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Neuro 430
Kids Judge Neuroscience Fair 2006 Exhibit
(with: Elizabeth Lauerman)
Writing in the Major Assignment
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"Don't Smoke Your Muscles"

Abstract:

Our model demonstrated how the drug nicotine effects skeletal muscle stimulation, and the way it attaches to an acetylcholine receptor site. Using plastic tubing and candy, our group was able to help the students to visualize this concept. To further clarify the topic, we proceeded to play a game with the children that allowed them to act as the nicotine and skeletal muscles themselves. Our group felt that the students grasped the general concept of nicotine's effect on skeletal muscle stimulation.

Introduction:

"The nicotinic acetylcholine receptors (nAChRs) belong to a superfamily of Cys-loop receptors that are characterized by a pair of disulfide-bonded cysteines separated by 13 residues in the extracellular domain" (Saladino, Alexander C., Xu, Yan, and Tang, Pei: 2005). The nicotine acetylcholine receptor is a ligand gated ion channel that stimulates nerve impulses in the presynaptic terminal, which then causes a release of acetylcholine into the synapse (Leite, John F., Rodrigues-Pinguet, Nivalda, and Lester, Henry A.: 2003). Nicotinic acetylcholine receptors are gathered at high densities in the postsynaptic membrane. This high density of nicotinic receptors is crucial for successful neuromuscular communication (Ramarao, Manjunath K. and Cohen, Jonathan B.:1998). The structure of these receptors consists of five subunits in a pentametric circle. Neurotransmitters in the extracellular domain are responsible for controlling the channel gating (Saladino, Alexander C., Xu, Yan, and Tang, Pei: 2005). Several types of nicotinic acetylcholine receptors have been discovered, however, the one we wish to discuss involves nicotine's effect on skeletal muscle stimulation.

Nicotine affects the human body's skeletal muscle in many ways. Being an agonist for a subdivision of acetylcholine receptors, nicotine is considered a non-competitive central nervous system agonist; meaning that nicotine mimics acetylcholine by binding to the acetylcholine receptors, and thus increasing the neurotransmitter's effect (Essman, Walter B: 1980). This increase causes an excitatory effect at the first synapse, which in return, causes the opening of Na channels. Short impulses in the

sympathetic and parasympathetic ganglia cells take place once the cell depolarizes, thus causing muscle action potentials. This process all takes place during 20- 30 msecs (Webster, R. A. and Jordan, C. C. 1989). While excitation is caused in the skeletal muscle, relaxation is felt due to the nicotine's stimulation of the cerebral cortex. Nicotine briefly stimulates, and then depresses, certain parts of the brain, mainly the ganglia, which causes a sense of relaxation (Burger, Alfred 1986). In terms of acetylcholine receptors, nicotine has a vast array of effects on the ganglia, as well as, skeletal muscle.

For our project, we wanted the children to walk away with a basic understanding of the workings of nicotinic receptors, and how they affect skeletal muscle. From the model, the children were able to demonstrate this concept for themselves by entering gumballs into the diagram, and seeing first hand that when they did this "nicotine" speeds up the skeletal muscle. However, while playing the game, they were able to further rationalize this concept by using a hands on technique showing that the skeletal muscle stimulation increased in the presence of nicotinic receptors. The game also demonstrated how nicotine works as an acetylcholine agonist through the passing of a "Nicotine" ball along with the "Acetylcholine". Overall, nicotinic receptors have a complex system of increasing stimulation on the skeletal muscle however, through our model; we hope the children walk away with the basic knowledge of how the functions of this system work.

Methods and Materials:

Our model consisted of Plexi glass, two plastic globes, plastic tubing, rocks, 2 funnels, candy, and foam board. Using the foam board, we constructed a three sided box. Next, we carefully inserted 2 pieces of plastic tubing through the top and bottom of the box. The plastic tubing labeled "Nicotine" was larger in diameter than the plastic tubing labeled "Acetylcholine", to allow more candy through to further visualize the concept of nicotine increasing skeletal muscle stimulation. Next, we attached a funnel to each piece of tubing, to help dispense the candy, and attached a clear globe to the bottom of each piece of tubing. We proceeded to paint and label the tubes to enhance our project's appearance, and to help the children recall what each tube represented. Two small slits were made in the side of each of the tubes, and plexi glass was inserted in a lever type fashion, to help demonstrate to the children that sodium was also released as part of the reaction. We felt it necessary to insert the levers into our model so that the children were able to see that sodium was being released instead of a mixture of candy that could possibly add some confusion. Next, to complete our model, a piece of plexi glass was glued on to the front, concealing our model in the box. In terms of the candy, small sour tarts were used to represent the sodium because we felt that they went through the tubing quickly without getting stuck. Gumballs and nerds were then used to represent Acetylcholine and Nicotine. To help demonstrate that Nicotine caused skeletal muscle

stimulation, we only inserted a few gumballs into the Acetylcholine tube while the Nicotine tube consisted of a large quantity of nerds.

For the game, we split up the children into two different groups. Group one were the neurotransmitters, and they were responsible for passing Acetylcholine to the "skeletal muscle" through a relay of high fives. As for group two, they were the skeletal muscle, and they responded to the Acetylcholine with high-fiving at a normal speed. When Nicotine was added to the relay, the "skeletal muscle" students proceeded to high five at a quicker pace in order to demonstrate that they were stimulated. This game helped demonstrate to the children that Nicotine along with Acetylcholine created an excited response in skeletal muscle tissue.

Results and Figures:

Figure one: Student Grading for Model Rank 1-5 (5 = highest)

Questions	Scores of 1	Scores of 2	Scores of 3	Scores of 4	Scores of 5	Average & standard deviation
Number 1	0	1	1	11	12	4.36 ± .75
Number 2	0	0	0	1	24	4.96 ± .2
Number 3	1	0	1	9	14	4.40 ± .91
Number 4	1	2	5	10	7	3.80 ± 1.08

Questions

Number 1: Could you understand what the presenters were trying to tell you?
Number 2: Were the presenters friendly?
Number 3: Was the exhibit fun?
Number 4: Would you like to learn more about this topic?

The students seemed to enjoy our model and the interactions it provided. They were eager to ask questions, and loved playing the game. The students gained a general knowledge about the workings of agonists, such as Nicotine, on an ion channel, and its effects on skeletal muscle stimulation. Upon completion of our model/game, the students completed a brief questionnaire that asked them to grade us on our presentation. The questionnaire was ranked from 1-5, with five being the highest. We scored high on several questions with our averages being 4.36, 4.96, 4.4, and 3.8. We scored the highest on the question "Were Your Presenters Friendly". When asked to leave comments about our model, the student's comments were overall positive. The favorite part of the exhibit was a toss up between the game, the quiz, and the candy, and the students walked away with a general understanding about the basic effects of Nicotine on skeletal muscles. The kids weren't on our side in the end, however, and unfortunately we placed 4th in our R rotation. I believe that we received this ranking from the children because our model was too in-depth at times.

Discussion:

The response to our project was positive in the end. The students seemed to grasp the overall concept, and they walked away with a general knowledge of the effects Nicotine has on skeletal muscle stimulation. My group intended to have them gain more insight into the workings of the agonist Nicotine in the ion channel; however, I don't believe we were completely successful due to the complexity of this topic, and the student's age. I believe we ranked fourth in the end due to this intricate component of our project. In terms of our model, we had to compromise crucial information about the system, and the binding of Nicotine to ion channels, in order to provide the children with a basic understanding of the effects of Nicotine on skeletal muscle stimulation. We were unable to include connections made in gap junctions, as well as, some of the important details involving the binding of agonists to the receptor sites. This made it difficult to explain the concept to the children at times, however, in the end; I feel that by simplifying the concept we helped the children to leave with a broad knowledge about the effects of Nicotine.

When analyzing our reviews, our scores were high. We received a 4-5 in every category except for "Would you like to learn more about this topic. In this area we received a 3.8, and I credit this to the complexity of our project. If I had to do this project again there are a few things I would change. First, I would reduce the difficulty of this model even further. I feel at times the general concept for our project was compromised due to its complexity, and this made it difficult for the students to grasp the concept. Secondly, I would not use candy to represent Sodium, Acetylcholine, and Nicotine. It seemed like a great idea at first; however, once your model had been run several times, the candy became sticky, and tended to stick in the tubes. Overall, I feel that the children's response to our model was positive considering the complexity of our topic.

References

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