Delving into the subject of the Brain and Essential Fats is a difficult journey, primarily because of how important the topic is and how little we know about how we think. There are 100 billion neurons sitting on top of our shoulders with ~60% of that nerve material made up of fats, saturated and unsaturated fatty acids (PUFAs) (Connor 1990, Chang 2009). Every day some portion of our nibbling finds its way into the neurons of our brain and through some miraculous cellular metabolism directly affects how we think, play, sleep and dream.

All cells have fatty acid membranes protecting the cytosolic life that goes on busily inside our cells day after day. Nerves are no different. Neurons have the same protective membranes with the same fatty acid phospholipid composition, but nerve membranes have a special job, they are endowed with the task of carrying all the signals inside our head and transmitting them to regulate all thought and motion. We can’t blink or think without fatty acids, yet we rarely give a thought about what we throw down. Venturing into the kitchen for sustenance puts us in charge of what goes into our brain, or, we may simply transfer that to McDonald’s or Taco Bell, now they’re in charge. The potential for brain damage is awesome, especially if there are little ones waiting patiently at the table. Since our brains are mostly fatty acids (60%), and essential fats should be in most every bite of food we take, a primer on fats and oils is in order, but only a little bit.

This article has 5 basic subjects 1) Shlomo Yehuda’s groundbreaking discovery of the preferred ratio of omega 6 and omega 3 Essential Fatty Acids (EFAs) 2) Yehuda’s 2005 paper on Test Anxiety with his preferred fatty acid ratio, 3) the overconsumption of Fish Oils, 4) a primer on fatty acid technology, 5) Good oils, not-so-good oils and bad oil, which – you might want to read first.

There is extensive research on the topic of “diet” and “brain”. Type those two words into Medline, and you’ll get 15,577 “hits” or research reports. Medline is part of the NIH in Washington that organizes medical studies from universities around the world. However, you’ll draw a blank slate if you believe you will advance your knowledge on how to change your diet so you can think better. The subjects of either diet or brain are well researched, but putting them together doesn’t elevate you, in fact the literature appears to say “we don’t have a clue” (Joint WHO/FAO 2002, FAO Food 2008).

We know that the membrane is composed of saturated and unsaturated fatty acids, including the omega 6 and the omega 3s, but until the research of Shlomo Yehuda from Israel in 1993, the medical community did not know, and for the most part, even today, refuses to acknowledge the magnitude of his contribution to the subject.

The Breakthrough 4:1 Fatty Acid Ratio

Prior to his ’93 paper, “Modulation of learning, pain thresholds, and thermoregulation in the rat by preparations of free purified a-linolenic and linoleic acids:”, Yehuda and others had proposed that diet had an effect on the fatty acid composition of nerve membranes and even stated that fatty acids could mediate some of the observed changes in learning and behavior (Yehuda 1987, Cosicina & Yehuda 1986, Yehuda & Carasso 1987, Yehuda 1989). Even though they had observed “changes in learning” in those prior studies, Yehuda now is more definitive. He clearly states in this study that modulation of learning is achieved using a 4:1 ratio, four parts of omega 6 linoleic acid (LA) and one part of omega 3 a-linolenic acid(ALA). He called it Special Formula 3 (SR-3).

ω6 linoleic LA is in most all seeds and nuts such as safflower, sunflower, corn, soybean, cottonseed, canola, etc., while ω3 a-linolenic ALA, is found in flax, hemp, chia, walnut, soybean, etc. The discovery of the optimal dietary ratio of the
Essential Fatty Acids (EFAs) was highly significant, since, being essential signifies that we cannot produce them and they must be in our food supply.

### Earlier Research leading up to the 4:1

Prior experiments using 14C-labeled fatty acids (for brain tracking) had shown a cellular preferential uptake of omega 3 ALA over ω6 LA in the brain as early as 1973 (Dhopeshwarkar, 1973). (ω is the lower case Greek letter omega). Initially they attempted to explain it by focusing on the amount of PUFAs (multiple double bonds) in soybean oil. However, sunflower oil, which contains a higher amount of PUFAs than soybean oil, failed to produce the positive effects of soybean oil (Yehuda & Carasso 1987, Yehuda 1989). Since the oil from soybeans contains more ALA (8-9%) than sunflower (about 0.4%), the benefits for the brain must have come from the increased ω3 α-linolenic. If the higher quantity of EFAs were not the answer, it must be somewhere in the ratio of the 6s and the 3s, the ratio to each other that held the key.

It was earlier recognized that ω6 LA (linoleic Acid) was important for normal health and brain development (Dhopeshwarkar, 1983). ω3 ALA had also been determined to have significant biological effects, now both were classified as EFAs (essential). Also, earlier studies suggested that ALA may be quite different from LA and may even have a biochemically distinct function (Bernsohn 1973).


Since ω6 LA is more common in our food supply than ω3 ALA, and ALA is now deemed to be essential, even though ω3 ALA is high in grasses, which is not common in our food supply, the question is, how much of each do we need.

The aim of the Yehuda ’93 study was to test the basic hypothesis; is the ratio of linoleic acid to α-linolenic acid the key factor in mediating the beneficial effects of PUFAs in the body and especially in the brain? This required a significant amount of research to challenge and record the learning characteristics of small animals in a stress condition.

---

The Learning Apparatus

The Morris water tank, a circular tank ~43 inches in diameter (110 cm), was filled with water with powdered milk added to make it opaque so that rats swimming in the tank were unable to see the resting platform submerged below water level. Each animal was released facing the wall in one of four predetermined starting points each separated by 90° around the inner perimeter. While the animal was swimming in the tank, it was able to observe the contents of the room. Special care was given to keep things in the room in the same location. They could navigate in the tank only by external cues, by looking around while paddling. Each animal was tested 8 times per day in the tank. The order of the starting points was determined by random selection. To prevent possible effects of a magnetic field, each one was allowed 120 sec. to find the platform, with an interval time of 20 sec. between trials. The maximum duration of the test was 16 minutes. The rats were tested on 3 consecutive days. During this period, the platform was in the same location in the tank. For each of the 24 trials (eight trials x three days), the time to find the platform was recorded. A cutoff criterion, defined as the first successful trial, was used to calculate an index of learning ability (rate of learning).

The research team tested 9 groups of rats with 7 different ratios of LA and ALA –3:1, 3.5:1, 4:1, 4.5:1, 5:1, 5.5: 1, and

*These statements have not been evaluated by the Food and Drug Administration. These products are not intended to diagnose, treat, cure or prevent any disease.*

**Budwig and Rudin**

Looking back on those early years is important to grasp the significance of Yehuda’s SR-3. At BodyBio we had recently completed a computer software analysis of a Johns Hopkins red blood cell fatty acid analysis (RBCFA) as an analytical service for physicians, which was central for our teaching program of fatty acids and the cell membrane. However, the basis of nutritional treatment was a dietary adjustment using the correct EFA oils according to each individual’s test. ALA had been determined by many others to be the key missing ingredient. Discovering Yehuda’s SR-3 was a major breakthrough, since prior dietary efforts to add in the missing ω-6 linolenic acid (ALA) had been a hit or miss exercise. Both seed oils containing ω-6 (LA) or ω-3 (ALA) were readily available, however, we knew that focusing on either ALA or LA, by themselves, would not provide benefits primarily from the prior history of both Drs. Johanna Budwig and Donald Rudin. Between 1960 both (Budwig) and through 1980 (Rudin) experimented with flax oil, which has a high ALA content (~55%). For years both used flax oil and both recorded significant improvements for disorders such as Schizophrenia, gastrointestinal, drying skin diseases, mucous colitis (spastic colon, irritable bowel syndrome) and others, including cancer. They both reported remarkable healing results.

Rudin, specifically wrote that it could last several months, but was always followed by a complete reversal, requiring stopping the flax oil. Then, several months later, he would try flax oil again on the same patient and it would work again, but only for a while and the on-again off-again cycle would return. One can only imagine their level of frustration. Both were brilliant scientists who had published extensively. Rudin was an MD and a Harvard professor, and Budwig had been nominated for a Nobel Prize seven times. Both had correctly identified ω-3 a-linolenic as the missing nutritional ingredient for innumerable disorders that plagued society. The EFA ratio of flax oil is 1 to 3.5, completely opposite to Yehuda’s 4:1.

They were using too much ALA. If only they had known of Yehuda’s work, the entire history of fatty acids would be rewritten. We know of this first hand since Donald Rudin was on our BodyBio Board of Advisors and shared his experience with us first hand. Unfortunately, he passed away in 2003. Before his death, Dr. Rudin wrote a letter to the editor of the Lancet, which was published, wherein he described the current fish oil ‘Omega 3 Overdose Syndrome.’

**Ongoing Yehuda Research**

After ’93, the Yehuda group continued their research with numerous studies using the SR-3 formula on both animals and humans, here are a few examples: 1994 on epileptic seizures with 84% reduction of seizures, 1996 on Alzheimer’s with improvements in mood, cooperation, appetite, sleep, ability to navigate in the home, and short term memory, 1996 on lowering cholesterol with improvements in fluidity, cognition, and neuro-pharmacological effects, 1997 with improved learning and improved neuronal communication, 1998 with in-depth analysis of learning, neuronal membrane composition and increases in brain essential fatty acid levels, 2000 on lowering cholesterol, stress, and improved learning, 2001 mediation of the nervous, endocrine, and immune systems, 2004 on control of induced anorexia and improved myelination, 2004 on seizure management, 2005 on student Test Anxiety (details below), 2007 on sleep deprivation, REM sleep, and cognitive impairment, 2011 on ADHD, currently poorly handled with drugs (check out “Anatomy of an Epidemic” by Robert Whitaker, 2010, a must read for anyone concerned about ADHD and all psychiatric disorders).

My wife, Dr. Patricia Kane, and I, have spent almost two decades teaching Yehuda’s brilliant work (the PK Protocol) to a growing group of doctors and their patients worldwide, which, even though subjective lacking documented research, have witnessed dramatic improvements for individuals especially with neurological disorders. In reviewing Yehuda’s studies for this article, we selected the 2005 paper on Test Anxiety with students, which epitomizes the uniqueness of the 4:1 ratio. Test anxiety can seriously impair academic performance, and the mere anticipation of a critical examination can hinder the ability to

*These statements have not been evaluated by the Food and Drug Administration. These products are not intended to diagnose, treat, cure or prevent any disease.*
study for it. All of us, at one time or another, have experienced “Test Anxiety”. The anxiety experienced before an exam or an interview, or first standing before an audience, or a first date, or beginning an athletic event before a crowd of onlookers, all can induce apprehension and anxiety. It’s a universal malady; you could call it “butterflies”.

**Test Anxiety 2005**

As head professor of advanced psychology at Bar Ilan University, Israel, Yehuda had ample experience for this disorder. He first secured two trained psychologists who identified 126 male students as test anxiety sufferers. The Bar Ilan University Ethics Committee approved the study. Seventy other students from the same classes who did not suffer test anxiety, served as the control group. The study started one month before the examination. No food intake was allowed 30min before taking the sample. Each subject was instructed to take one capsule which contained 225 mg of pure linoleic acid and pure α-linolenic acid in a ratio of 4:1, twice daily in the morning and evening. Thirty-eight students received placebo (mineral oil) and 88 received the special FA mixture.

There’s no easy way to judge the EFA’s examination outcomes, however, there are a number of characteristics that illuminated their benefits. The subjects reported better appetite, improved mood, better ability to concentrate, less fatigue during the day, better sleep and the ability to organize themselves for the test was much improved. No improvement was observed among the placebo group. The non-anxiety group who also took the treatment likewise showed some improvement in ability to concentrate, less fatigue during day and improved quality of sleep. While test anxiety students showed an elevated morning cortisol level, the PUFA treatment reduced the elevated level to normal. It is interesting to note that the control group also showed a reduction in their cortisol level.

Improving cortisol levels (lowering) with the SR-3 mixture had also been reported earlier (Yehuda et al. 1999, Van Duinen et al. 2004). The Anxiety Study started one month before the examination. Morning salivary cortisol samples were collected at 8:00 AM, while the subjects were still at home. No food intake was allowed 30min before taking the sample. Briefly, samples were collected using cotton swabs chewed for 2 min and inserted into a plastic test tube, cooled and later measured by radio immunoassay. Seventy-eight out of the 88 test anxiety students reported that even after the conclusion of the study they no longer experience a state of anxiety.

Even though the Test Anxiety study demonstrates the importance of correcting body EFAs though diet, there is a subtle characteristic reviewing the results. The improved studying capability occurs without fanfare. There’s no spontaneous improvement, which suggests a subtle changed mental ability. It now becomes the norm. It’s not easy to wrap your mind around the implications of adding the correct EFAs to the diet. Just one teaspoon of 4:1 oil a day. How difficult is that? We readily add 3-4 times that much oil on our salads, which rarely provide the correct EFAs we need. It is generally something like olive oil, which has little beneficial value. What would that do for our youngsters, not just university students, going to school every day? The whole concept is life-changing, and the cost is literally peanuts. At BodyBio we currently use a mixture of sunflower and flax oils that we combine to deliver a 4:1 ratio. Some of our little ones take 5 - 6 tablespoons a day, and request it. Imagine - they request it. What do they know—or what is their brain telling them they need?
**The Basic Fatty Acid Dilemma**

Part of the difficulty of a better understanding of fats and oils stems from the word itself – fat. Some think instantly of excess weight or of someone they knew who was a bit dull “fathead”. The word “fat” has a bad image. In addition the recent media explosion regarding fish oils has managed to distort the entire fatty acid picture. Anyone interested in their health searching Google for the latest is inundated with the marvelous results of fish oil and omega 3 EPA and DHA. However, reviewing the research of brain benefits for fish oil the results are mixed, there are as many negative results as positive (Holness 2004, Arendash 2007, Church 2010, Rockett 2012), even though fish has long been regarded as brain-food.

The sheer volume of information on fish oil and omega 3 is overwhelming. As you would imagine much of the Googled information originates from producers touting their special fish oil. After so much media hype, the inevitable occurred sweeping everyone into taking fish oil. The general philosophy prevailed, “if one is good, 2 or more is better”. I don’t have to tell you that most go for the “MORE”. Yes – fish oils are important for our health, but, careful, too much of any nutrient can harm, remember Budwig and Rudin. At BodyBio we see the over-expression in their RBCFA test results from Hopkins. The over-expression of fish oil has become endemic. Almost everyone seeking to improve their health has taken too much. The RBCFA Report tells it like it is. Too much omega 3 fish oil suppresses the omega 6s. You now have too much 3s and too little 6s, all of which is correctable, if, you know that you have overindulged. Most don’t know. Most never get an RBCFA Report which could tell them. Should you now rush out and get a FA test? The answer is – not necessarily. That’s a medical decision. If you’ve taken more than one a day, our general suggestion is to stop the fish oils and go back to eating fish, or, stop for 3-6 months and then take just 2-4 capsules per week, which will allow the body’s metabolism time to readjust. However, if you are plagued with a difficult health problem an effort to balance your EFAs scientifically is highly recommended, but would require a consultation with your doctor.

Most everyone associates fish oil with the omega 3s, which they are, but – fatty acid technology needs a bit more explanation. To get “the rest of the story” please read the Two EFA Families.

---

**The Two Essential FA Families and their two levels:**

As reported there are two (2) EFA families, omega 6 (ω6) and omega 3 (ω3), with the lower FA level LA and ALA (1st floor) becoming the precursor for the upper FA levels (2nd floor) in both families. The lower ω6 level is linoleic acid (LA), found in most nuts and seeds and high in safflower, sunflower, corn, soybean, *cottonseed, *canola, etc. (*these last two are not recommended, canola is high in erucic acid which is toxic to the membrane, cottonseed is permitted higher pesticides since it is not classed as a food). The 2nd floor ω6s, which all animals can produce initially, however slight, is arachidonic acid (AA), which the media has been attacking for half a century, and which is also totally mistaken. There are also two additional 2nd floor ω6 EFAs, GLA from Primrose oil and DGLA from GLA, both are on the 2nd floor with AA. For this discussion we will disregard GLA and DGLA and confine the 2nd floor omega 6s to AA. The 1st floor ω3 FA is a-linolenic acid (ALA) found in flax, hemp, chia, walnuts, soybeans, canola, etc, which is the precursor for the 2nd floor ω3s, EPA (eicosapentaenoic acid) and DHA (docosapentaenoic acid). Viewing the precursors ALA and LA as living on the 1st floor and AA, EPA and DHA as living on the 2nd, we can begin to unravel the distortion of fish oils and the omega 3s.

Fish oil contains only the 2nd floor EPA and DHA, while eating fish provides all of the membrane FAs that the body needs including ω6 EFAs (Connor 1990). A reverse distortion is quite possible concerning omega 6s. Egg yolk contains a high concentration of AA. Imagine a concentrated capsule of egg yolk with a high AA content, which, I must add, we would welcome for individuals with a low test result of AA. Now picture the media taking off touting “Egg Yolk” and the health benefits of Arachidonic Acid (Payet 2004), which is critical for our health (eggs and animal proteins are a preferred source of AA). However, touting that singular nutrient “Egg Yolk AA”, even though important, would not work any better than it has for fish oil. The end result would be an overdose of AA. Balanced nutrition is the only way to go. The vast majority of the media has been woefully ignorant of the two levels of EFAs in their touting of fish oils, omega 3s, and their tirade against ω6s and inflammation, which, is significantly one sided and beyond the scope of this article*.

---

*These statements have not been evaluated by the Food and Drug Administration. These products are not intended to diagnose, treat, cure or prevent any disease.
**The Large Animal FA Dilemma**

Humans have very limited ability to take the 1st floor EFAs, LA and ALA, and metabolize them up to the 2nd floor EFAs, DGLA, AA, EPA, and DHA (Singh 2005, Chang 2009). Our cellular production for all the vital 2nd floor fatty acids dramatically declines with age (Uauy 2006). All large animals, which we are, lose the ability to maintain adequate production of 2nd floor EFAs, either ω6 or ω3s. Little guys like mice and gerbils, etc., are capable in producing all the AA, EPA and DHA they need, and they do it from LA and ALA. Their metabolism is much higher and their life span much shorter. They can do it – we can’t. So, in a way, for us, all the FAs on the 2nd floor, of necessity, become Essential. We must add them into our diet (which has been our evolutionary history). As a consequence of the metabolic insufficiency, all large animals including the grazing animals, in ratio to their size, have smaller brains and weaker eyesight, except humans and dolphins (Crawford 1989, 2000). All predators get their 2nd floor EFAs – predominantly AA and DHA, from the internal organs and brains of the grass eaters which have accumulated them over their lifetimes. Predators enjoy the higher EFAs at almost every meal, which directly relates to their superior brains and eyesight. Where do we fit into that evolutionary picture (?), certainly not with the grazers.

As discussed, much of Yehuda’s research was with rats. To an extent, using efficient little animals has added to the confusion regarding our evolution. How come we are so smart and endowed with a large brain if we are inefficient in metabolizing the important brain fatty acids that would make us smart? Michael Crawford, Imperial College, London, along with David Marsh, clears up the mystery in ‘The Driving Force’. They hypothesized, that we did not evolve on the plains of Africa, we were more aquatic and lived near oceans or lakes where we had access to shell fish, crustaceans, and fish oils, as we continue to do today with modern cooling technology.

Fatty Acid metabolism is generally not a table-talk discussion, even though it is a part of most meals and a vital detail for our health. The health value of the essential omega 6s does not correlate with the media hype of claiming that they are the sole source of inflammation in the body*, or that fish oil and the omega 3s are the panaceae. However, fatty acid technical manuals cover the subject of fatty acids and membranes quite accurately, showing the beneficial role of the ω6 PUFAs. Also, the newly discovered 4:1 ratio brings the ω3 ALA PUFAs into a clearer focus.

Yehuda laid the foundation in ‘93 with his seminal paper regarding the ratio between the omegas’. His profound 4:1 ratio of omega 6 LA and omega 3 ALA has given us the basic Essential FA formula to enable us to raise fluidity (Yehuda 1996, 2012, Lu XF 2010) of our highly active membranes, which are endowed with that very task. Now, we are better equipped to send the right signals from the brain to run the entire system, and we can do it throughout our lives. In media vernacular, that’s “News”. Think of it – brain function for a lifetime.

Take a walk through any psychiatrist office on the globe today and the mere thought of sending clear intelligent signals simply by changing your diet, takes on a whole new meaning

**Good oils, not-so-good oils and bad oils**

However it evolved, the bad image of FATS is with us, even though fatty acids are vital for every cell of the body and brain. To add to the distortion, the medical media has descended on saturated fats as heart destructive, which it is not, yet reversing a 100 year negative concept is probably impossible; however, we may be able to dent it with facts.

1) Fats and oils come in just 2 varieties, either phospholipids with two fatty acid tails or triglycerides with three FA tails. Phospholipids make up the protective skin of the membranes of our cells, while triglycerides are simply put away for later. Phospholipids are tiny building blocks which automatically assemble into membranes and surround every cell and organelle. They are the beginning of all life on the planet, and they are 70% FAT.

2) Fatty acids do not make you fat, carbs do. Carbohydrates (excess sugar) are converted into the 3 tailed FAs – triglycerides, which are stored for use later, an important asset to have in case we run out of food, which no one does any more, at least not the ones in our neighborhood. A triglyceride is a fat molecule with 3 (tri) fatty acid chains that finds their way around our middle and is the stored fat we regard as "bad", however, on a baby it can be quite pleasant.

3) We generally eat fats at most every meal, even if it’s in a salad with dressing. The EFAs are highly fluid, but the SFAs (saturated FAs) are rigid, they are not fluid. Real butter from a cow is a SFA. Our membranes need the SFAs for substance and form, however, we are able to produce SFAs, they are not essential. Most all seeds and nuts have fluid EFAs that are crushed into oils that go into food manufacturing, most of which are over-processed and become rancid and/or hydrogenated, which covers all supermarket oils on the shelf. The over-processing oils also include processed butter look-a-likes, margarines, butter-type spreads, including your favorite mayonnaise, Hellman’s, Mayo, etc. Vegenaise, in the refrigerated section, is a much better choice for mayonnaise.

The runny, liquid oils (safflower, sunflower, soybean, corn, flax, etc.) contain the healthy EFAs and should be cold pressed and organic for your table oils. Suggest keeping them in the frig. SFAs are solid in the body (butter, lard, coconut (less so)) but are still vital for our health. They are plentiful in animal foods (beef, eggs, chicken, fish etc.). We need both, SFAs and EFAs.

4) What we generally do not need are MUFAs, mono-unsaturated FAs. They are the omega 9s, predominantly olive oil. All plants and animals are able to produce ω9 MUFA, which provides some fluidity in the body, but, in reality, ω9s are inconsequential. We don’t need them which includes olive oil. It will not harm you if you use it, but will not be missed if you avoid it. Olive oil has an image of health – and respectability. Placing a bottle of olive oil on the table makes the chef look good, though, in essence, what olive oil actually does is provide an oil with less value when there are really better choices. Olive oil has a nice image, but the EFAs are where the action is for body function, especially the brain. If the EFAs are not on the table where you can eat them, you’re thinking machinery will just make do without – not a good idea. Put the olive oil back on the kitchen counter, you can heat it without concern so use it for cooking.

5) Coconut oil – now there’s a winner. Coconut oil is fluid in the body, but it’s solid in any spot on the globe that happens to be cool. Coconut is a medium chain fat which is rapidly burned for energy in the mitochondria, which loves those shorter FA chains. They are more easily handled and absorbed. There is no better oil for French fries than coconut. In fact that should be a stable food in every house. Try it, their yummy.

6) The bad guys on the block are the fast food fries, they’re everywhere in most every fast food chain. They all use vegetable oils, the EFAs, which should not be heated because of their multiple double bonds. They quickly become rancid, and are turned into hydrogenated fats, trans fats, the worse kind for our health. The Fast Food emporiums all heat the EFA oils over and over again, and, for the most part, this same disregard for oils goes on in every restaurant on the globe making it very difficult to dine out and make good food choices.

7) Over the last century and continuing today, we have been plagued with disinformation about Fats and Oils and have been the recipients of bad manufacturing processes originating from the oil and food producers with mechanical hydrogenation of the EFAs. This is currently changing and becoming less in the Western countries with the increased knowledge of trans fats. However, this ugly mechanical distortion of oils has yet to reach most of the world.

*These statements have not been evaluated by the Food and Drug Administration. These products are not intended to diagnose, treat, cure or prevent any disease.*