Don't Let Cocaine Tie You Down!

Kids Judge Paper
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Abstract

The goal of this project was to demonstrate cocaine-induced interruption of dopamine transmission to fifth grade students. Our presentation incorporated a basic discussion of normal and cocaine-influenced dopamine transmission, as well as a game in which the children acted out the pathway as neurons transferring dopamine back and forth in the presence and absence of cocaine. The children evaluated the model on its clarity, how fun it was, how friendly we were, and how much they wanted to learn about the topic in the future. These evaluations suggest our model was successful and well-liked. We placed third in our category.

Introduction

Cocaine addiction is a foremost health problem on a global scale. Its consequences include a variety of direct health problems, such as heart attack, seizure, and respiratory failure, and other indirect problems such as crime, decreased productivity, and social depression (7).

Cocaine induces its effect in large part by increasing extracellular dopamine levels in the limbic system, a primary "reward pathway" in the brain (3). In this, when dopamine neurons are excited, dopamine is released into the synapse, where it binds to dopamine receptors on post-synaptic cells. Dopamine stays in the synapse until it is taken up by cellular transporters (4). Cocaine binds to these transporters and thus inhibits dopamine reuptake, effectively increasing the amount of time dopamine remains in the synapse (6).

The reward pathway of the limbic system consists of the mesoaccumbens dopamine pathway, which connects the ventral tegmental area of the midbrain to the nucleus accumbens of the ventral striatum (8). Normally, this pathway is activated by activities like eating and sexual activity, and it enables organisms to learn via positive reinforcement (7). Cocaine mimics these effects. In this, it has been hypothesized that drugs like cocaine are addictive because long-term use produces cellular adaptation both within this mesoaccumbens reward pathway and in its connected areas (8).

Adaptations that occur within the mesoaccumbens dopamine pathway result in emotional and motivational aspects of dependence, whereas adaptations that occur in the other areas of the limbic system tend to cause relapse into drug abuse after extinction. This is due to the fact that they are responsible for the cue-related aspects of cocaine dependence (8).

The process of cellular adaptation to cocaine often happens through dopamine depletion (2). Dopamine depletion happens because the constant presence of dopamine in the reward pathway (due to long-term cocaine use) initiates a g-protein coupled pathway that eventually leads to a change in gene transcription in neurons. Specifically, this process leads to the up-regulation of the gene for dynorphin. Dynorphin travels back to pre-synaptic terminals via axon collaterals and causes a decrease in dopamine release from that cell (5).

After such cellular adaptations to high levels of cocaine occur, the brain will always be primed to reinstate drug use as drug-related cues or stress will affect the brain differently than they did before addiction (1).

The goal of this project was to demonstrate the basic, cocaine-induced interruption of dopamine transmission to fifth graders. This concept was illustrated using a simple pre and post-synaptic cell model in which the children acted out dopamine transmission in the presence and absence of cocaine. We also hoped to impart on the children the fact that cocaine can permanently alter the brain, thus affecting how well they are able to do things they enjoy.

Methods

Materials: Three small Koosh™ balls, three small plastic containers, three belts, four sheets of 8.5”x11” white paper, nineteen pieces of 4”x2” white paper, one roll of clear packing tape, markers, crayons, twine, and a stop-watch.

Construction: We created three dopamine receptors by printing “Receptor” on three of the small pieces of paper and taping these labels to the containers. We created signs for the children to wear during the game by printing “Nerve Cell #1” on three pieces of small paper, and “Nerve Cell #2” on three pieces of small paper, and then putting these on twine necklaces. We then made signs to indicate the placement of each “nerve cell” (kid) during the game by printing “Nerve Cell #1” on three pieces of the large white paper and “Nerve Cell #2” on three pieces of the large white paper. These signs were laminated so they would last several rounds, and were taped to the floor in Nerve cell 1 and 2 pairs approximately ten feet apart. The remaining pieces of small paper were used to make “Cocaine Consequence Coupons.” Each was labeled with one of the following statements: “You used cocaine, you get a heart attack;” “You used cocaine, you get a seizure;” “You used cocaine, you get to vomit;” and “You used cocaine, you get diarrhea.” Finally, we used the markers, crayons, and remaining pieces of large paper to make a poster explaining the steps of dopamine transmission.

Presentation: We began our presentation with a basic explanation of dopamine transmission in terms of a simple pre and post-synaptic system. To clarify the steps, we acted them out using the same procedure the children would subsequently use in the game. We explained the importance of this pathway by asking the children to describe their favorite hobbies, and then explaining that this system enables them to participate in such activities.

After we explained normal dopamine transmission, we put the students into groups of three so that they could act it out. In this, one child was the pre-synaptic cell (Nerve Cell #1), one was the post-synaptic cell (Nerve Cell #2), and one was a counter. The children wore the signs so that this vocabulary was reinforced throughout the activity. They also stood on their appropriate signs on the floor.

Nerve cell #1 got to throw his/her dopamine (Koosh™ ball) to nerve cell #2, who caught it in his/her receptor (plastic container). Nerve cell #2 then dumped out the dopamine, and nerve cell #1 ran forward to retrieve it with his/her transporter (the hand they did not use to throw the dopamine). The children did this as many times as they could in one minute while the counter kept track of successful transmissions. This activity was repeated three times, so each child had a chance to play each role.

Next, we explained that when people used cocaine, their dopamine transporter is "tied down", so the neurons cannot communicate with each other as well. To illustrate this idea, we put the children back into their groups and let them play the game again. This time, however, the transporter hand of nerve cell #1 was tied to his/her side by cocaine (a belt). We asked questions to help them solidify the conclusions we hoped our presentation would teach. These included: "When did you get more transmissions, when you had cocaine, or when you didn't?" and "If you wanted to do your best at your favorite hobby, would you want to use cocaine, or not?" We then let different teams race each other. For this activity, the groups got to choose whether or not they wanted to do it with cocaine.

Finally, we gave each student a coupon and asked them to read it out loud to the others so that the physiological consequences would be grasped by the students.

Results

Thirty-nine fifth graders evaluated our presentation. Our mean score for question number one, "Could you understand what the presenters were trying to tell you?" was 4.74. Our mean score for question number two, "Were the presenters friendly?" was 4.82. Our mean score for question number three, "Was the exhibit fun?" was 4.58. Our mean score for question number four "Would you like to learn more about this topic?" was 4.17. Our overall mean score was 4.58. We placed third out of three exhibits in our category. For a summary of these scores, see Table 1.

Table 1. Summary of Kids Judge Scores

	1	2	3	4	5	Mean
Question 1	0	0	2	6	31	4.74
Question 2	0	0	0	7	32	4.82
Question 3	0	1	2	9	27	4.58
Question 4	0	2	6	14	17	4.17
Overall						4.58

Comments concerning the children's favorite part of the exhibit included: "The game," "catching dopamine," "throwing dopamine," "all of it," "being nerve cell #1," and "being nerve cell #2." Then children's comments about what they learned from our presentation included: "That when you use cocaine, it is like your neurons have their hands tied to their bodies – it's hard to pick the dopamine up," "cocaine is evil," "cocaine makes it harder to get the dopamine," and "a lot about transporters." Additional comments from the children included: "I loved it," "the presenters are great," and "it was fun."

Discussion

The mean scores for each category except question four were high, indicating that our presentation was clear and easy for the students to comprehend. They also seemed to think we were very friendly, and that the game was fun. The score for question four was slightly lower, indicating that the material may not have been presented in a manner that motivated the students to learn more about the topic, or, that it did not seem fun enough for them to want to learn more.

Our overall score of 4.58, coupled with the comments from the children indicate that, for the most part, our goal to explain how cocaine changes both brain function and overall health, was met. While the children were participating in our presentation, they seemed quite attentive and pleased, asked questions, and wanted to try the relay multiple times to fully explore the topic. For instance, each student wanted to try retrieving the dopamine with "cocaine" in many different ways – lying on the floor, standing on their knees, etc. to prove that, no matter what, it was harder to retrieve the dopamine with cocaine inhibiting their "transporters." One student even noticed that the others were doing this and asked "Do your nerve cells learn to do different things to get the dopamine better when you use cocaine?" which allowed us to delve a bit into addiction with that group.

Our game was definitely the most popular part of the exhibit, and it worked out well because the children actually got to BE the nerve cells, so the consequences of cocaine, even on a cellular level, were made very tangible to them. It was very well designed for fifth graders, and each child was able to play each role to fully grasp all the consequences of cocaine within the dopaminergic pathways of the brain.

Our presentation could have been a bit clearer and more concise at the onset. As it ran a bit long in our morning groups, the first few groups did not have as much time to play the game. We adapted our presentation throughout the day as we discovered how the children seemed to learn best (more by doing the activity than by listening to us). This miscalculation in planning probably affected how fun the first few groups of children found our presentation.

While we tried to make the model as realistic as possible, some attributes of cocaine interference and its consequences had to be ignored as we attempted to balance simplicity with accuracy. We only portrayed a simple pre and post-synaptic system, rather than explaining the fact that the pathway actually consists of more complex, multi-synaptic connections. We also did not explain any other modes of dopamine removal from the synapse. Finally, we did not incorporate the mechanism of addiction because its complexity was generally beyond the scope and time scale of this presentation.

In comparing our overall scores with the results of the judging, I was surprised that, even though our scores were high, we placed third. This discrepancy between the vote and the scores could be due to several factors. The children may have been trying to be nice, even when they did not actually think our presentation was as fun as others. Or, the voting may have been most influenced by the presentations the children attended right before they voted. Finally, our model, while clear and easy to understand, was not very flashy or exciting to look at, so it may not have been as memorable as others.

In future presentations, we would plan our presentation so it was more clear, concise, and fun from the onset. We would also try to incorporate more brightly colored signs and / or candy to make the presentation more memorable. We are very satisfied by our overall scores, and feel they accurately reflect the success of our model.

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