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Neuro 430

Kids Judge Neuroscience Fair 2006 Exhibit

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Writing in the Major Assignment

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Growth Cone Game

Abstract

The goal of this project was to demonstrate the specialized role of the actin cytoskeleton in the growth cone during axonal propagation to fifth grade students. Our presentation incorporated a basic discussion of why the growth cone is necessary, the role of actin as a component of the growth cone, and how environmental signals play a vital role in axonal guidance. We accomplished our goal using a model growth cone and an interactive game. The student participants 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.

Introduction

The purpose of the game of growth cone was to demonstrate the specialized role of the actin cytoskeleton in the growth cone during an axon's progressive modulation and course through developing tissues at a fifth grade level of understanding. Secondly, we planned to illustrate how signals transduced from the environment play a vital role in axonal guidance. Our goal was to transmit the idea of how different chemical cues and signals are involved in the growth pattern of axons and lead to eventual axonal survival at a level that a fifth grade student might comprehend.

The growth cone is the elongated end of a growing axon responsible for ultimate pathway guidance. Growth cones advancing to their synaptic targets will encounter a variety of guidance cues (1). Various types of signals either attract or repel axonal growth cones as they travel toward different targets. There are two major components of the cytoskeleton in the growth cone: microtubules and actin filaments (2). For our project, we focused primarily on actin filaments as they play a principle role in cellular morphogenesis, locomotion, and migration. The sensory ability of a growth cone depends primarily on the highly-mobile filopodia (4).

Filopodia are long cytoskeletal extensions comprised primarily of actin, which are responsible for sampling the environment and navigating obstacles via chemotaxis. When filopodia encounter various attractive or repulsive chemotaxins in the

environment, the growth cone is signaled to proceed, recoil, or rotate (3). Actin plays a crucial role in the motility of filopodia – actin uses myosin molecules to move cytoskeletal components in a retrograde manner, incorporating a range of possible directional changes (2). The ability of actin to be recycled in a forward manner is crucial in the ability of the axon to self-navigate an environment to a specific chemotaxic target (4).

We used our model set-up of place mats as actin components, where the participants stopped at various locations throughout an environment strewn with chemotaxins. Paper chemotaxins with either positive (attractive) or negative (repulsive) signals guided the participants to either the right or left of the box respectively. The purpose of the experiment was to give the students an idea of how chemical signaling plays a role in axonal guidance.

Methods

Materials: ten place mats, wrapping paper, masking tape, hot glue gun, markers, fourteen boxes, ribbon, a plastic cup, candy.

Construction: We created chemotaxin boxes, cardboard boxes wrapped in patterned paper which was put together using masking tape and hot glue. We constructed chemotaxins from yellow construction paper with either a large positive or negative symbol on the star. Holes were cut in the top of the boxes and a variety of chemotaxins were placed in the boxes. Masking tape was used to outline the border of our environment. We labeled place mats with masking tape to be used as recyclable actin components. We constructed a two model neurons – one of the neurons had a braided ribbon “axon” with a plastic cup or growth cone. We engineered a model “path” using cups which the growth cone had to navigate around. We put together a few small visual posters with pictures of growth cones to give the students an idea of what a real growth cone might look like.

Presentation:

We began our presentation with a basic explanation of growth cones, neurons, and actin components. To clarify the idea of a growth cone, we acted out axonal development using our model neurons and sample growth cone. We explained the importance and purpose of a growth cone by comparing a growth cone to a guide in the woods. We then had the children repeat new words such as actin, growth cone, and chemotaxin back to us in order to involve them in our presentation.

After we explained the basic idea behind axonal growth, we explained the rules of our relay race where the kids would be split into two groups, with each group given six place mats or “actin” components.

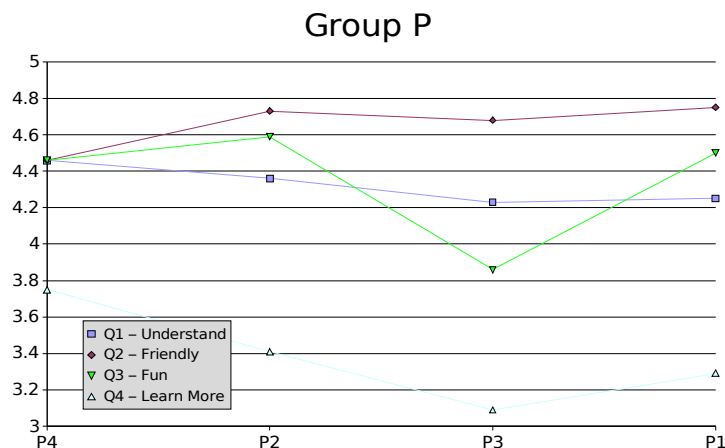
The masking tape outlined the environment that the groups would be working within. We acted out how to use the actin squares to move around the environment and how to reach into the boxes containing chemotaxins in order to be directed throughout the environment. The kids then had to move throughout the environment, stopping at each box to be directed to either the right (positive star) or left (negative star) of the box.

Each group was to go from one side of the environment to the other and back again. When the students were crossing pathways with each other as they were directed throughout the field, we explained how sometimes axons also cross and bump into each other as axonal development occurs. At the end of the race, we asked the students questions such as, “what are the names of the environmental signals which guide a growth cone?” This enabled the students to express what they had learned from the presentation and the game. We then explained that there were special cues in the environment called survival factors which helped an axon to survive once it has reached its final target. To represent survival factors, we gave the students their choice of candy to reward them for their attention and participation.

Results

Twenty-seven fifth graders evaluated our presentation. We were in section P and were group P2 in our presentation. Our mean score for question number one, “Could you understand what the presenters were trying to tell you?” was 4.35. Our mean score for question number two, “Were the presenters friendly?” was 4.75. Our mean score for question number three, “Was the exhibit fun?” was 4.59. Our mean score for question number four “Would you like to learn more about this topic?” was 3.40. Our overall mean score was 4.27. We placed second out of four total exhibits in our category.

Figure 1.



Comments concerning the students' favorite part of the presentation included: "actin helps the growth cone move," "the actin squares were fun to move," "actin helps axons move and they [axons] can cross each other." Additional comments from the children included: "the presenters were very nice," "The game was fun," and "speak up."

Discussion

Our mean scores for each category, with the exception of question four, were high; indicating our presentation was clear and easy for the students to comprehend. Our overall score of 4.27, coupled with the comments from the children indicate that, for the most part, our goal to demonstrate the specialized role of the actin cytoskeleton in the growth cone during axonal propagation was met. While the children were participating in our presentation, they were attentive, asked questions, and wanted to try the relay multiple times to fully explore the topic. For instance, each student wanted to try retrieving the chemotaxin in the box and take turns leading the front of the growth cone. One student even noticed that the axons were crossing and asked, "do axons in your brain sometimes cross like we are crossing," which allowed us to delve a bit into the complicated meshwork of neurons that make up your brain and spinal cord.

Our game was definitely the most popular part of the exhibit, and it worked out well because the children actually got to BE the growth cone, so the direct impact of chemotaxins on axonal guidance were evident to them. It was very well designed for fifth graders, and each child was able to play each role to fully grasp how growth cones read environmental signals, and actin moves in response to the signal in order for an axon to reach its target cell.

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.

We tried to make the model as realistic as possible; however, some attributes of axonal guidance had to be ignored as we attempted to balance simplicity with accuracy. There are numerous types of signaling and molecules which play a role in growth cone guidance. Actin, although vital in the modulation and rearrangement of the growth cone, is only one component in an array of molecules which play vital roles in axonal propagation. Finally, we did touch on a variety of cytoskeletal components which contribute to the morphogenesis and motility of growth cones.

In comparing our overall scores with the results of the judging, I was content with our group placement of second. I believe that our model and presentation maintained a

respectable balance of educational and scientifically valid material combined with a simple but innovative model of axonal guidance. I think our second place finish may have been due to a variety of factors, including the complexity of the material and the lack of relevance to the daily life of a fifth grade student. 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 when it came to voting for a favorite presentation.

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 a movie to make the presentation more memorable. We are very satisfied by our overall scores, and feel they accurately reflect the success of our model.

Works Cited

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