Place Power

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Abstract

A child sized radial arm maze (RAM) was constructed for the purpose of teaching the concepts of memory to elementary school students. One of the most important aspects of science is the propagation of scientific knowledge to the younger generations. Using coat racks and some tape, we constructed a RAM that was large enough for a human to go through. The children were active participants in a test of memory based on neural place cells. The children learned the aspects of our memories and how drugs can negatively affect our memory by being active participants of our model. We also used an animal sized RAM to back up the information that they had learned in the human model. Overall, the children walked away from our model with a greater understanding of how their memory works to remember the places that they have been. Our model received first place in our division based on the amount of fun that it was for the children, and the high level of interactivity that the model contained.

Introduction

The radial arm maze is a model used to evaluate spatial memory in various animals. The ability of neural place cells and memory is tested by the RAM, it determines if an animal is capable of remembering where it has been. This ability is crucial in the survival of certain animals. For example, a bee needs to remember which plants it has harvested in order to be more efficient, a rat needs to remember where his home is, and humans need to remember where they put their keys. If spatial memory cells do not function, then an animal would have no recollection of looking in one place over the others. In humans, this would manifest itself as searching under the couch ten times and not remembering that you checked there. We will use the RAM based on the motivation of food, eight arms will be arranged with food at the end of each arm. A human and most animals can use their memory to remember where they had been, and where they need to go. The animal that has the best memory will get the food fastest and thus in the real world will get more food increasing his survival rate.

The RAM has been used to assess the effects that surgical, behavioral, pharmacological, age, gender, and radiation has on long and short term memory (1). Multiple experiments have been run using the RAM as a test for how alcohol affects memory (2). Tests have also been run using the RAM to asses the long term impairment of memory following Nitrous Oxide induced analgesia (3). Any time a researcher wishes to test the effect of a drug on memory, the RAM is most likely used. For humans, the maze should be easy, thus a modification was made in which each arm was concealed by a piece of painters plastic. This eliminated the visual cues of the room when the subject is located in the central platform. For the Kids Judge Science Fair we used the RAM as a model to convey the concepts of neural place cells

and memory to children.

We hope that the children walked away from our display with an understanding of how certain parts of our brain (prefrontal cortex, and hippocampus) work to encode our memory (2). We also wish to convey the concepts that certain drugs (alcohol, PCP, THC, and mushrooms) can have very serious negative effects on our memory. We showed the various effects of the drugs spinning the child around in the central platform after each return from an arm. Most of all, we just wanted the children to have a good time while still learning something about their brains. Our hope is that one day, this brush with science will spark their interest in a career in a scientific field.

Methods and Materials

The RAM consists of a central platform that extends out in equal directions with 8 arms. Our RAM arms' were arranged in the ±x and ±y axis with 2(–x=y) and 2(x=y), labeled 1-8 with +y being 1. At the end of each arm a hidden reward (skittle) was placed. An entry down a non traveled arm will be a correct response; a repeated entry down that arm was an error. Good performance in the RAM was determined based on the number of errors.

To create a RAM you need thick making tape, sharpies, 8 lab coats, a rat sized radial arm maze, one mouse, candy skittles, 8 cups, poster with catchy phrases and pictures of the brain, lab timers, 50 ft of painters plastic, and 4 coat hangers. The 4 coat racks are placed in a standard X pattern. Each coat hanger should be approximately 5 ft long and all 4 hangers radiated outwards from the center. The coat hangers are wrapped in painters plastic 8ft x 8ft x 50ft creating a central area that had 4 doors. Off of each door, two pathways with masking tape placed on the ground in a rectangular shape, making a total of 8 radiations from the central area. At the end of each radiation a cup should be placed and the radiation numbered. Two concentric circles around the whole maze defined an area for researchers only. The researchers are permitted to stand in this area across from the 4 doors.

The children are split into a group of 4-5 researchers and a group of 2-3 subjects (the lab rats). One child is placed in the maze and given the simple instruction of getting the candy at the end of each arm. Two rules the child had to follow are that he must not step outside the lines of tape, and must enter the center of the maze after each arm. The other subject was to run in the maze at a latter time. The group of researchers got lab coats and timers with a sheet designed for taking data. When the subjects run the maze the researchers can gather data. The researchers also yelled out the number of the radiation that the subject enters so that researchers on the other side could complete their data. Drugs are administered by spinning the children around whenever they entered the center of the maze.

Results

The Kids Judge Neuroscience Fair went really well. The children seemed to accept our model and were not afraid to jump in and try. I think the biggest selling points of our model was the skittles, the lab coats, and the mouse. The children were especially pumped to put on a lab coat because they felt like they were real researchers.

When the child that was treated with drugs (spun around) they made approximately three errors. The average number of errors for a child who was not spun around was one. This three fold performance decrease was crucial in conveying the properties of drugs and memory to the children. One of the main comments we received on our evaluation sheets was that "drugs hurt your memory", and "when you take drugs you can't remember stuff." The children really seemed to love the whole model.

The animal model with the mouse was the cream on the cake. When they saw the mouse enter each arm they immediately drew a parallel with our model and the information really sunk in. We often found it hard to get the groups to leave when it came time for rotations. When there was an open period we were so crowded with children that we had to have some sit out and wait for their turn.

Overall we received first place for our category and division. The ratings that we received are listed in Table 1.1.

Table 1.1 – Averages of the rankings for A1 Place Power

Q1 Understand	Q2 Friendly	Q3 Fun	Q4 Learn More	Average
4.86	4.95	4.84	4.5	4.7875

We scored rather high on all categories except for the amount of learning which took place. Our average score was the highest of all the groups in the fair and our individual scores were not beat by any group student or faculty. For our division the scores on the questions were comparable to the voting. The groups that received the highest voting had the highest average rating across all the questions. The voting seemed to be related the most to the amount of fun that the children had see figure 1.1.

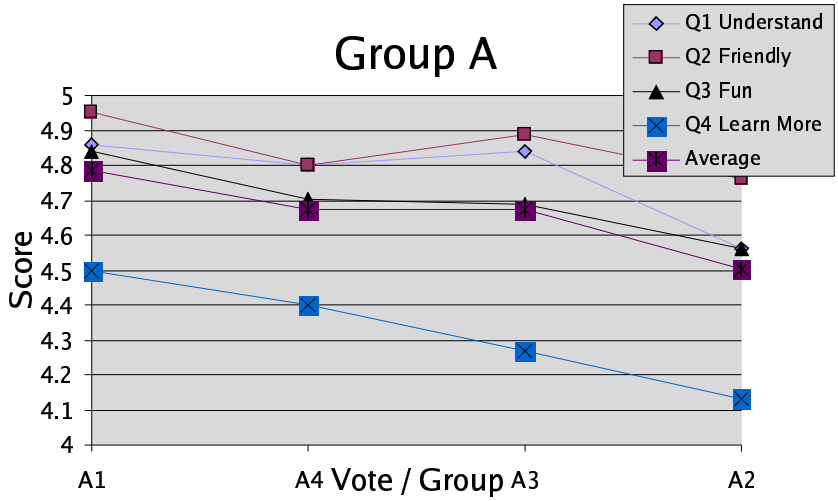

Figure 1.1 – The average scores of division A vs. the place vote the group received.

Discussion

We believe that the kids learned that they have place memory which tells them where they have been and where they need to go. They also learned that if you take drugs then your memory is negatively effected causing it harder to function. By disorienting the child, by spinning him around, we were able to convey that drugs alter your mental abilities and thus your memory capacity decreases.

The human brain is more complex than a rat so our model was changed to make it harder to complete the maze. The main difference in our model was the elimination of all visual environmental visual. We eliminated the visual cues by blocking the view to the radiations when the subject is in the center of the RAM. The children also had to be kept in the dark about the maze because if a human learns how the maze works they have an unfair advantage when running the maze. When we had the open session children who were researchers came back and wanted to be the subject. When they ran the maze their performance increased due to prior knowledge. The amount of fun that the children had at our model was dependent on the high level of interactivity, along with a constant changing environment to suit different styles of learning. First we started out with a visual learning, so the children could see the effects of drugs on performance. We backed up that information with numerical data based on the number of errors. And we tied it all together with the verbal explanation of the maze while showing the animal model to provide a general outlook. On average the normal child had an error rate of 1, while the child who was spun around had an error rate of 3. This hard data really convinced the children that the drugs effects cause a decrease in performance. Since the children were constantly jumping from one event to the other there was no free time where they could get bored and lose interest.