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|  | Can one's diet actually effect her ability to reason? Up until midway through this century, the answer to this question was always "no." Work done by scientists such as Richard J. Wurtman in the 1970's, however, began to bring to light new evidence supporting the hypothesis that nutrition may in fact have a greater impact on the brain than was previously thought. He found that certain foods may break through the blood-brain barrier, thus effecting one's ability to remember and changing her behavioral patterns. Even before this, in the 1960's, Dr. Bernard Agranoff studied the effects of reducing the amount of protein in the brains of goldfish. His results concluded that memory can in fact be altered by adjusting the level of proteins in the brain. Recently, neurologists have come to accept the idea that certain groups of food can make a significant change in one's behavior. Eating a protein-rich meal, for example has been shown to increase alertness while eating a meal high in carbohydrates results in a more relaxed state.  Before the 1960's, it was generally believed that diet has no effect on the brain's activity due to the existence of what is called the blood-brain barrier, a protective layer of cells on the brain that protects it from substances in the blood and from changes in blood chemistry. The barrier works by inhibiting the transmission of most substances into the brain and spinal chord. Because of this barrier, it was commonly believed that only a few basic nutrients in food would be allowed to enter through the barrier to the brain. This would suggest that eating something rich in carbohydrates or proteins would have little to no effect on the brain because the brain is protected from fluctuations of nutrients in the blood stream.  These ideas first began to change with increased studying of the brain. Some of the most important work concerning how the brain functions took place in the 1920s when German scientist Otto Loewi began to study neurotransmitters. Understanding neurotransmitters is essential to understand how diet effects the brain.  A neuron is a long, thin cell that specializes in the transmission of signals; it is the nervous system's nerves. A neuron consists of a long arm known as the axon and many shorter arms (or branches) called dendrites. Axons and dendrites like to hundreds of other neurons, forming a thick web of neurons in the brain. Signals are transmitted when an electric impulse is sent through one axon and therefore reaches all other neurons in the brain. These signals are started by neurotransmitters which release chemicals to neighboring nerves. Every axon contains neurotransmitters at their end. The chemicals are released and cross the space between axons and start an electrical wave to the nearby neuron. Loewi discovered the first neurotransmitter, acetylcholine, and studied how neurotransmitters function and what they are composed of. It is the chemical release of neurotransmitters that is so important in the study of the effects of diet on the brain because diet has a great impact on these chemicals.  This information has been especially significant in treating such diseases as Parkinson's disease which leads to the deterioration of muscles. A drug known as L-dopa has been found to enter through the blood-brain barrier, relieving symptoms of the disease. Breakthroughs in Parkinson's disease research were to a great extent a result of Dr. George Cotzias' work. Cotzias treated victims of Parkinson's disease with chemicals that are changed into the neuortransmitter dopamine in the brain. Parkinson's disease destroys neurons in the brain that use dopamine.  It is quite possible that people eat chemicals that can be made into neurotransmitters. For example, almost everyone eats choline, a chemical found in liver, eggs, and soybeans; Choline is the starting materical that the body uses to manufacture certain neurons. Because the food in people's diet can be made into neurotransmitters, then what people eat on a daily bases may effect neurotransmitters as well. This idea was at first hard to accept, though, because of the blood-brain barrier.  Scientist Richard J. Wurtman made the greatest impact on the relationship between diet and brain activity in his experiments in the 1970s. Wurtman and his team provided evidence supporting the theory that food may penetrate the blood-brain barrier with greater ease than was earlier believed. He also showed that the presence of different levels of neurotransmitter precursors can influence the amount of each that may enter the brain. This work has greatly advanced the study of how food effects one's brain.  Many studies have proven that protein has a great impact on the brain. Proteins are the third group of macromolecules, consisting of a chain of amino acids joined by polypeptide bonds. There are many different classes of proteins, each with a different function in a living creature. For example, enzymes, a type of protein, produce nucleic acids and cleave polysaccharides. Some proteins have been proven effective in memory stimulation as well.  Two proteins are believed to have a role in memory retention. One example is the protein CREB. For the past five years, Cortex Pharmaceuticals has been testing various drugs that can be used to combat Alzheimer's Disease in elderly patients. Tim Tully and Jerry C.P. Yin of Cold Spring Laboratory performed an experiment with fruit flies to prove that CREB would be beneficial to the memory loss victims. The two scientists measured how well flies remembered to avoid an odor that had been delivered along with an electric shock wave. There findings showed that the flies genetically engineered to produce more CREB remembered the odor after an entire week. The normal flies, however, needed several training sessions to memorize the pattern. While the flies with lower levels of CREB did not have an improved long-term memory, their short term memory was unaffected.  The other protein linked to memory retention is glutamate. Glutamate is the main excitatory transmitter in the central nervous system. In further testing by Cortex Pharmaceuticals, scientists invented a new family of drugs called Ampakines. Ampakines enhance glutamate communications in the brain on a particular subset of receptors called AMPA receptors. These drugs have been proven to increase the memory of many animals and humans, especially those with special disorders such as Alzheimer's and schizophrenia. While these drugs are helpful for memory retention, studies have also shown that an excessive amount of glutamate can be harmful to an organism. For example, overly abundant levels of the protein have led to degeneration disease such as Huntington's chorea.  Fats have also played an important role in the study of the effect of diet on the brains activity. Fats are storage molecules that consist of a great deal of Carbon-Hydrogen bonds.  The memory remains one of the greatest mysteries in science today. Most of the information that scientists do know about memory stems from experiments performed on goldfish, gerbils, rats, and flatworms. The tree steps toward memory making are registration (seeing and understanding something), retention (storing the memory), and recall (remembering it). In the 1950s, Karl Lashley did studies on the brains of rats and found that over ninety percent of the brain may be removed before the rat will forget its way through a maze. Wilder Penfield also did studies to learn what part of the brain remembers. He would perform brain surgery on conscious people to find what parts of the brain control what. When he touched a spot on the brain called the hippocampus, patients would sometimes recall a memory. This led Penfield to the conclusion that although the hippocampus does not fully control one's memory, it greatly effects it.  Dr. James McConell conducted a series of experiments at the University of Michigan to study the memory of the flatworm. He taught the worms to crawl towards a light whenever they felt a small shock. Once they learned to do this, he would cut the worms in half. The head of the worm would grow a new end and the end would grow a new head. Amazingly, both sets of worms remembered to head towards the light when they received the shock. After this, McConell chopped the trained worms into tiny pieces and fed them to untrained worms. He found that the worms that ate the learned worm pieces performed much better than did those worms that were neither trained nor fed the worm pieces. McConell reported his findings in his book The Mind of Man where he called this eating of memories a transfer of information.  After much doubt and skepticism was expressed surrounding McConell's experiment, he attempted to replicate it with rats. Because rats have digestive enzymes and would therefore swallow the transferred information, McConell chose to inject the rats with the information. This time he trained rats to perform certain tasks, once they did so, they were killed. The RNA taken from the trained rats brains were then injected into the brains of untrained rats. The experiment proved successful when the injected rats were able to learn the tasks faster than those rats that had not received the injection.  McConell's experiments interested many people, excited with the idea of producing a memory chemical for humans. Dr. Georges Ungar explored this option when he taught rats to fear the dark by giving them a shock every time they entered a dark box. He then killed these rats and injected parts of their brain into brains of unafraid rats. These rats then demonstrated a fear of the dark. Dr. Ungar called this phenomena scotophobin, meaning "fear of the dark." This experiment proved that memory may be transferred through chemicals.  After Ungar and McConell's experiments, many laboratories began to expand on their work. At the University of Michigan, Dr. Bernard Agranoff taught goldfish to swim over hurdles towards a light and away from an electric shock. The fish were able to learn this trick fairly easy. Dr. Argranoff then injected a drug known as puromycin into the heads of the goldfish to study its effects. Puromycin is an antibiotic that reduces the rate of protein made by the brain. The goldfish immediately forgot to swim toward the light when the shock was released because of this drug. After about an hour, the fish would regain its memory and remember to swim over the hurdles. This experiment has been interpreted to show that protein is an essential part of the memory.  Dr. Wurtman did many experiments to study how eating meals may effect the brain, specifically the memory. After meals, the level of amino acids outside of the brain fluctuates. When a meal high in protein is eaten, the level of amino acids in the blood stream is greatly increased, whereas a meal rich in carbohydrates decreases the level of amino acids. The amino acid level increases when proteins are consumed because proteins are made up of amino acids. The level of amino acid drops when proteins are consumed because carbohydrates are made of sugars. When the body ingests sugars, it responds by releasing insulin which promotes the entry of sugars and amino acids into cells. Carbohydrates increase the amount of tryptophan (a chemical that is the precursor used by the body to make the neurotransmitter serotonin) that enters the brain, making amino acids more available for the sythesis of serotin. Wurtman's experiments showed that when animals were fed high levels of protein, tryptophan levels in the blood increased while the concentrations of trytophan (and therefore levels of serotin) in the brain decreased. When the animals were fed fats and carbohydrates, however, brain levels of tryptophan and serotin rose. This experiment shows that eating high levels of carbohydrates and fats may actually be beneficial to the brain.  These experiments show that diet may quite possibly have a significant impact on the brain, specifically memorization skills and the transmission of signals in the brain.  The major goal of our research is to study the effects of a carbohydrate, protein, and fat-based diet on the memories and thinking skills of mice. We will time how long it will take mice on a balanced diet to run through a maze and find the cheese at the end and compare this time to the same mice's times after they are on their special diet. |

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*For More Information about Creekwatch, please contact Eric Thiel at* [*ethiel@pleasanton.k12.ca.us*](mailto:ethiel@pleasanton.k12.ca.us)