# Introduction

## David Piekarski and Kyle Monez

The brain is the most complex computing system this world has ever seen. It is stronger than the greatest super-computers and more mysterious than the origins of Wolverine.While this is wonderful for the development and extradition of ideas for human society this presents a formidable challenge. The brain, being as complex as it is, is very difficult to understand as far as the inner-workings are involved. Scientists have only uncovered minute amounts of information from which to study from. For many centuries the question has been asked, “where and how are memories formed?” but until very recently we have not had either the technology or the know-how to answer it. Aristotle thought the function of the brain was to cool the heart and from there he derived his cardiocentric view of the organ. Socrates then said, “is the blood the element of which we think, or the air, or the fire? Or perhaps nothing of the kind, but the brain may be the originating power of the perceptions of hearing and sight and smell, and memory and opinion may come from them...” From here the race was on. Galen began cerebrocentric experiments and the knowledge of the brain advanced, however often in faulty directions. For example, for many years mental illness was supposedly cured from a process known as trepanning in which a hole would be drilled into the skull to release the devil within the soul that caused the illness. Even with these minor setbacks the knowledge of the brain advanced greatly. It came to a point, specific to memory, that Rene Descartes began asking “Where is memory in the brain and how is it established?” To this day we still don’t have a definitive and unequivocal answer.

There was a famous psychologist named Pavlov that illustrated learned behavior in the world-renown “salivating dog” experiments. Here, every time he fed the dog he would ring a bell. After time all he had to do was ring the bell to make the dog salivate, as if the dog were going to eat something. Another experiment was done in which Thorndike, Watson, & Skinner had a baby named Albert. Everytime a rat was put into his cage they would make a loud sound behind the baby to scare it. Later Albert developed a fear of just the rat because it was associated with the loud bang. This is called operant conditioning.

Learning mechanisms have been studied for years in hope that one day we will understand the basic “memory machine,” a.k.a. the brain. Since our experiences and perceptions are committed to memory the instant that they are processed it is the single most important component of the human brain, allowing us to survive by carrying out basic functions and activities. While there are many different kinds of memory and different learning styles/techniques such as associative (when one associates an object or idea with another for ease of memory, a.k.a. Pavlovian learning), Motor learning (when one performs a motor task in response to an outside condition), sensory (trained to respond to changes in a stimulus) and cross-modal generalization (when one using a certain sense to recall a different sense. An example would be using a face to recall a sound).

We used operant conditioning to train planarians to react observably to a light being shined on them. We did this by shining a light on them and giving them an electric shock strong enough to make their bodies convulse but weak enough so as not to be lethal. We repeated this enough times so that the trained planarians convulsed as if they were shocked when we only turned on a light (the electrical shock was absent). Here we successfully repeated the experiments of Pavlov and skinner; however, we took it a step further. To determine whether memory is chemically based we took the already trained planarians and ground them up and fed them to untrained planarians. Here, if memory were chemically based (as opposed to structurally) then the light would elicit the same effect on the untrained planarians as it did in the trained planarians. Since we are repeating this experiment we already had data from other experiments. This data showed that about 50 percent of the untrained planarians reacted to the light[[1]](#footnote-0). This influenced our hypothesis greatly. We feel that this information strongly defends the position that memory is chemically based, especially since with the mastication and destruction of the brain structure it is almost assuredly not due to structure.

We selected this topic because we both wanted a project that would be both challenging and interesting. This experiment allowed us to apply psychology, biology and electrical wiring into one experiment. It was challenging however because we were working with live animals and that sometimes became difficult to keep them organized and unmoving. Also, I (David) have always had a fascination with the brain and hope to one day become a psychiatrist. This seemed like a subject that was both relevant to my personal interests and to the biology class.

The information that can be obtained from experiments like these can hopefully unlock some of the mysteries behind the human memory. Brain functions and chemicals are most likely very similar since we all were derived from the same source. Also, attributing to the fact that all living things have the same genetic chemicals it is not a stretch to say that whatever chemicals that make memory are of similar structure and function (especially since it is thought that RNA might be that chemical).

This simple (not requiring complex equipment) experiment can and has unleashed endless debate as to the truth about memory. Hopefully experiments like these will help to illuminate the truth.

**Conclusion:**

This experiment shows learned behavior can be transferred by the consumption of the physical manifestations of that learned behavior (i.e. the animal). Because the cannibal planarians could not physically obtain memories from the electrical impulses of the nervous system and since the structure of the brain was destroyed during mastication we deduce that only the chemicals would have any possibility at influencing the actions of the cannibal planarians. We deduce from research sources that RNA was probably the main constituent in this transfer of unique learned ability.

Potential Problems:

With a complex and often times unpredictable experiment (though very exciting!) many things can go wrong. It is imperative that the researcher know about electrical current and its implications on animal bodies. It would be terrible to have a current so strong that the worms perish a terrible lonely death. However, if the current is too weak then the experiment will not produce results. If there is too much water in the tray the worms will not complete the circuit, thus they will accept none of the electricity and learn nothing. In addition, if the tray is too wide the electrical current will weaken and circumlocute the individual worms. Also the material the apparatus is derived from could draw electricity away and produce little or no results. If the drift to far away from the electrical arch center (the foil gap) they may not receive a shock and thus learn nothing.

Recommendations for future experiments:

We recommend getting started earlier with the experiment because it takes longer than one would expect. Also it takes analyzation of the data to arrive at a sequitur of the information. One of the most imperative recommendations would be to purchase a professional “train-a-tray” because we ran into problems and setbacks with our homemade training apparatus. Also it would allow the researcher more possible information and data if it were possible to tag and identify specific worms to track the differences in the individuals.

**Resources:**

1. [www.t3.rim.or.jp/~hylas/planaria](http://www.t3.rim.or.jp/~hylas/planaria)
2. [www.woodrow.org/teachers/bi/1998/planaria/#summary](http://www.woodrow.org/teachers/bi/1998/planaria/#summary)
3. [www.voicenet.com/~GINETTE/PLANARIA.HTM](http://www.voicenet.com/~GINETTE/PLANARIA.HTM)
4. <http://ourworld.compuserve.com/homepages/GIsenberg/plantxt.htm>

5. Graven, Jacques Non-human thought: the history of the animal psyche.

New York, stein and Day 1967

Graven, Jacques

1. Cawkell, Current Comments, “Using the SCI to Illuminate Scotophobia,” 1974-1976, P364-366

   **Hypothesis**: We believe that after teaching the worms to react to the light alone and feeding these worms to other untrained planaria the untrained planaria will react the same as the trained planaria when placed under a light source.

   **Prediction**: If we train planaria to convulse under a light source and we feed them to untrained planaria then the untrained planaria will react the same as the now posthumous planaria.

   Our project requires few materials and plenty of time.

   **Materials:**

   Train-A-tray or home made Shocker (our shocker was composed of half of a water bottle with foil lining the bottom. A one-inch gap in the foil was cut at the center of the bottle. The foil was held down with duct tape. The two shocking wires from the transformer where connected to the foil, one at each end to create a current. Wires from the battery where connected to the corresponding battery wires on the transformer. A toggle switch was placed on one of the wires to control the shock. For our specific transformer a ground wire was connected to a pipe in the ground)

   Lamp with on/off switch

   Planaria (of course)

   Pond water or water that has been declorinated.

   Transformer

   Battery (we used a AA 1.5 volt battery, this may changed depending on the size of the transformer)

   **Procedure:**

   1. Set up your shocker or Train-A-Tray which ever you are using. See above on how to make your own shocker. The shocker should be In a relatively low light are compared to the light of the lamp you are using. Place your lamp directly over the top of shocker. Our lamp was roughly 10 inches (vertically) away from the shocker.

   2. Place roughly 25-30 worms in your shocker.

   1. Shock your worms. When doing this turn the light on at the precise moment you flip the toggle switch on the shocker. Wait one second and then turn off the light and the shocker at the same time. The worms may convulse or twitch after the energy has been turned off so you need to wait for them to flatten out before shocking again. This could be anywhere from 30 seconds to a minute of rest time and 5 seconds of convulsing or twitching after the electricity had been turned off.
   2. This should be done for about half an hour each day. Do this for about a month or until the worms convulse only under the light. You may test this periodically to see if they worms have learned to convulse while only being exposed to the lamp.
   3. Once the worms have learned to convulse under only light they are ready to be mashed up. Drain away some of the water so a small puddle is left. Mash up the entire worm inside to shocker making sure the head and back are in small pieces. Add 25 to 30 new Planaria that have been gathered in the same location as the first worms. Let these worms feed on the corpses of the old worms. After the bodies of the other worms have been digested you may test to see if they absorbed the chemicals from the other worms by turning the lamp on over the worms. IS they convulse then you know that they have absorbed the chemicals. Some worms may not twitch if all of the chemicals where eaten by the other worms. If the majority of the worms react that should suffice.

   [↑](#footnote-ref-0)