Essential Fatty Acids and ADHD: Part I

Our bodies are composed of billions of cells-units of life—of various shapes and functions. Each cell is surrounded by a waterproof membrane composed of special types of fats that separate the watery contents of the cell from the watery fluid outside the cell. These special fats are called essential fatty acids (EFAs). They are vital nutrients that come directly and only from our foods. Our bodies cannot make these nutrients so we must get these essential nutrients in the diet we eat for normal physical and mental health.

An EFA molecule has at least 18 carbon atoms. The carbon atoms are strung together rather like beads on a necklace and held together by single or double bonds. All EFA have at least 2 double bonds that make a kink in the molecules.

One end of the EFA molecule (COOH) loves to hang out with water but the other end of the molecule loves to hang out with other fatty molecules. This property is responsible for the role EFAs play in cell membranes.

There are two families of EFAs, the omega-3s and the omega-6s. The two families are not interchangeable. Your body can't make omega-3 fatty acids from omega-6 fatty acids or vice versa.

The parent molecule of the omega-6 family is linoleic acid (LA). LA has 18 carbon atoms and 2 double bonds. A three-dimensional model would show that the molecule is not straight—it has a kink in it due to the 2 double bonds. The first double bond occurs on the 6th carbon from the methyl end of the molecule. Hence it is an omega-6 fatty acid. LA is sometimes referred to as "18:2n-6 which means that it has 18 carbons, 2 double bonds and it's an omega-6 fatty acid. LA is found in corn, soy, safflower and sunflower oils. Most Americans get more than enough omega-6 fatty acids in their diet.

The omega-3 family starts with alpha-linolenic acid (ALA). Like LA, ALA has 18 carbons but it has 3 double bonds that start on the 3rd carbon from the methyl
end of the molecule so it's referred to as "18:3 n-3. Because it has 3 double bonds, ALA is more kinked than LA! ALA is found much less abundantly in the American diet. Canola, walnut and flaxseed oils are good sources. Fish oils have large amounts of longer-chain omega-3 fatty acids, DHA and EPA.

LA and ALA undergo several transformations in which they are lengthened twice by two carbons and more double bonds are inserted. The double bonds are important because they cause kinks in the fatty acid molecule. While saturated fatty acids (the kind of fat we try to avoid that's present in fatty meats, cheese, butter, etc) have no kinks and thus pack closely together in the membrane, the kinks in the EFAs prevent the molecules from becoming packed together and allow the membrane to be fluid.

The following diagram shows the other members of the EFA families. The molecules in red are the most important ones for normal brain function.

**Omega-6 Fatty Acids**

- LA (18:2n-6)
  - ↓
    - ↓
      - GLA 18:3n-6
  - ↓
    - ↓
      - DGLA (20:3n-6)
  - ↓
    - ↓
      - AA (18:4n-6)

**Omega-3 Fatty Acids**

- ALA (18:3n-3)
  - ↓
    - ↓
      - 18:4n-3
  - ↓
    - ↓
      - 20:4n-3
  - ↓
    - ↓
      - EPA (20:5n-3)
So what do these molecules have to do with your child’s brain function? EFAs are crucial for 2 reasons. First, the balance between the omega-3 fatty acids and the omega-6 fatty acids affects the properties of the cell membrane and the ability of molecules to enter and exit the cell or to bind to receptors in the membrane. Second, your child’s body also uses longer omega-3 and omega-6 fatty acids to manufacture different series of hormone-like chemicals, including prostaglandins. Prostaglandins (PGs) help cells communicate with each other. Series 1 PGs are manufactured from DGLA and tend to promote healing activities while series 2 PGs derived from AA tend to be pro-inflammatory. Series 3 PGs are made from EPA and promote healing, positive actions.

Long-chain omega-6 fatty acids (AA) and especially long chain omega-3 fatty acids (EPA and DHA) are more concentrated in the brain and retina than in other cells. They play vital roles in normal brain and nerve function. If your child has a short supply of these critical EFAs, his/her body and brain cannot perform normally! It may be time to “oil your child!”

**Symptoms of Essential Fatty Acid Deficiency**
How do you know if your son or daughter is getting enough EFAs? Here are 7 symptoms. Your child doesn’t have to have all of them, just a few that you would rate as “pretty much” or “very much.”

1. **Excessive thirst.** For example, does your child drink more fluids than other family members or his/her friends? Does he/she keep water by his bedside at night? Do teachers complain that he/she wants to make frequent trips to the waterfountain.

2. **Frequent urination.** Does your child visit the bathroom more often than other family members or his friends?

3. **Dry, flaking skin.** Does your child use moisturizers because of skin dryness? Does your child’s skin lack luster? Does he/she have eczema?

4. **Dry, straw-like or unmanageable hair.** Does your child’s hair lack luster? Does it feel dry? Does it need conditioners?

5. **Dandruff.** Does your child have dandruff? Do you have to use an anti-dandruff shampoo?

6. **Brittle or soft, pealing fingernails or toe nails.** Do your child’s nails break easily? Does he/she bite his/her nails? Or are they soft and peal easily?

7. **Follicular hyperkeratosis.** Does your child have tiny, hard bumps, on the backs of his arms, elbows, thighs or even on his face?

If you answered “pretty much” or “very much” to 2 or more of the above questions, then your child’s health and behavior may benefit from increasing EFAs in his/her diet or using EFA supplements.

There are **blood tests for plasma and red blood cell EFAs**, but these are problematic. They are expensive and must be ordered by a physician. Very
few physicians are familiar with these tests and how to interpret them but some of the reports do come with some explanations of the findings. Also, very few labs perform plasma phospholipid and red blood cell fatty acids tests. Two that do are Meridian Labs in Kent, WA and Great Smokey Labs in Asheville, NC. Instead of using these tests, some nutritionally-oriented physicians rely instead on detecting deficiency symptoms followed by a trial of EFAs.

Studies at Purdue University have reported that about 40% of boys with ADHD had more symptoms of essential fatty acid deficiency and had significantly lower levels of omega-3 and omega-6 fatty acids than controls with normal behavior. The reason for the lower levels is not known but could include lower dietary intake or a metabolic block in the omega-3 and omega-6 fatty acid pathway.

For more information about fatty acids and behavior please refer to these books: "Help for the Hyperactive Child" by William G. Crook, M.D., "Superimmunity for Kids" by Leo Galland, M.D., and my book “12 Effective Ways to Help Your ADD/ADHD Child.” You'll also like Andrew Stoll's book, “The Omega-3 Connection: The Groundbreaking Anti-Depression Diet and Brain Program.” Dr. Stoll is a Harvard physician and has done ground-breaking research on the links between EFAs and bipolar disorder. “The LCP Solution “ by Jacqueline Stordy is also interesting.. Your library or bookstore can order these for you or you can order them online at www.amazon.com.

You'll also like this website: www.fabresearch.org. This is a site by Alex Richardson, Ph.D., one of the pioneering scientists who has studied ADHD and fatty acids.
Essential Fatty Acids & ADHD Part II

Last month I introduced the subject of essential fatty acids (EFAs), their roles in the body, why they are considered essential and their role in normal brain function. This month I’m going to cover various research reports dealing with EFAs in children and adults with ADD/ADHD.

In 1981 two bright, observant mothers noticed that hyperactive children (the terms ADD and ADHD had not yet been coined) seemed to have more symptoms of EFA deficiency than children without attention and hyperactivity problems. They proposed that there could be a deficiency of EFAs that was playing a key role in causing behavior problems.

Then in 1983 Mitchell and his coworkers proposed that “maladjusted” behavior in children might be caused by a deficiency in EFAs. They studied 23 “maladjusted” children and 20 normal children. They examined the EFAs found in red blood cells and concluded through statistical analyses that the levels of EFAs in the maladjusted children were significantly lower than those of the normal children. However, the term “maladjusted behavior” was unclear as to what specific behaviors were occurring in these children. Were they really hyperactive?


After studying a group of hyperactive children, Mitchell and his associated reported in 1987 the clinical characteristics and serum EFAs in the hyperactive children vs. controls. They compared 48 hyperactive children with 49 age-and-sex matched controls. Interestingly, the hyperactive children reported more coughs and colds, more thirst, more frequent urination, and more serious illnesses and accidents than the normal children. When they compared the
EFAs in the serum of the blood, they found significantly lower levels of the omega-6 fatty acids, DGLA and AA, and lower levels of DHA, an omega-3 fatty acid. These 3 fatty acids are critical for normal brain function.


In 1995 my professor John Burgess, Ph.D. and I reported a study we had conducted. We studied 43 children without ADHD and 53 children with ADHD who had been diagnosed by their family doctor or psychologist. We found that the children with ADHD had significantly lower levels of critical EFAs in their blood. In plasma the ADHD children had lower levels of AA, EPA and DHA. In red blood cells there were lower levels of AA. But not every child with ADHD had lower levels but about 40% had both lower levels of EFAs and increased symptoms of EFA deficiency.


We also studied the relationship of omega-3 fatty acids to behavior, learning and health problems in these same children. In children with low omega-3 and omega-6 EFAs in their blood, there were more symptoms of EFA deficiency than those with higher levels of these fatty acids. More behavior problems, more temper tantrums, and sleep problems were found in those with lower total omega-3 fatty acids. Additionally, more learning and health problems were found in the children with lower omega-3 fatty acid concentrations.

(Stevens et al. 1996 “Omega-3 fatty acids in boys with behavior, learning and health problems.” Physiology & Behavior Vol. 59 pp. 915-920.)

Concentrations of EFAs in the blood have also been studied in adult psychiatric disorders. Studies of large populations in the United States and
other countries suggest an association between decreased omega-3 EFAs intake and the increase in depression that has occurred in recent years. Plasma and RBC concentrations have been reported to be lower in depressed patients in comparison with healthy controls. EFAs concentrations are also altered in schizophrenic patients compared to healthy controls. Patients with bipolar disorder have also responded well to EFA supplements.

Symptoms of EFA deficiency (excess thirst, frequent urination, dry skin, dry hair, dandruff, tiny bumps on the backs of the arms or thighs and/or brittle nails) have also been reported in both children and adults with dyslexia, a type of learning disorder that is often found in ADHD children and adults.


(You'll like Alex Richardson's website at www.fabresearch.org interesting and helpful.)

In conclusion, EFAs appear to play a role in ADD/ADHD and other behavior, learning and psychiatric disorders. The origins of these abnormalities in EFA status are not known at this time. Are they dietary? Are they metabolic? Is there a genetic component? Are they interacting with other nutrients? This important research continues at Purdue and other major research centers.

**Essential Fatty Acids and ADHD Part III**

As we've seen in the last 2 newsletters, essential fatty acids (EFAs)—omega-6 fatty acids and omega-3 fatty acids—are extremely important for normal brain function. So you will need to “change your child’s oils” by decreasing and eliminating “bad” fatty acids and adding “good” fatty acids to your child’s diet.
Actually, this should be a change for all family members because essential fatty acids play a major preventive role in chronic diseases such as heart disease, diabetes, arthritis, cancer, etc. So “oil” your whole family!

**OILS YOU NEED TO DECREASE OR ELIMINATE FROM THE DIET**

1. **Decrease saturated fat.** The fatty acids in saturated fats are “straight” shaped molecules that pack together in the cell membrane making it more rigid. Membranes that are too rigid don’t perform normally. Saturated fats are found in meat, whole milk, cream, cheese, vegetable shortening and butter. Decreasing these fats is the first step. (However, small children need whole milk for their brains to develop normally). If you read the nutrition label on processed foods, you’ll see that they list actually amounts of saturated fat.

2. **Hydrogenated fats.** Some oils are hydrogenated so they will have a longer shelf life. Hydrogen atoms are added across the double bonds creating single bonds. Again, these new molecules pack together in the cell membrane affecting its fluidity. Hydrogenated oils are solid at room temperature. An example is Crisco solid shortening made by hydrogenating soybean oil. Read all labels for hydrogenated fats and avoid products that contain these.

3. **Partially hydrogenated fats.** Some oils are just partially hydrogenated to prolong the shelf life of many foods. These compete with EFAs and increase the need for EFAs. Read all your labels because you’ll find partially hydrogenated fatty acids in many processed foods. For example, they are found in most crackers, cookies, breads, baked goods, potato chips, corn chips, etc.
4. **Trans fatty acids.** You’ve probably read about trans fatty acids. Trans fatty acids have the same number of hydrogen and carbon atoms as other fatty acids but their shape is different. This trans shape occurs in the processing of some foods like margarine, and non dairy creamers. The harder the margarine is, the more saturated and trans fatty acids present. French fries, doughnuts, potato skins, potato chips, and any deep fried meat, fish or poultry and some other processed foods are also high in hydrogenated and trans fatty acids. So you’ll want to avoid foods that contain trans fatty acids.

What kind of margarine should you choose? **Benecol** is one possibility. It does not contain trans fatty acid. It’s made from canola oil, plant sterols but it does contain some partially hydrogenated and hydrogenated soy oil so it is not ideal. **Smart Balance** contains no trans fatty acids and is made from palm oil, soy, canola and sometimes with added flax oil depending on which Smart Balance you select. However, palm oil contains some saturated fatty acids. **Canola Harvest Margarine** does not contain trans fatty acids and is made from canola and palm oils. Some doctors think that a little bit of real butter is better than margarines that contain trans fatty acids. Whipped butter will help you use less butter. A new product in our grocery store is Land of Lakes Butter Spread that contains both butter and canola oil, a healthy source of omega-3 fatty acids.

**EFA**s YOU NEED TO INCREASE IN YOUR DIET

While you’re decreasing the harmful fats in your family’s diet, you’ll want to start adding good essential fatty acids (EFA). As you may recall there are two families of EFA, the omega-6 fatty acids and the omega-3
fatty acids. Both must be consumed in the diet because our bodies can’t make them. And remember, we cannot convert omega-3 fatty acids into omega-6 fatty acids or vice versa.

Most Americans consume plenty of omega-6 fatty acids and too few omega-3 fatty acids. In fact, most fatty acid researchers think that it’s the ratio of too much omega-6 fatty acids to too few omega-3 fatty acids that is out of kilter. In general, most Americans consume a ratio of 10 or 12 parts of omega-6 fatty acids to one part of omega-3 fatty acids. (12/1). Studies suggest that a ratio of 4 parts omega-6 fatty acids to 1 part of omega-3 fatty acids (4/1) would be much healthier.

There are 2 ways to reduce the ratio: The first is to decrease the amount of omega-6 fatty acids in your diet and the second is to increase the amount of omega-3 fatty acids.

So what are the sources of omega-6 fatty acids that we should be decreasing? Corn (61% is linoleic acid) soy (54%), safflower (77%), sunflower (69%), cottonseed (54%), and peanut oils (33%) are major sources of linoleic acid, the first member of the omega-6 family. They are found widely in salad dressings, mayonnaise, margarine, and many processed foods. Scientists recommend that we receive about 1-2% of our total calories from linoleic acid. On a 2500 kcal diet, this corresponds to about 1 tablespoon of the above plant oils each day.

Researchers think that we need to consume about 0.5 to 1% of total calories from omega-3 oils. What are good sources of omega-3 fatty acids? Soybean oil is a good source (7%) of alpha-linolenic acid. However, it has 54% from linoleic acid so soy oil is not the best source in terms of improving the omega-6 to omega-3 ratio. Canola is a good source of linolenic acid (10%) with less linoleic acid (22%). So you can use canola oil to make your own salad dressings (really easy) and
perhaps your own mayonnaise (if you’re ambitious and have a little more time!). You can use canola oil to make pasta and bean salads. Canola oil is an all purpose, inexpensive oil and is good for baking and stove-top cooking. **Don’t fry with canola oil or any oil because oxygen in the air and the high temperature damage the good fatty acids.**

**Walnut oil** also is an excellent source of linolenic acid and is delicious in salad dressings. However, it’s a bit pricey! **Walnuts** (but not pecans or other common nuts) are an excellent source of linolenic acid.

**Flaxseed and its oil** are even richer sources of linolenic acid. The taste of flaxseed oil is slightly fishy or nutty. Some children will take the oil off a spoon (about 1-2 teaspoons a day can be quite helpful for improving deficiency symptoms and behavior) while others need to have it disguised in other foods like chili or spaghetti sauce. Another way to get the oil is by eating the flaxseed itself (gradually build up to about 2-3 teaspoons a day). You will have to grind it into a powder using an inexpensive spice or coffee grinder. Then it can be added to salads, homemade bread, cereals, yogurt, applesauce, chili, spaghettis, etc. Use immediately after grinding.

It’s important to protect all your vegetable oils from damage from air, heat, and light. Keep all your vegetable oils (except olive oil) refrigerated upon opening. Then you can squeeze the contents of a vitamin E capsule into the oil. Slowly disperse the vitamin E in the oil but don’t shake it! You don’t want to add air bubbles! The vitamin E, a powerful antioxidant, will protect the EFA molecules.

**Another fine source of linolenic acid is beans—not all beans but certain ones such as soy, navy, northern, pinto, red and kidney beans.** These are also an excellent source of minerals, antioxidants and fiber. So serving chili, bean and vegetable soup, and 3 bean salad made with these beans will add linolenic acid to your diet.
Cold-water fish are also excellent sources of long-chain omega-3 fatty acids—EPA and DHA. These cold-water fish include fresh and canned salmon, fresh tuna, albacore tuna packed in water, herring, sardines and flounder.

There are 2 problems with these fish: 1) getting your child to acquire the taste of these oily fish! One dad who raises farmed salmon found that telling his young child that Spiderman loves salmon encouraged his child to eat bits and pieces of salmon placed on a Spiderman plate and finally the child would ask for it!

2) Safety is the other problem. These fish may be contaminated with mercury and cancer causing chemicals called PCBs. So you are caught between a rock and a hard place: the DHA and EPA in these fish make them extremely healthy but the contaminants can harm the nervous system and cause cancer! Pregnant women and children are more susceptible to these possible problems so they are advised not to eat shark, swordfish, and king mackerel. Don’t eat fish skins because the skin accumulates toxins. If you score the flesh and then grill or broil the fish, the juices containing about half of the contaminants will drip off. Children should not eat albacore (white) tuna. Wild salmon generally have a lower level of contamination than farmed salmon. Canned salmon is wild salmon. Farmed salmon may contain contaminates because they are fed feed made from smaller fish that consumed industrial chemicals and PCBs. If you decide to purchase farmed salmon, ask where it was raised and under what conditions.

Another good source of DHA is found in some chicken eggs that have fed on good sources of omega-3 fatty acids. Eggland and Cage-Free Omega-3 Eggs are 2 brands found in our grocery store. The eggs have a slightly different taste your child may or may not like.
You may ask, “Where does olive oil fit into all of this?” Olive oil does not contain EFAs but is a rich source of oleic acid, an omega-9 fatty acid. Our bodies can make oleic acid, therefore it is not an essential fatty acid. Diets high in olive oil are quite healthy.

Next month I'll talk about the results of intervention studies where EFAs have been given in supplement form to children with ADHD. I'll also discuss how you can choose a supplement for your child.

Supplementing Essential Fatty Acids in ADHD Part IV

Revising your diet to include more omega-3 fatty acids as I advised last month is a healthy change for all family members. So don't stop! Oil your family every day! However, some children with ADHD need even more fatty acids. First, I'll review what scientific studies have shown. Then, I'll talk about how to give your child fatty acid supplements.

In 1987 an early study by Aman and coworkers reported the use of primrose oil capsules, rich in GLA, an omega-6 fatty acid, in children with ADHD. Although a few children seemed to improve, for the most part there were no strong benefits.

More recently scientific studies have focused on using omega-3 fatty acids. In 2001 in a double-blind, placebo controlled study, Robert Voigt and coworkers at the prestigious Mayo Clinic gave supplements of only DHA to children with ADHD. There were no improvements in those who received the fatty acid or those who got the placebo (olive oil) despite that plasma levels of DHA more than doubled.

In 2002 Alexandra Richardson, Ph.D. and her coworkers, reported the results of another double-blind, placebo controlled study that supplemented children with ADHD related symptoms and specific learning problems. The
supplement she used contained 480mg DHA, 186 mg EPA, 96 mg GLA and 60 IU vitamin E (as alpha-tocopherol) total each day for 3 months. Improvements were reported in the supplemented group on 7 of 14 scales for cognitive and behavioral assessments. She concluded, “Given the safety and tolerability of this simple treatment, results from this pilot study strongly support the case for further investigation.”

In 2004, John Burgess, Ph.D. associate professor of Foods & Nutrition at Purdue University and I reported in the journal *Lipids* the results of a double-blind, placebo controlled study we had conducted (with the help of other colleagues) that gave supplements of essential fatty acids to children with ADHD type symptoms. The subjects all had some symptoms of essential fatty acid deficiency including excess thirst, frequent urination, dry skin, dry hair, dandruff, brittle or soft nails, and tiny hard bumps on the backs of the arms or on the thigh. Each fatty acid capsule contained 480 mg of DHA, 80 mg EPA, 96 mg GLA and 24 mg of vitamin E each day. Each placebo capsule contained 0.8 mg of olive oil. The children took 4 capsules with breakfast and 4 with dinner for 4 months. We drew blood to measure fatty acids at baseline, 2 months and 4 months. We also collected 3-day diet records of everything the children ate or drank before and after the supplementation period.

While the results were not spectacular, we did see some encouraging changes. Parents’ scores for Conduct were significantly lower in the group that got the essential fatty acids. Teachers’ scores for Inattention also improved significantly. Increased DHA in the blood was associated with a decrease in the deficiency scores and also with teacher evaluations of attention. Higher EPA was associated with a decrease in the deficiency scores and also in a short-item questionnaire for parents that assessed behavior. Some symptoms of essential fatty acid deficiency also improved: 50.1% improvement for dry skin and 42.6% for dry hair. Frequent urination scores decreased significantly (29.7%) in the EFA supplemented group compared to the placebo group. Excessive thirst scores improved 33.3 % in the EFA supplemented group but this was not significant.
What surprised us was that higher vitamin E levels were associated with a decrease in all teacher evaluations: the teacher short item questionnaire about behavior, and teacher evaluations for hyperactivity, attention, conduct and oppositional defiant disorder.

These 3 studies do give us some helpful information. In the first study, giving just DHA alone did not lead to improvement. In the other 2 promising studies, the supplements chosen contained not only DHA but also EPA, GLA and vitamin E. Studies of essential fatty acid supplements in other psychiatric disorders suggest that EPA is much more involved in mood than DHA. **So it’s possible that higher EPA and lower DHA supplements might work even better.** Another study of schizophrenics found that using vitamin C and vitamin E with essential fatty acids seem to improve the symptoms of the disorder even more. **So taking antioxidants may also be helpful.**

**Choosing Supplements for Your Child**

There are several ways to approach supplementation. One way is to give your child flaxseed oil. Several doctors have found this approach quite helpful using anywhere from 1 to 6 teaspoons of flaxseed oil depending on age and size of the child. As I mentioned last month, many children will just take the flax oil off a spoon (it has a slightly nutty or fishy taste) or it can be disguised in foods. One child would swallow it if he immediately drank some orange juice. Capsules are a possibility but it takes 4 capsules to make 1 teaspoon. There are no reported studies that used flaxseed oil as the supplement but one is to be published soon. Some doctors find that if flaxseed oil doesn’t help, then some children with ADHD will respond to 1-6 capsules of evening primrose oil, a rich source of GLA, an omega-6 fatty acid. This oil can be rubbed into the skin and is absorbed quite well. Some children do best on flaxseed oil and evening primrose oil.

Another option is to use supplements of fish oil like the ones mentioned above. Which supplement of fish oil should you consider? As I’ve pointed out, no one knows the “right” combination of omega-3 and omega-6 oils for ADHD. I’d look for one that contains more EPA than DHA and also contains some GLA.
You’ll find brands that are 3:2 EPA to DHA up to 7:1 EPA to DHA. If you can, choose a brand that states the supplement is free of mercury and other harmful contaminants. Follow the dosage recommendations on the bottle.

Don’t expect instant results. It may take a couple of weeks to note improvements in behavior. If your child has some of the symptoms of EFA deficiencies you may see improvements in those in a week or two. But it will take 3-4 months to see full improvements in these symptoms and behavior symptoms. It’s possible adding a modest antioxidant supplement may also help. I’ll keep you informed as more research results are published.