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Neuro 430
Kids Judge Neuroscience Fair 2006 Exhibit
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Writing in the Major Assignment

The Totally Tasting Tongue

Abstract

For the Kids Judge project, my partner and I took a complicated neuroscience topic and made it understandable and presentable to fifth grade students. How successful we were was determined by the students' evaluation of our project. We taught the students about taste and argued that taste receptor cells are broadly tuned to all tastes, are not segregated on the tongue, and the transduction mechanism of how taste is coded to the brain. This was accomplished through a simple taste test, a model tongue, and several diagrams. The results indicated that the students understood the topic and wanted to learn more about it in the future. The project was therefore a success.

Introduction

The purpose of this project was to convey to the Kids Judge students that taste receptors are broadly tuned to all tastes, are not segregated to specific areas of the tongue, and follow a complex transduction pathway to the brain. To do this, the information was presented verbally and visually through a diagram of the signaling pathway to the brain and a model tongue. The following is an explanation of how these concepts were presented to the students.

The five basic tastes (sweet, salty, bitter, sour, and umami) each have a separate mechanism for being detected on the tongue. Sweet, umami, and bitter tastes (sucrose, glutamate, and some complex molecules like quinine and PTC) use a second-messenger system of activation where the tastant binds a G-protein coupled receptor and cAMP levels rise before depolarizing the cell. Sour and salty tastes, in the ionic form of hydrogen and sodium, affect the cell differently. Hydrogen blocks potassium channels to hyperpolarize the cell and sodium depolarizes the cell. Once the depolarization reaches a threshold, a calcium influx causes a transmitter release, which causes an increased firing of the action potential. (1, 2)

During the Kids Judge fair the students learned about the five separate tastes through our tongue model. The tongue contained vials of taste solutions. The students were given samples of each taste to help them distinguish between the tastes. In addition, the students did not learn each taste's specific mechanism for causing an action potential in the cell. This information, though relevant to the classification of taste, may have been too complex for the students to learn. Instead, other topics were discussed in the ten minute presentation.

The two types of taste receptor cells can be separated into two genetic categories, T1Rs and T2Rs, and are "broadly tuned to multiple modalities of taste." These categories determine what type of protein subunit is coupled with the intracellular receptor. Though one category is more specific for a type of taste, such as T2Rs coding for mainly bitter tastes, it is not limited to that taste. For example, T2Rs can still create an action potential when exposed to sweet, sour, or salty tastes. Receptor cells can detect all types of taste, are found all over the tongue, and are not segregated to specific areas as once thought. Using the patch clamp technique, a single taste receptor can be isolated from any part of the tongue and its response to different tastants can be measured. If two taste receptors from different areas of the tongue respond similarly to tastes, then they can be identified as the same taste receptor. Taste receptor cells respond to multiple tastes and are not segregated on the tongue. (1,2,3,4)

In the presentation, this information was presented verbally and by using the tongue model. The taste vials were randomly spread out over the tongue. The students learned that there is not a "taste map" on the tongue, and all tastes can be sensed in all areas of the tongue. Furthermore, the model included papilla all over the tongue. We explained to the students that papilla contain taste receptor cells, which code for taste. This would have been too difficult to demonstrate using the model. To do so, each vial would have had to contain multiple tastes, and it would then have been impossible for the students to distinguish between tastes. The students learned of the existence of taste receptors, but not the genetic categories. Again, it would have been too difficult to show two types of taste receptor cells using our simple easy-to-understand model.

Once a taste causes an action potential in a taste receptor cell, the signal must get to the brain. Three nerves innervate the tongue and receive inputs from various taste receptors. Each cranial nerve sends taste information from a specific area of the tongue; cranial nerve VII from the anterior two-thirds of the tongue, cranial nerve IX from the posterior one-third of the tongue, and cranial nerve X from the back of the mouth. This information is relayed to the nucleus of the solitary tract in the brain stem, then to the thalamus and the cerebral cortex, while also going the limbic system. Taste in the brain is an "integrated system" and the cranial nerves on the tongue do not send signals independently. The complex transduction pathways do not follow a "label line," where one taste receptor affects one neuron to signal the brain, as some research would argue. (1, 5)

This complex signaling pathway for taste was presented using a diagram. For example, on the poster board there were pictures of where the three nerves innervate the tongue, enter into the brain stem, and are relayed to different areas of the brain. Though these nerves and specific areas of the brain were labeled, it was not important that the students learn them. Rather, the students should have learned that the signaling pathway is complex and involves different areas of the brain.

The students in this project learned about the five basic tastes, broadly tuned and non-segregated taste receptors, and the complex signaling pathway of transduction. Some details were ignored or glossed over, such as how each taste is encoded, the genetic categories of taste receptors, the experimental evidence supporting how taste receptors are broadly tuned, and the specific names of the cranial nerves and areas of the brain that receive signals. Instead, the students were able to grasp broader concepts of taste by being able to see, touch, and even taste our model.

Methods

To simplify these concepts to the students, we incorporated a model tongue, diagrams, and a taste test into our demonstration. First, we built a model papier-mâché tongue and painted it to show where the designated areas of taste were thought to be. Around the tongue were oversized taste buds. We then filled the tongue with vials of sour, sweet, salty, bitter, and umami tastes. The tongue was appealing to the students because it was brightly colored, and easy to understand. Along with the model tongue was a small diagram identifying each color-coded area as a "taste section." We then asked the kids to formulate a hypothesis about where one might taste sour or sweet on an unlabeled tongue picture. Every time the students predicted that the taste would be segregated to a specific area, as indicated on the chart.

During the presentation a taste test was used to test the hypothesis of whether taste was really segregated into specific areas of the tongue. We tested whether or not these taste sections were accurate by having the students close their eyes while we chose a taste and dabbed the taste with a q-tip around the tongue. The student then had to identify what taste was on the q-tip and where he or she tasted it most. We jotted the results from all the students and compared them with the tongue chart. The students were able to come to the conclusion that the taste section chart was not accurate.

To explain to the students why sections of the tongue are not selective for taste, we used a "bull's eye diagram." This diagram shows how taste receptor cells may be more receptive to a specific taste, but can still code for all tastes. We explained that this was why any taste could be tasted anywhere on the tongue.

A poster was used to explain the types of tastes and the transduction pathway from the tongue to the brain. The pathway was simplified to show a tongue, 3 cranial nerves, and three sections of the brain that receive taste information (hindbrain, midbrain, forebrain). We explained that through the pathway, they are able to know when and what they're tasting. Diagrams helped us present information in a simple manner to the students.

Results

Our project placed first in three categories relative to the four other demonstrations in Group G; how easily it was understood by the students, how friendly the presenters were, and how much the students wanted to learn more about it in the future. Our project placed third in how fun the project was and in the overall score. This data is attached.

Discussion

Our model was successful in teaching the students about taste concepts. According to the class statistics we placed first for the student's ability to understand what we were teaching and them wanting to learn more about the subject. This was the goal of our project; to take complex subject matter and present it in a way that was understandable to someone at the fifth grade level. However, we placed third in how fun it was to the students relative to other projects. The two projects that rated higher in this category used a game to teach their concepts. We chose not to have a game but instead have an experiment where the students could test a hypothesis (whether taste was segregated on their tongue), and find out why that is. This way the students were interacting with the presentation and using the scientific process. Overall, the project was a success.

This model could be improved in a few ways. For example, along with the taste test, a short game could be incorporated that would require more interaction on the student's part. This may make the presentation more fun and appealing. In addition, the bull's eye diagram was somewhat confusing for the students and probably could have been left out. Furthermore, the tastes in the vials were not easily identifiable to the students. Alternative tastes could have been used, or could have been stronger. The umami taste, soy sauce in water, may have also tasted salty, while the sour taste of lemon juice was too dissolved in water to be detected. Another confounding variable was the students were receiving candy before the taste test, which would make it difficult to distinguish between sweet from the candy and another taste from a vile. By fixing these problems the demonstration would be more effective in appealing to and educating the students.

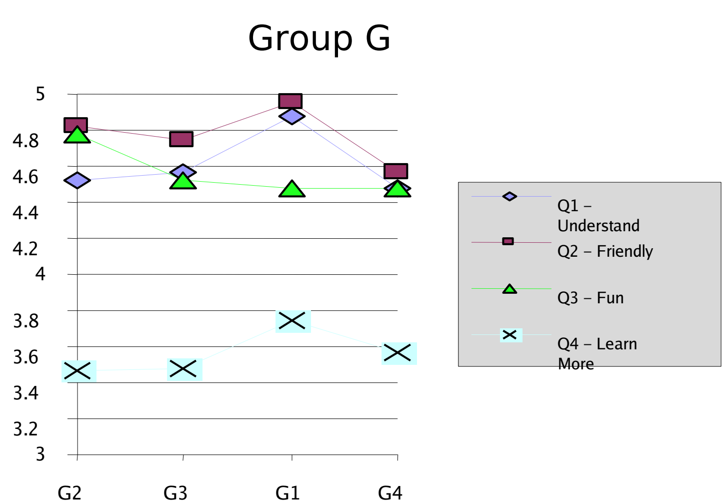
In this project, our goal was to argue that taste receptor cells are broadly tuned to all tastes and are not segregated on the tongue. The students were able to come to this conclusion using the scientific method, the taste test to test their hypothesis and come to a conclusion after seeing the results. Furthermore, the students were able to learn why this may be and how the taste signal gets from the tongue to the brain. The demonstration may not have been as fun relative to other projects, but its success lies in the fact that the students understood the concepts that were presented and wanted to learn more about the subject in the future.

Data

Table 1: Class statistics of Kid Judge ratings

Project Name	Code	Num Votes	Vote Plac e	Q1 – Understand	Q2 – Friendly	Q3 – Fun	Q4 – Learn More
My Oh Myelin	B3	10	1	4.45	4.9	4.6	3.68
Why Does My Mouth Feel Numb	B1	9	2	4.56	4.8	4.52	3.84
VAWBAM	B2	4	3	4.24	4.68	4.26	3.56
The Brain Under the Microscope	B4	2	4	3.6	4.16	3.44	3.24
Putt Putt Pathways	G2	11	1	4.52	4.82	4.78	3.47
Why You Can't Sleep With the Lights On	G3	6	2	4.57	4.74	4.52	3.48
The Totally Tasting Tongue	G1	5	3	4.88	4.96	4.48	3.74
Lobalization	G4	2	4	4.48	4.57	4.48	3.57
Egg-tastic Fluid	R2	13	1	4.67	4.92	4.67	4.13
What Do You See	R1	7	2	4.4	4.96	4.64	3.84
Sleep and Performance	R4	3	3	4.52	4.8	4.12	3.72
Don't Smoke Your Muscles	R3	2	4	4.36	4.96	4.4	3.8
The Secret Ingredient	P4	7	1	4.4583333	4.46	4.46	3.75
Growth Cone Game	P2	5	2	4.36	4.73	4.59	3.41
How Big Is Your Leg In Your Brain	P3	1	3	4.23	4.68	3.86	3.09
Synaptic Tag	P1	11 (disqual)	4	4.25	4.75	4.5	3.29

Graph 1: Comparing ratings from Group G. G1 is the Totally Tasting Tongue



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