mediate the rapid action of neurotransmitters at the synapse (Unwin, 1993). The following figure is of a ligand-gated ion channel (Unwin, 1993):



The pre-synaptic terminal contained twelve neurotransmitters (e.g., chocolate eggs) that were “released” into the “synapse” to be able to bind to the receptors on the post-synaptic cell, allowing the channel to open and ions to flow through. We also had some larger egg candies that represented a drug so when we had the kids perform the task again, there were drugs added to the system demonstrating how drugs get in the way of your body’s neurotransmitters to bind to their receptors. The references we used for building this model were *Storage and Release of Neurotransmitters* by Regis B. Kelly, *Action Potentials Recorded from Inside a Nerve Fibre* by Hodgkin and Huxley, and *Neurotransmitter Action: Opening of Ligand-Gated Ion Channels* by Nigel Unwin.

We wanted to explain the concept of how a neuronal transmission is sent between neurons. How when one neuron is stimulated its synaptic vesicles fuse with the plasma membrane to release tiny chemical signals called neurotransmitters, and that those

neurotransmitters float across the synapse to bind onto a ligand-gated ion channel. These then go through a conformational change and the gate opens allowing ions to flow in and out of the cell. Thus causing an action potential in the second cell, and the process repeats itself on down the line.

Synaptic vesicles are very small and contain chemical neurotransmitters such as acetylcholine, glutamate, GABA, glycine, and the biogenic amines (Kelly, 1993). All these neurotransmitters have different binding sites and therefore act upon different cells in different ways. This is because there is a variety of neurotransmitter-specific channels and channel subtypes having distinct ligand binding, ion selectivity, and conductance properties (Unwin, 1993). The releasable synaptic vesicles docked at the plasma membrane fuse when calcium enters the nerve terminal through voltage-gated calcium channels (Kelly, 1993). Exocytosis of neurotransmitter occurs when the phospholipid bilayer of the docked secretory vesicle becomes continuous with that on the plasma membrane (Kelly, 1993).

After the neurotransmitter is released from the pre-synaptic cell it goes on to activate the ligand-gated ion channels on the post-synaptic cell. The purpose of ligand-gated channels at the synapse is to respond to the stimulus provided by the neurotransmitter by altering rapidly the potential of the post-synaptic membrane (Unwin, 1993). After the neurotransmitter binds to the protein on the target cell, ions flow through it down their electrochemical gradients, the potential across the membrane changes, and the molecules of the target cell respond (Unwin, 1993).

Methods

All the materials used for our model were boards, wire, cat toy tennis balls, poster board, two buckets, some cardboard, a plastic sheet, and some chocolate candy. The construction of our model was probably not too difficult compared to some, but it was tough trying to get the wire part of our model to work like we wanted it to.

First, we had to nail the boards together, which we had a hard time doing because the nails were not quite long enough so we had to use a bunch to make it stable enough. Secondly we had the challenge of puncturing the tennis balls so that they would slide along the wire well enough, but also be able to stay at the positions on the wire that we wanted them to. The third, and final, problem we had with this particular part of our model was trying to attach the wire to the boards and have it shaped the correct way. We decided to staple the wire to the side of the stand with a staple gun, this was a good idea, but it took a number of tries to get the staples in enough to hold it up because the wire was so thick and the staples were not that large. After attaching the wire to the sides of the stand we realized that we need to stabilize the wire by attaching it to the base somehow. By wrapping another wire around the shaped wire, and attaching the second wire to the base, we were able to stabilize the "action potential" so that it would not move while the children were moving the tennis balls, which represented sodium and potassium ions, along the wire it would not move as much. The only problem we had with the buckets, these represented post and pre-synaptic terminals, was cutting the holes large enough that the "neurotransmitters" would bind, but not large enough that they would fall through. This posed a problem so we decided to place tape on the underside of the cardboard, under the holes, so the "neurotransmitters" would not fall through. Using a plastic sheet for the pre-synaptic terminal came to us at the last minute. We were unsure

of what would be the best thing to depict the release of a neurotransmitter from the pre-synaptic cell, but it seemed like a perfect idea to have the plastic sheet with holes cut in it to show the fusing of vesicles to the cell membrane, therefore releasing the neurotransmitters.

Results

I believe that our model was very kid friendly because it is not too difficult to understand and it had a number of hands on parts to it. The kids really seemed to enjoy our model and presentation of it. Even though we did provide candy I think that the children also enjoyed playing the role of a neuron and with the tennis balls on the action potential.

I was surprised at some of the questions that the children were asking. As a result of the drug part of our model, I remember two children in particular that asked rather in depth questions. We had one girl ask about the effects of alcoholism on the brain and neuronal transmission and the other asked about antidepressant medication. Luckily because of the background of another class that I am currently taking I was able to answer there questions.

We repeatedly asked each group if they understood the concept, which they would always reply yes to, or if they wanted us to go over it again. All of the children showed great attention skills when we were talking and they all seemed to understand the concept that we were trying to teach to them. I do not know if our presentation incorporated techniques to tell if the children actually understood, but because we had the poster with the action potential on it and the wire model, along with the buckets to show

what causes the action potential, I think that we repeatedly described to them the steps of a neuronal transmission in a way that would be really easy for them to understand. From the question that they asked and their comments on the evaluation sheets, I do think that our presentation did make it easy for them to understand the concept.

We received third place, out of five, in our section, which was section A, in the Kids Judge with Brains contest. I believe that our overall ranking shows that the kids had a good time at our station and that they were able to leave with a little more knowledge about the subject.

We received really good evaluations from the children and also the leaders of the groups of kids. Most of the children commented about how they learned about how drugs affected the neurotransmitter binding, and how the over all affect of that was either no further neuronal transmission or it mimicked the normal transmission. Of course the children said they liked the candy, but not as much as they commented on playing with the tennis balls on the action potential and being able to do the action with the buckets and neurotransmitters. The children also commented on how friendly we were and that we had a fun attitude while teaching them about our topic. The averages of our evaluations were all higher then the overall ranking we received. The average for question four was the only one that was close to our voting ranking of three, it was a 3.67. Every other evaluation ranking was in the 4.0 range.

Discussion

Even thought our model was fairly "primitive" compared to some other groups I think that it really allowed us to get the concept across to the children. It also gave the

children a chance to play around with the model, and from my experience, hands on activities always allow for better learning of a concept. The kids apparently enjoyed being able to play with the different parts of our model; this is apparent from their comments in their evaluations and from their enthusiasm on Brian Awareness Day. I do believe that if we had been able to have a little more time to work on our models we would have been able to build a better set up for our action potential and possibly planned to have more buckets, and a better system to work them, so more kids could have participated.

Overall I think that our model was really good for the kids. We did not want to make anything too difficult for them to work with or to understand, but yet we did not want to make it too easy. I think that our execution of our concept for this presentation was just right for the age group that we were working with. Obviously the children agreed with me, from their comments, that this was a good way to teach them about synapses, neurotransmitters, and action potentials. I do think that we could have made our wire action potential a little more aesthetically pleasing if we had more time to find better materials for the job. Another thing that I wish we could have done was involve more children in the activity by having more buckets. By doing this we could have had a whole line of "neurons", children and buckets, which would have also helped more with explaining how a number of neurons communicate. Also, this would have been good to show more of the affects of a drug on that system, since most of the kids seemed interested in how drugs affected the neural transmission.

With the time constraint we had to delegate different parts of the presentation so that we both got a chance to speak to the children, and we also had to cut back on some

of the things that we wanted to say to allow the children to ask questions before they had to rotate. Since there were more kids in a group than there were activities to do at out table, and all of them wanted to volunteer, we had to have multiple kids hold on to a bucket and act as the neuron. Even though it got a little crowded when they all bunched together I think it worked well because they were all able to see what was happening even though they did not all get to be part of the "action".

I had a really good time presenting our topic to the children. I was surprised by the enthusiasm that they showed to learn and participate in the activities. I do wish that we had a little more time to prepare our model so that more children could have participated with out having to bunch together, but I am happy with the comments that we received from the children and leaders, and the ranking we received over all.

Works cited

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