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Neuro 430
Kids Judge Neuroscience Fair 2006 Exhibit
(with: Darius Banks)
Writing in the Major Assignment

Synaptic Tag

Abstract

The goal of "Kids Judge! Neuroscience Fair" was to learn how to teach kids the concept of neuroscience in an understandable way. In order to make easier for kids to understand the concept, the modularity of neurotransmission, we conducted the synaptic tag game. In the game, kids actually acted as neurotransmitters, enzymes, and receptors. The game made kids to understand better and kids enjoyed the event.

Introduction

Neurons communicate with other neurons via chemical synapses by releasing neurotransmitter. First, voltage-gated ion channels open due to the action potential on the presynaptic cells. Then, calcium ions enter the presynaptic cell through the voltage-gated ion channels. This causes neurotransmitter to be released from the presynaptic terminal by exocytosis. When released, neurotransmitters diffuse across the chemical synapse and bind to receptors that are linked either directly or indirectly to ion channels in the postsynaptic cell (Bertram, 1998). Ion channels exhibit a wide range of selectivity properties and permeation rates and they open their gates simultaneously (Kavanaugh, 1998).

However, the transmission of information in the nervous system can be modulated at synapses presynaptically and postsynaptically. This modulation of synaptic transmitter plays an important role in information processing in the nervous system and it may also be involved in the cellular mechanisms of learning and behavior (Weight, 1976). Presynaptic modulation inhibits the excitation of a transmission signal by changing neurotransmitter release (Vizi, 1984). It produces facilitation, depression, or posttetanic potentiation of neurotransmitter release (Weight, 1976). On the other hand, postsynaptic modulation inhibits the effect of the excitatory neurotransmitter on the postsynaptic membrane (Vizi, 1984). In addition to that, action potentials in the postsynaptic cell can modulate the release of synaptic transmitter due to the accumulation of extracellular K ions (Weight, 1976).

Behind the synaptic transmission, random kinetics is also involved. Each release site contains four Ca ion binding sites. In order to release neurotransmitter, Ca ions must bind to each binding site with affinities ranging from high to low (Bertram). It is competitive for Ca ions to bind the binding site.

Our model demonstrated the concept above. Specifically, the modalities of synaptic transmission. Two people represented the enzymes that inhibited or activated the synaptic transmission. All other people were the molecules of neurotransmitters. Kids except the two people representing the enzymes tried to go to the postsynaptic area from the presynaptic area. In our model, the two people representing the inhibitors tried to interfere with people representing as the neurotransmitters not to transmit from a presynaptic cell to a postsynaptic cell. When the two people represent as activators, only people who were tagged by them could go to the postsynaptic cell. This gave an idea that tagging was a random behavior. Attacking neurotransmitters by enzymes in the nervous system is also random. Kids could learn how neurotransmitter was released across the synapse by being neurotransmitters and could learn how transmission could be affected by the enzymes.

Methods

Our model demonstrated the modalities of synaptic transmission. To create a space of the synaptic transmission, we first made an enough rectangular space by putting tape on the floor. For presynaptic sites and postsynaptic sites, we made a couple of cross marks with tape on each short side within the rectangular space. For enzymes, we made two squares at the middle of the rectangular space. In addition to that, we made many cross marks in the rectangular space so kids could transmit from the presynaptic sites to the postsynaptic sites stepping on the cross marks. In the first trial, kids representing neurotransmitters just went to the postsynaptic sites from the presynaptic sites to see how actual neurotransmitters transmit through a synapse without the enzymes. Next, kids representing neurotransmitters tried to go to the postsynaptic sites while two kids representing the enzymes were trying to tag the neurotransmitters to interfere with transmissions. Finally, kids representing the neurotransmitters went through the rectangular space with the helps of the two kids representing the enzymes by tagging. The synaptic transmission is activated or inhibited by enzymes and the activation or the inhibition of the synaptic transmission is random. Also, neurotransmitters transmit across the synapse randomly.

Results

Kids enjoyed and understood our model as shown in Table 1. On the results sheet, many kids said it was fun, especially the game. They enjoyed moving across the synapse as

neurotransmitters while enzymes tried to inhibit the transmission. They also commented that they learned the brain has many processes by the effect of enzymes, inhibitors and activators.

Table 1 The average scores (out of five) in the four categories that kids graded

Understand	Friendly	Fun	Learn more
4.25	4.75	4.5	3.29

Discussion

Overall, kids enjoyed and understood the model. As they commented, they understood how the synaptic transmission occurred and how enzymes modulate the synaptic transmission. Through the game, they also learned the randomness of tagging by the enzymes. However, the actual synaptic transmission is more random. Neurotransmitters diffuse across the synapse instead of moving from one cross mark to another in the game. Enzymes are also more freely although they have stayed in the squire box in the game. Tagging by enzymes is also more random, because enzymes do not know where they are going to tag. In order to make sure the kids to be safe and to understand the concept easily and because of the limitation of the space, we did not demonstrate the randomness completely accurately.

Some kids really enjoyed themselves throughout an exhibition. However, a few kids seemed not to be interested in much especially during explaining the concept of the synaptic transmission. For people who are not interested in science it might be harder to participate compared to people who like science. But, having the demonstration by themselves through the game helped kids to be interested in as well as to understand the concept.

As shown in Table 1, the average score in the category asking kids wanted to learn more was low compared to other categories. This might be because the concept in neuroscience is not really connected with their lives or kids have no questions or wonderings about the concept. It is important to make kids to be interested in neuroscience.

If I have a chance to demonstrate the model again, I will change the part of the neurotransmitters tagged by the activators. In our demonstration, the neurotransmitters were needed to be tagged by the activators every time they moved from one cross mark to another on the floor. It took times the neurotransmitters to go to the receptors on the postsynaptic cell, compared to tagging by the inhibitors. Since the enzymes facilitate the release of the neurotransmitters, tagging by the activators one time works better. The cross marks was used for making sure the kids to be safe, but it would be fine without the cross marks. Without the cross marks, the neurotransmitters can behave more randomly and the model demonstrate the diffusion of the neurotransmitters more accurately.

References

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