

Excitotoxins – The Taste That Kills

Russell Blaycock, MD

Book overview written by: Eliza Fulton, 2nd year Holistic Nutrition student of Clayton College for Natural Health and Owner of Insurance and Wellness in the Rockies (3/10/08)

Excitotoxins are taste enhancers that are found in abundance in many food products and have been shown to cause damage to human brain cells. This dietary factor may be the cause of many degenerative diseases like Parkinson's, Huntington's, ALS and Alzheimer's Disease according to neurosurgeon, Dr. Russell Blaycock, MD. Is there any truth to this? In this paper I hope to provide information to help you become better educated about the dangers of excitotoxin additives in foods so you can make better choices for a healthier future for you and your family.

Since this is a complicated topic let's start with a basic understanding of how the brain works in relationship to exposure to MSG and other food enhancing chemicals known as "excitotoxins." Excitotoxins include MSG, hydrolyzed vegetable protein, astartame (sold as NutraSweet) and cystein. These excititoxins all have a similar impact on select neurons in the brain; they cause them to become over stimulated and to actually fire continuously until they exhaust themselves and die!

The Human Brain

First, let's discuss the brain. It is made up of many sections and each section provides a specific set of functions in the operation of the body. It is like a giant computer but is much more sophisticated. The brain is only 2% of the body's total weight and yet it uses 20% of its oxygen and 25% of its glucose (energy producing molecules). The majority of the energy used in the brain is for supporting impulse generation and transmission. The brain never rests. Neurons fire like dominoes and race across the empty spaces between the neurons at speeds of up to 200 miles per hour. The chemical transfers fly across the gaps between the neurons with trillions of messages every second. A properly functioning brain is required for all operations within the body and overstimulation of parts of the brain can cause destruction of these fragile neurons and their connections. In layman's terms listed below are the various parts of the brain and what functions they are responsible for.

Area of Brain	Function
Frontal Lobes	Allow us to learn restraint and to keep our emotions controlled, tact, socially acceptable behavior, tenacity and the ability to focus on a single task are all regulated here. The back side of these lobes regulates some movement; the right side controls the left side of the body and the left side controls the right side of the body
Parietal Lobes	Integrate all parts of the brain so we have a clear picture – When this part of the brain is damaged (as with Alzheimer's Disease) the person cannot find the way home.
Occipital Lobe	Is the visual lobe of the brain which takes data from the optic nerves in the eyes and connects this information to may areas of the brain.
Temporal Lobes	Store and feeds back recent and distant memories – this area is known as the "hippocampus" and is also damaged in Alzheimer's Disease
The Ventricles	Are a series of caverns deep in the core of the brain (corpus

	callosum) is the cooling system of the brain and also a transport system for chemicals, hormones and electrolytes. Since all neurons in the brain work together (not independently) this is a critical system and is filled with crystal clear cerebral spinal fluid that circulates throughout the entire brain.
Thalamus	Situated above the brain stem it is an integration unit like a miniature brain. It performs many complex functions and even has an independent reaction to some functions like pain, crude touch, language and possibly even some memory.
Striatum	All automatic movements are controlled here, like swinging your arms when you walk. This area is affected with cerebral palsy where movements become jerky instead of smooth.
Brain Stem	Consists of two hemispheres called the cerebellum. Impulses originate here like breathing, heart rate, balance and motor nerves of the face, neck and cranial nerves. It is responsible for our alertness and keeps us awake (people in a coma have an injury to this part of the brain). The upper area of the cerebellum is important in the causation of Parkinson's Disease
Hypothalamus	This wedge shaped part of the brain controls the release of hormones that travel to the pituitary gland and regulate growth metabolism, the onset of puberty and all endocrine systems. It also regulates hunger, fullness, sleep and waking cycles, autonomic systems, emotions and our biological clocks

Most parts of the brain have a blood-brain barrier that protects these fragile systems from internal and external toxins. The brain must stay in balance to work properly and several factors affect this. We know the brain is generally very resilient, however, certain areas of the brain are very sensitive and the hypothalamus is one of these areas. Since the brain is a chemical factory that depends on infinitesimal amounts of chemicals in the correct balance to allow for proper functioning; fluctuations in that balance can cause serious problems. Details of how the brain actually works still remain a mystery. It is like a cosmic universe unto itself.

We do know that chemical deviations in the brain can be of great concern, especially in the formative years when the brain is growing and the blood-brain barrier is not yet fully formed. Deviations late in life are also of special concern as the cumulative effect of years of various levels of abuse (a diet high in excitotoxins) and injury (head injuries, strokes, etc.) can cause the onset of many neurological diseases like Parkinson's, Huntington's, ALS and Alzheimer's Disease.

Scientists have learned from many studies that certain parts of the brain are especially sensitive to excitotoxins. High concentrations of these chemicals in the blood affect the brain. Toxic chemicals in the brain include glutamate and enormous amounts of glutamate are added to foods as taste enhancers – monosodium glutamate (MSG) is one the most serious offenders, along with aspartate and cystein.

A blood-brain barrier helps protect the brain from free radical damage and also exposure to excitotoxins. However, some parts of the brain have no blood-brain barrier. These include the hypothalamus, circumventricular organs, pineal gland and a small nucleus of the brain stem. Where the barrier exists can also become damaged and develop leaks. This happens when there has been a

stroke, head injury, degenerative disease, infection, fever or low blood sugar (hypoglycemia). When this happens toxins can enter the brain and cause damage.

So let's look at the whole picture. When we eat the primary function of food is to support the chemical reactions of the brain and the body. Cells absorb nutrients using a lock and key system. The key to absorption of the nutrients by the cell is often either sodium or calcium, which opens the lock. In the brain neuron calcium opens the cell allowing it to receive the nutrients and this triggers the neuron to fire and transmit signals. When the neuron is exposed to excitotoxins the brain's locking system is disrupted and the neuron fires incessantly until the neuron dies.

Here is the concern. Within the brain we know there are at least three types of glutamate receptors (and there may be as many as 20 more sub-types). MSG triggers all three types of glutamate receptors in the brain to fire. Zinc, magnesium and glycine are the locks on the system that block the calcium channel from staying open in the presence of unwanted toxins, thereby shutting the door. The American diet, however, is typically very low in both zinc and magnesium. Thus, the door to the neuron does not shut in the presence of MSG or other excitotoxins, and the neuron continues to fire until the neuron actually becomes exhausted and dies. This is why these toxins are called "excitotoxins."

Areas of the brain that have the highest number of glutamate receptors are the most sensitive to excitotoxin injury. These include: the cortex, striatum, hippocampus, hypothalamus, thalamus, cerebellum and visual and auditory systems. As excitotoxins MSG and NutraSweet activate a number of brain systems that affect sensory perception, memory, orientation to time and space, cognition and motor skills. The affects of excitotoxin exposure are cumulative over the years.

How much MSG is really in our diet and how long has it been there?

In 1909 Professor Ikeda and his friend Saburosuke Suzuki began making a taste enhancer called MSG. By 1933 the Japanese were using over 10 million pounds of MSG per year. In 1948 the Armed Forces (wanting to make the rations taste better) held a conference with food giants like Pillsbury, Oscar Mayer, Libby, Stokley, Campbell Soups, Continental, General Foods and Borden's and they all started using MSG in their foods. The amount of MSG used has doubled every decade since 1940. It is now found in our foods under various labels which include: hydrolyzed vegetable protein, vegetable protein, natural flavorings and spices. These definitions of taste enhancers can be from 30% to 60% MSG and not have to be disclosed on a food label. Manufacturers also do not have to disclose several known carcinogens as the FDA does not regulate those. Taste enhancers are now big business and some of the worst offenders include soups because the MSG is in liquid form and is so readily absorbed into the blood stream and then carried on to the brain. Diet sodas are also serious offenders as they contain NutraSweet and are also a liquid.

Are there any studies that document damage from MSG?

There have been many studies that document the danger of excitotoxins. One study completed in 1957 by Lucas and Newhouse, Ophthalmology residents, studied the affects of MSG on animals and found that 100% of the nerve cells in the inner layer of the retina were completely destroyed by the introduction of MSG. In 1968 Dr. Olney from the Department of Psychiatry at Washington University in St. Louis repeated the same tests and found the same retinal destruction but also observed widespread destruction of the neurons to the hypothalamus and other adjacent areas of the brain. Both studies showed the worst destruction in newborn and immature animals. Similar damage was demonstrated when NutraSweet was used in the tests instead of MSG. The exposed

animals also grew up, as adults, to be shorter in stature, obese and to have reproductive problems as well as an early onset of puberty. Thanks to Dr. Olney's efforts MSG was voluntarily removed from baby foods in 1969. Since the child's brain is four times more sensitive to MSG than the adult brain this was a very important change.

Humans are also more sensitive to excitotoxin exposure than any other species. Blood levels of MSG in humans are 20 times higher than a similar exposure in monkeys and 5 times higher than in mice. Our MSG levels also remain elevated in the blood and brain for much longer periods of time than is demonstrated in any other species.

Is there any way to counteract the MSG as it seems to be in all packaged foods?

Neutralizing factors to excitotoxin poisoning in the brain appear to include Vitamin C and Vitamin E. It is interesting to note that the highest concentrations of Vitamin C in the body are concentrated in the brain. Other antioxidant helpers are beta carotene, Vitamin K, Vitamin D, Vitamin A and the minerals magnesium, chromium, zinc and selenium.

Scientists are now discovering that the calcium channels (which keep the neurons open to invasion by the excitotoxins and eventually exhaust the cell by causing it to fire incessantly until it dies) are very specific. The excitotoxin chemicals only attack neurons with glutamate receptors and ignore all other cells. Neurons with glutamate receptors include 50% of the fore brain synapses and are concentrated in areas of the brain known to be affected by chronic diseases such as Alzheimer's Disease, Huntington's, Parkinson's and ALS.

Why is low blood sugar a cause for alarm?

First of all, when MSG or other excitotoxins enter the blood stream everyone has a built in higher or lower sensitivity to these toxins based on their individual resilience. When a person is hypoglycemic the body is weak, the mind is fuzzy and neurons are already firing spontaneously because of the low blood sugar condition in the brain. Since the brain needs very large doses of glucose to function properly hypoglycemic individuals already lack the energy needed by the brain to operate properly. These tired neurons are now further stimulated by the addition of the MSG or other excitotoxins and the overstimulation causes the affected cells to die. High doses of MSG cause rapid death and low doses cause a slower death. Keeping a normal blood sugar level is critical to brain function and excitotoxin protection. Excessive exercise (like marathon runners and tri-athletes etc.) can induce hypoglycemia and these people need to take extra care not to exhaust the body because the brain does not get adequate nutrition when we are in a hypoglycemic state and it therefore becomes especially susceptible to damage.

What about the affects of excitotoxins on children?

Excitotoxins in the child's diet is of great concern. We know that children are four times more sensitive to excitotoxins than adults. The developing brain is in the process of doing critical wiring that will affect its functioning for the rest of the person's life. Newborns and toddlers are at very high risk of damage when exposed to excitotoxins. In this group there is seen excess electrical activity and even seizures when excitotoxins are introduced in large amounts. The amount of re-wiring a brain can do to correct any damage that occurs is limited. In fact, the majority of brain re-wiring process takes place from week one of conception to a period of about six to seven years of life. The effects of excitotoxin damage during these formative years can include mild dyslexia to severe outbursts of uncontrollable anger, autism, schizophrenia and cerebral palsy. Tendencies toward violence and criminal behavior later in life can also be the result of this early damage. There

is a concern with children who are exposed to excitotoxins regularly in the formative years that they may grow up to be shorter in stature and obese, as was seen in several animal studies; plus have an earlier on set of puberty than normal. Hyperactive behavior, where the ability to focus is lacking, and lowered intelligence were also observed in animal studies. There were also problems with the endocrine system later in life in several animal studies. Frontal lobe damage caused by exposure to excitotoxins is often not seen until years later as children become school age or as teenagers. The affects of the damage are cumulative in nature and can include the inability to control emotions, arrested development, learning disabilities, lack of an ability to see the big picture, social incompetence, inability to show empathy toward others and being unable to perform complex problem solving.

These developmental problems can begin while the child is growing in the mother's womb and may cause many of the problems mentioned above, along with problems like autism, stuttering and delayed speech. The placental barrier is just a single layer of cells and the developing brain does not have a blood-brain barrier in place. The most vulnerable time is the first eight weeks of the fetus' life. Once born the rapidly growing brain is about 80% of adult weight by age four, 90% by age eight and is full sized by age sixteen, but not fully matured until much later. Junk food consumption by teenagers is a difficult issue and a real concern.

How can we protect ourselves from all these hazards?

Since some restaurants use as much as 9.9 grams of MSG into a single dish to enhance the taste (enough to produce brain damage in animals) it is important to watch where we eat and what we feed our children. Fast foods are known to be full of excitotoxins. We know that humans have higher blood levels of glutamate following ingestion than any other species studied. We are extremely sensitive to excitotoxins and especially when more than one type is eaten at a given time. If you give a two year old child soup and a diet pop you are exposing that child to 500 micromoles of MSG in the blood which is enough to cause destruction to the nerves in the hypothalamus. In humans, once the blood level of the excitotoxin has subsided, the brain levels of the excitotoxin remain elevated for up to 24 hours. The destruction of the neurons continues. Therefore, people who drink three or four diet pops per day, never have a drop in the dangerously high levels of excitotoxins in the brain.

The greatest damage will be in the hypothalamus which controls the endocrine functions. This includes the thyroid gland, adrenals, gonads and also the production of prolactin (the ability to produce milk following the birth of a child). There was a marked reduction in fertility of both male and female rats when exposed to MSG early in life.

One needs to show extreme care about eating processed foods (full of excitotoxins) when hypoglycemic. Also, if a person has a migraine headache, suffers from seizures, or has a head injury or other neurodegenerative disease, this person is at even greater risk when exposed to excitotoxins in the diet.

The key here is to eat food as close to nature as possible at all times. We should each consider clearing our pantries and refrigerators to eliminate all foods with MGS, NutraSweet and hydrolyzed vegetable protein. This includes virtually all processed foods, some of the worst offenders are soups, salad dressings, steak sauce, gravy mixes, chips, cream sauces and gourmet foods. Read labels carefully and re-learn the joys of cooking and a simple diet.

What about our aging populations?

As we discussed the affects of excitotoxin exposure are cumulative over time. Diseases that are expressed by the destruction of glutamate receptor type neurons in the brain include Parkinson's, Huntington's, ALS and Alzheimer's Disease.

We know that the percentage of people with Alzheimer's is 3% of all people between the ages of 65 and 74. This number jumps to 18.7% for people ages 75 to 84 and after age 85 the disease is seen in 47.2% of the population. By 2030 the current population of people over age 65 will have doubled! Chronic dementia accounts for 50% of all nursing home admissions. Many people view Alzheimer's disease as "a funeral that never ends." So what can we do?

As we age the blood-brain barrier is often damaged by silent strokes, this creates holes in the barrier. There is also a natural death of neurons, by age 65 approximately 60% of the cells are dead in the human nigrestrial system. In rats only 20% of these same cells are lost in old age. We have eaten an enormous amount of excitotoxins over our lifetime and when glucose levels are low (hypoglycemic) then malfunctions occur in the blood-brain barrier and excitotoxin damage is even more likely to occur.

The brain also shrinks as we grow older, however there is no difference in the brain metabolism of a young and an old person. Function does not decline with age. Progressive loss of neurons naturally begins at about age 30 with a 60% loss at extreme ages. The hippocampus is sensitive to the effects of aging; this governs primarily learning and memory. As we grow older we tend to grow intellectually lazy, we write lists instead of trying to remember things, we use a calculator and don't do the math etc. We need to exercise our brains and challenge them with new learning and problem solving skills throughout our lives, just as we need to exercise our bodies.

Mini-strokes can also occur and not be noticed, which causes defects in the brain and makes holes in the blood-brain barrier. Low thyroid production can also cause severe intellectual deterioration as can depression and low brain levels of B12. So there can be many causes to a loss of brain function over time. The brain will always re-wire itself and try to compensate. However, when there is a 20% loss of neurons in any given area of the brain failure will occur.

In Alzheimer's it is the recent memory that goes first (hippocampus and temporal lobes) and these areas show extensive damage. The areas of the brain affected by Alzheimer's have neurons with the highest concentration of glutamate receptors. There is a general hypothesis that Alzheimer's is caused by an abnormal accumulation of excitotoxin damage in the brain. Alzheimer's patients show over 35% to 40% of all glutamate receptor neurons destroyed and as much as 60% or more of the NMDA type glutamate receptors destroyed. Alzheimer's targets specific neurons that are most impacted by MSG, NutraSweet and other excitotoxins.

Elderly people also do not eat well; they lose their appetite and often have a chronic hypoglycemic situation. This causes the neurons to be even more vulnerable as we age.

Habits are hard to change. What can we do?

I agree, but the choice is clear, either eliminate bad food habits and increase the chance of living a normal life or continue poor eating habits and potentially develop one of these seriously crippling diseases. It is clearly of great concern.

Incorporating foods that are high in magnesium is important (broccoli and spinach). The elderly and most Americans are often low in magnesium. We also know that people who take anti-inflammatory drugs (like those taken for arthritis) have a lower risk of Alzheimer's disease. It is believed this occurs because the blood-brain barrier is strengthened. It is also important to have enough good carbohydrates to keep the blood sugar constant and to keep from developing hypoglycemia.

Fast food diets that are high in processed carbohydrates, fats and phosphoric acid (in soft drinks) are low in magnesium. This continued deficiency will lead to head aches, blurred vision, muscle twitching, nausea and general weakness. It also causes excess parathyroid hormone production and pronounced excitotoxin sensitivity. Magnesium accounts for over 300 enzyme reactions and is critical in the body. Recent studies show that up to 75% of all Americans are deficient in magnesium. Phosphate in colas depletes magnesium and is of special concern with children and teens. Zinc is the other critical mineral for normal functioning of the brain.

The FDA estimated that Americans consumed over 3,500 tons of NutraSweet in 1985. Over 100 million people use NutraSweet routinely. Headaches are the number one complaint of NutraSweet users. NutraSweet spent 60 million dollars in advertising in its first three years and played a major role in revitalizing what was then a stagnant soft drink industry. The Glutamate Association was formed to help keep MSG and NutraSweet on the market. They lobbied to reduce the labeling requirements on foods and to allow MSG to not have to be listed on the label unless it was pure MSG. However, spices, natural flavorings and flavorings can all contain from 30% to 60% MSG without disclosing it!

Changing our diet to eliminate excitotoxins takes will power and also skill in reading labels. One might also consider supplementation to help protect the brain from the cumulative affects of these excitotoxin poisons.

Foods to watch out for include: Soybean milk (naturally high in glutamate / often has hydrolyzed vegetable protein added to it), kombu, miso, and soy sauces all contain MSG.

Sources of MSG include: MSG, Monosodium Glutamate, Hydrolyzed Vegetable Protein, Vegetable Protein, Hydrolyzed Plant Protein, Plant Protein Extract, Sodium Caseinate, Calcium Caseinate, Yeast Extract, Textured Protein, Autolyzed Protein, Autolyzed Yeast, and Hydrolyzed Oat Flour.

Additives frequently containing MSG: Malt extract, Malt Flavoring, Bouillon, Broth, Stock, Flavoring, Natural Flavoring, Natural Beef or Chicken Flavoring, Seasoning and Spices.

Additives that may contain MSG or Excitotoxins: Carrageenan, Enzymes, Soy Protein Concentrate, Soy Protein Isolate, and Protein Concentrate. Protease enzymes of various sources can release excitotoxin amino acids from food proteins.

Suggested Reading:

Excitotoxins – The Taste that Kills, by Dr. Russell L. Blaylock, MD

The Zone – A Dietary Roadmap, by Dr. Barry Sears

Suggested Supplements according to Dr. Russell L. Blaylock, MD , Neurosurgeon and Author of Excitotoxins – The Taste that Kills

Alpha-lipoic acid	Exceptional for excitotoxin protection
Co-enzyme Q10 & Niacinamide, Riboflavin & Thiamine	Prevents excitotoxin damage by improving energy in the brain
Acetyl- L-Carnitine	Reduces memory loss in the brain (expensive)
L-Carnitine	Improved long-term memory and learning
Taurine	Function is to protect the brain & stabilize nervous system excitability
Lecithin	Repairs injuries to the insulation of nerve cells (keep refrigerated)
Phosphatidylserine	Phospholipid with superior neurological properties / improved memory over time; natural glutamate blocker
Dihydro-ergot Compounds (Hydergine)	Counteracts effects of aging brain – oxygen delivery and free radical scavenging
DMAE (Deanol)	Natural in sardines and anchovies – increases choline in the brain – helps moods, improves memory and learning ability (even in children)
Quercetin & Hesperidin	Protects eyes and retinal barrier – may also strengthen blood-brain barrier
Vitamins C & E	Antioxidants (helpful also in cancer prevention)
Minerals Magnesium & Zinc	Excitotoxin protection – protects the cells

Reference:

Blaylock, R. (1997). Excitotoxins – The Taste That Kills, Albuquerque, NM: Health Press NA.