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Neuro 430
Kids Judge Neuroscience Fair 2006 Exhibit
(with: Brandon Alcott and Justine Gullaba)
Writing in the Major Assignment

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(**V**isual, **A**uditory, **W**ernicke's Area, **B**roca's Area, **A**ngular Gyrus, **M**otor)

Abstract

After the postulation of pathways that accounted for language processing, many studies have been done on structures of language pathways. Until now, we still don't know how language is constituted. Our project set goals to teach children the most basic understanding of language processing. In this model, we used posters to demonstrate the pathway. We played two games with the children and explained how the games were related to the pathways. In the end, the kids judged our performance based on their understanding of the topic, funniness of the model, friendliness of the presenters, and their intention to learn about this topic in the future. As a result, our group ranked in third place. It appeared that the complexity of the subject lowered the interest level of the children. We discussed ways to enhance the kids' interest level.

Introduction:

Study of language was thought to be a difficult task for scientists since language is unique to humans. Nevertheless, through observations made on various kinds of aphasias resulting from lesions of different brain structures, scientists have made models of how language is processed and produced. The famous Wernicke-Geschwind model provides a plausible pathway of language processing. (Catani, 2005) It suggests that the Broca's area and Wernicke's area are responsible for comprehension and articulation of speech respectively. Between the two areas are one-way fibers that connect them, called the arcuate fasciculus. These assumptions were made from clinical studies. Ironically, they were also challenged by more clinical observations on aphasic patients. (Scott, 2000) Varieties of aphasic syndromes dependent on the locations of lesions opposed the rather straight forward model. Despite scientists' effort to expand on the relationship between brain areas and language processing founded on Wernicke's model, the models postulated by Lichtheim, and other neurolinguists did not stand against criticisms. (Scott, 2000) Fortunately, as the technology advanced, more detail to this network is coming under the light. By using PET and fMRI, brain areas can now be associated to the many components of language, including speech and comprehension.

In one study, the superior temporal gyrus was examined to investigate its relevance to processing intelligible speech and acoustic noise. Similar to the old model, the superior temporal gyrus along with the structures beneath it are associated with auditory information processing. This study added complexity to the over-simplified pathway. The anterior portion of this gyrus responded only to intelligible speech auditory input while the rest of it was activated to both intelligible and non-comprehensible input. (Scott, 2000) There is also a specialized hemisphere for language. 96% of the population show left hemisphere dominance for language. (Lambertz, 2005) Studies using fMRI confirmed this claim. Aside from validating old theories, progress of experimental techniques overthrew and modified some mistaken hypotheses. For instance, the arcuate fasciculus was thought to connect Broca's and Wernicke's areas. Lesions along this fiber resulted in conduction aphasia. While clinical cases suggests a greater complexity to this connection, some studies showed that there is indeed an unknown pathway that runs lateral and parallel to arcuate fasciculus. (Catani, 2005) In fact, studies like these have discovered many previously unknown pathways and areas that are involved in language processing.

Before the whole picture is resolved, we can never ensure anyone what we believe is true. As we uncover the underlying principles of why language works the way it does, many recognize that the intricacy of this system is far from our imagination. Therefore, in order to show ordinary people, especially children, how language is produced and comprehended, we simplified and reduced the recently constructed models to the old Wernicke-Geschwind model. After all, in a common sense, this model satisfactorily predicted symptoms of different aphasia when given the lesion's location.

Our model aimed to teach children about the different portions of the brain that were responsible to language. It was our goal to explain to them the general functions of each area. As vaguely as the title suggests, the six major areas in the Wernicke's model were introduced to them. The children would be asked to participate in two different tasks that required speaking, drawing, listening, and writing. This was to arouse their attention and interests in this issue. We would then explain to them what parts of their brain they used when they were accomplishing the tasks. This process would be aided with poster and various objects that were metaphorically associated with each area. Most certainly, using this model, we encouraged the children to get basic understanding of the few areas related to language.

Methods:

The model aimed to illustrate the pathways utilized in the production of speech and comprehension. In order to demonstrate the pathways, components of the pathways became crucial to understanding of the model. By addressing how information is passed from sensory organs to subsequent analytic centers step by step, we provided the kids with a general scheme on the routes that different modalities of sensory input take to reach the brain, get processed and produce outputs in form of writing or reading. Keeping it simple and easy to understand was the goal of the model.

We used a poster as a visual aid to illustrate the different areas of the brain and two pathways for reading and writing. On the poster, we drew three brain pictures, one colored, two uncolored. On the colored brain picture, we used different colors to differentiate the different areas involved. We used green for Broca's area, brown for motor cortex, purple for auditory cortex, pink for Wernicke's area, yellow for angular gyrus, and red for visual cortex. We also listed the general functions for each area. To help the kids remember the different areas, we posted pictures that were analogous to the areas. For example, we used a picture of a man exercising to represent the motor function of the motor cortex. Likewise, we used a dictionary picture to imply the translation function of the Wernicke's area. Visual cortex was represented by a camera picture. Similarly, auditory cortex was paired with a picture of microphone. All of these served to generalize the main jobs of each area. Beside pictures, we also used objects to represent each area. We believed this was more impressive to the kids if they could actually hold the objects while we were explaining the pathways and areas.

The model had two portions. The first part was the plain description of what each area does. This process was aided by the use of the poster, pictures and objects. The second part involved playing games with the kids. We designed two games. One illustrated the pathway for information that entered through our ears. Another one focused on visual input. During the first game, we asked the kids to listen to a poem by Silverstein. This poem was a short descriptive essay about a messy room. We played it three times. After that, we asked the kids to draw on a paper with color pencils of what they had heard from the poem. This game took about six minutes. We compared the drawings and gave the winner some candies as a prize. After this game, one of our members explained to the kids how the auditory information traveled to the auditory cortex and got transported to the other areas mentioned from the beginning. We related the pathway to what they were doing in a stepwise fashion. Following the explanation, we played the second game which used the pathway that involved visual information instead of auditory information. In this game, we chose a volunteer from the kids to hold a card with a word written in red at the top. The bottom part of the card was written with three black words that were forbidden to say. The kid's goal was to get other kids to say the red word without using any of the black words. We did about six cards per group on average depending on the time course. It took about three minutes to finish this game. Right after playing the second game, one of the group members explained about the pathway the same way we did in the last game. After the explanation, we asked the kids several questions to test their knowledge about the pathways and areas. We also gave them opportunities to ask us questions.

Materials used to make this model included a 56inch by 42inch poster, race car(motor cortex), dictionary(Wernicke's area), skull(Broca's area), a microphone(auditory cortex), a camera(visual cortex), a piece of wire(angular gyrus), paper to draw on, color pencils to draw with, a CD with the poem in it and a stereo, special made game card, candies.

Results:

Fig1: Raw data of scores in four categories (on a separate sheet)

Fig2: Kruskal-Wallis procedure and H scores

Fig3: Scores distribution in graph

We used Kruskal-Wallis procedure to determine if there was any difference in the scores among the B group in each category. Null hypothesis was that there was no difference between the scores. According to the test, we rejected the null hypothesis with strong evidence (above 99% probability of rejecting null hypothesis) that the scores were significantly different.

Our model was placed third in the B group. We scored 4.24/5 for understanding. Among the B group, our group's presentation was relatively harder to understand than the others. This was observed as our understanding score (B2) was at third place while B1 had the highest understanding score. In terms of the degree of friendliness, we got 4.68. Similar to the understanding score, we were at the third place. The fun score and intention to learn more score were 4.24 and 3.56 respectively. All of our scores ranked in the third place. This ranking perfectly matched with our voting rankings. Some kids did ask some interesting questions about how the processes of speech production and comprehension took place in the brain. Since answers to these questions were mostly unknown or unclear, we told them to realize that there are still many mysteries about the brain waiting to be found out. Others asked if there are alternative pathways. We told them that speech is a complicated function that involved many areas in the brain other than the ones we talked about. This model we presented was an oversimplified version that let them have a glimpse of how the brain provides language function. According to the evaluation form, the favorite part of the exhibit was the games. Many of them liked the poem game more than the flashcard game. Some of them enjoyed learning about the different brain areas. Some of them just simply liked the candy. In terms of what they learned, most of them said they learned the functions of the different areas involved in speech production and comprehension. Most of them learned the pathway for spoken words (in poem game). When we asked them to repeat the areas and the pathway, most of them were hesitant to speak. However, a few of them seemed to be able to connect the different objects with the different areas and more or less describe the pathways.

Discussion:

The purpose of the model was to teach the kids about language processing in the brain with relatively comprehensible analogies and visual aids. The games designed in this model served to outline the general steps for information to go from eyes or ears to areas of the brain that interpret, translate and produce useful output like muscular movements of the hand (writing) and pharynx, tongue, larynx, and vocal cord (speaking). As obvious as it is, there are many problems with the model that we presented. It did not account for all observations of language production and processing. This model only points out the most basic components of language processing. Many recent studies showed that language function requires far more than just six areas. Nonetheless, this model is capable of explaining some clinical verbal or graphical deficits caused by lesions along the pathway. This model led us to think about how exactly language works in our brains and what other functions it may have beside communication. In other words, language may serve as a cognitive tool in central nervous system that provides a framework at where thoughts and emotions can spring.

During KidsJudge, the kids were not very responsive when we tried to describe the different areas of the brain to them in the beginning. We assumed that this is because they were not excited by the plain explanation of the difficult ideas and terms. However, as we approached the game section, the kids appeared to be more energetic. They were apparently happy with the games. If we are to describe the whole model as a wave, the peak would be the games sections, while the trough would be the explanation of the pathways and areas. It was hard for the kids to grasp the difficult ideas. The problem with this project was the complexity of the pathways. From observing other groups, they tried to teach the kids relatively simple concepts compared to ours. It would be hard for them to retain the complex pathways. Even though we tried to make it as simple as possible, the already simplified model appeared to be confusing to the kids. This led to the relatively low scores on understanding, funniness, and intention to learn about the topic. Moreover, as I have mentioned before, the pathways we used were incomplete and not viable to explain all phenomena of language. In order to make it possible for the kids to understand, we sacrificed accuracy. Instead of using a more advance model, we chose a pioneer model discovered decades ago. To minimize the complexity of the subject, instead of including the two pathways used in drawing and speaking in our model, we could emphasize mainly on the brain areas. However, if we were to keep the original model, we would do better to incorporate action game into the model. For example, we could assign each of them to a specific brain area. Then, we could ask them to communicate with each other by throwing balls in a particular order that fits the pathways. Acting it out could impress the kids and fortify their memory of the pathways.

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