

ANTI-OXIDANTS, OMEGA-3 FATTY ACIDS, AND COGNITIVE DECLINE WITH AGING

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Mental capabilities have become an increasingly valuable commodity, especially in recent years with the bursting of the dot-com bubble, the general economic downturn, and the advent of competition for jobs with rising countries such as China and India. The focus on increasing and retaining cognitive abilities such as memory and executive functions has risen over the past couple of years. In the year 2006 the release and popularity

big corporate stores alike. Children in homes across the US are encouraged to eat foods rich in these compounds. But is there a real correlation between these foods and mental capabilities? As we shall see, research has shown both sides of the coin. While the consumption of anti-oxidants has been commonly shown to increase cognitive abilities, there has also been research illustrating that consumption of anti-oxidants has a minimal effect on the aged brain. Similarly polar findings can easily be found for the prevention of cognitive decline and Omega-3 Fatty Acids.

Studies showing a positive correlation between cognitive impairment and oxidative stress have been replicated many times over and the correlation between the two is relatively trusted. The human brain is placed under as much oxidative stress as the rest of the body, but has been found to be more sensitive to damage from the free radicals that result from oxidative stress. (Butterfield et al., 2005) The body incurs oxidative stress simply by carrying out normal functions like breathing. Oxidation has the harmful effect of producing free radicals, which are highly reactive molecules that react readily with lipids, proteins, and DNA causing them to become radicals, and altering their natural



Figure 1. A list of the most common anti-oxidant rich foods. Graphic by Tanu Ashok Patel

of the book, IQ and Global Inequality by Richard Lynn and Tatu Vanhanen captured precisely this fascination with cognitive abilities. For some, this interest has meant adopting the "tiger mom" tactics of Yale law professor Amy Chua (Chua, 2011), while for others, this has meant turning to less rigorous tactics, such as the consumption of herbal concoctions involving fish oils and anti-oxidants simply because they've heard of the benefits these foods have on cognition, an idea that has become urban lore of late. The popularity of supposedly mind-sharpening anti-oxidants and fish oils has only increased over the years, and the foods containing these ingredients continue to fly off the shelves of small herbal shops and

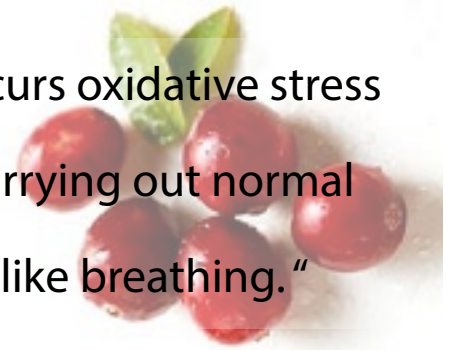


role in cells. For example, DNA that has reacted with a radical might undergo a molecular process that could cause shortening of the telomere- which is a portion of DNA that has been found to be highly linked to aging. (Appleton et al., 2004; Diet of Walnuts, Blueberries Improves Cognition; May Help Maintain Brain Function, 2007) Anti-oxidants alleviate this burden by reacting with these free radicals before they can react with vital proteins, lipids, and nucleic acids. Part of the popularity of anti-oxidants might be because they are readily available in many every-day foods. Phenolic anti-oxidants are one of many types of anti-oxidants, and can be found in tomatoes, berries (blueberries, strawberries, raspberries), wines, grapefruit and black and green teas among other foods and drinks. (Wu et al., 2004)

While it might be easy to predict a connection between anti-oxidants and their role in preventing oxidative stress, In 2005, Lau et al. completed a controlled study at the Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University, addressing whether the correlation between anti-oxidants and decreased cognitive decline was indeed a significant causal relationship. They fed 6 to 15 month old rats either a control diet or a diet rich in Vitamin E, strawberries, and

rich diet would reverse cognitive decline that had already begun to occur. What they found, however, was that no such improvement took place. However, they did find that these rats had improved balance and coordination.

“The body incurs oxidative stress simply by carrying out normal functions like breathing.”



These results suggest that while a diet rich in anti-oxidants can be beneficial in the cognitive decline associated with aging, it may not be possible to reverse cognitive decline with only the increased consumption of anti-oxidants once the decline has already begun. Additionally, the fact that the rats in this study were fed high amounts of anti-oxidants raises question about whether it is feasible for humans to eat enough anti-oxidants to show the same effects. In other words, while there appears to be a positive correlation with cognitive abilities and anti-oxidant consumption, additional research is needed to determine whether or not these effects are significant at normal anti-oxidant consumption levels.

Cognitive decline is a key physiological effect of healthy aging as well as Alzheimer’s disease (AD) and a number of other neurodegenerative diseases. AD patients in particular typically have lower than normal levels of acetylcholine, a neurotransmitter that has been negatively correlated with diseases such as Alzheimer’s disease, in their brain. This may be due to the presence of acetylcholinesterase, an enzyme that breaks down acetylcholine. Acetylcholinesterase creates an environment that allows for the formation of Beta Amyloid plaques. Beta Amyloid, a peptide, is clinically used as an indicator for Alzheimer’s disease. (Diet of Walnuts, Blueberries Improves Cognition; May Help Maintain Brain Function November, 2007) Essentially, when acetylcholine levels in the brain are low, beta-Amyloid plaques are able to form. Although the presence of Beta-Amyloid plaques has been heavily correlated with Alzheimer’s disease, it is important to note that the plaques have yet to be implicated for playing a role in causing the disease. To this day, the role of Beta Amyloid is under question, and is being avidly pursued by a number of research groups.

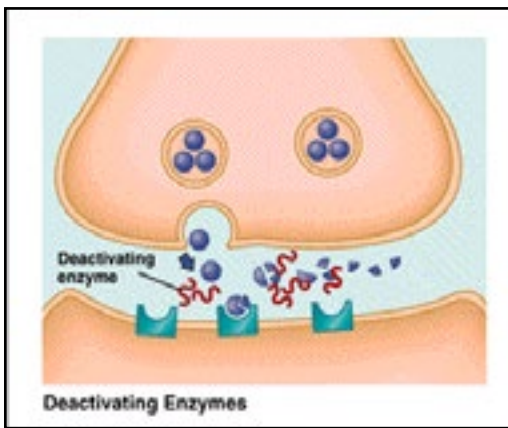
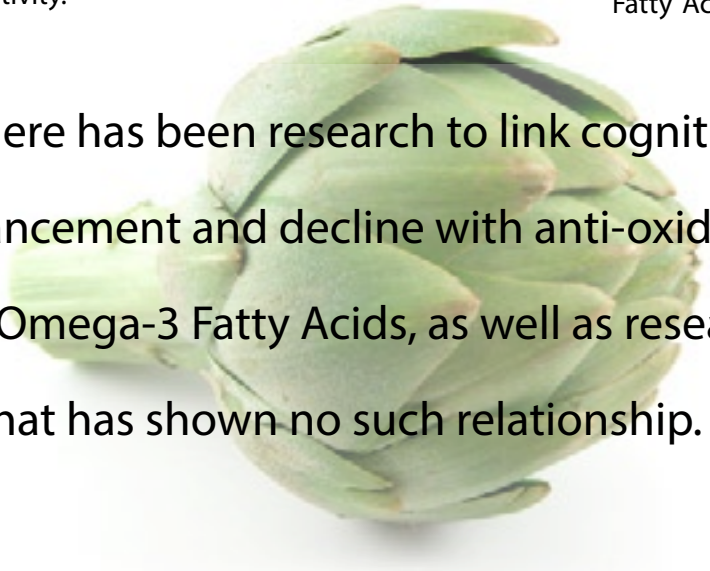


Figure 2. Acetylcholinesterase prevents normal function of acetylcholine by deactivating the neurotransmitter as it is spreading from neuron to neuron.

spinach, all of which are foods rich in anti-oxidants. Over time, they found that the rats on the Vitamin E rich diet had less of a risk of developing age-related cognitive disabilities. To study this phenomenon further, they gave 19 month old rats a diet of strawberry, blueberry, and spinach extracts to test whether or not an anti-oxidant

The logical step then might seem to increase the levels of acetylcholine in the brain. Omega-3 Fatty docosahexaenoic acid (DHA) has been shown to increase to do just that (Anti-Alzheimer's Mechanism In Omega-3 Fatty Acids Found, December 2007) not only in rats, but in nerve cells in culture and in human subjects. The Zutphen Elderly Study (van Gelder, Tijhuis, Kalmijn, & Kromhout, 2007) is only one such study that echoes those results. This paper, published in the American Journal of Clinical Nutrition, describes a longitudinal study following 210 elderly men from the town of Zutphen in the Netherlands over the course of five years. Zutphen is a small fishing village that was chosen for the ease with which subjects can access Omega-3-Fatty acids from fish, as well as its proximity to the researchers, its small size, and relative lack of immigration and emigration. Dieticians measured the amount of Omega-3 Fatty Acid intake from fish, nuts, meat, and certain herbs in these 210 men at various intervals of time over the course of the five years. The men were additionally tested on their cognitive abilities at various points during the study. The researchers came to the general consensus these researchers came up with was that the men who had more Omega-3 Fatty Acids in their bodies showed the least cognitive decline, even after taking into account the different lifestyle choices that could affect the amount of oxidative stress in the body such as alcohol consumption, smoking status, and physical activity.

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At the same time, some research has shown that taking Omega-3 Fatty Acid rich fish oil pills may not affect cognitive abilities during fetal development. The studies cited follow mothers that ingested these pills during pregnancy, as well as mothers that did not. The study then tested these children for cognitive development when they were six years of age, only to find that the two



Figure 3. The most common foods rich in Omega-3 Fatty Acids

groups of children did not show a statistically significant difference. (Escolano-Margarit, et al., 2011)

As mentioned above, the research in this field is highly varied. There has been research to link cognitive enhancement and decline with anti-oxidants and Omega-3 Fatty Acids, as well as research that has shown no such relationship. Perhaps the results of these studies are influenced by placebo effects, or by other human life-style factors. At this time, the results from studies done on mice might be the closest we can get to truly trust-worthy results, simply because the studies on mice could be completely controlled in a way that studies on humans cannot be. In those studies, there is a direct link between cognitive decline and accumulation of acetylcholinesterase and free radicals. However, we have to ask ourselves: is it safe to extrapolate rat data and apply it to humans? Only time, and increasingly involved research methods will be able to tell.

REFERENCES

Appleton, C.; Deary, I.; et al. (2004). "Cognitive reserve and the neurobiology of cognitive aging". Ageing Research Reviews 3 (4): 369-382.
 Butterfield, A.; Ding, Q.; et al. (2005). "Evidence of increase oxidative damage in subjects with mild cognitive

- impairment". *Neurology* 64 (7): 1152–1156.
- Chua, A. (2011). Home. Retrieved Nov 08, 2011, from Battle Hymn of the Tiger Mother: <http://amychua.com/>
- Cole, G. M., Lim, G. P., Yang, F., Teter, B., Begum, A., Ma, Q., et al. (2005). Prevention of Alzheimer's disease: Omega-3 fatty acid and phenolic anti-oxidant interventions. *Neurobiology of Aging* , 133-136.
- Cutler, R. G. (1991). Antioxidants and aging. *American Journal of Clinical Nutrition* , 3735-3795.
- Diet of Walnuts, Blueberries Improves Cognition; May Help Maintain Brain Function. (2007, November 7). Retrieved September 29, 2011, from Science Daily: <http://www.sciencedaily.com/releases/2007/11/071106122843.htm>
- Escolano-Margarit, V. M., Ramos, R., Beyer, J., Csabi, G., Parilla-Roure, M., Cruz, F., et al. (2011). Prenatal DHA Status and Neurological Outcome in Children at Age 5.5 Years are Positively Associated. *The Journal of Clinical Nutrition* , 1216-1223.
- Fotuhi, M., Mohassel, P., & Yaffe, K. (2009). Fish consumption, long-chain omega-3 fatty acids and risk of cognitive decline or Alzheimer disease: a complex association. *Nature Clinical Practice Neurology* , 140-152.
- Freeman M.D, M. P., Hibbeln M.D, J. R., Wisner M.D, M. K., Davis M.D, J. M., Mischoulon M.D, P. D., Peet M.B, F. M., et al. (2006). Omega-3 Fatty Acids: Evidence Basis for Treatment and Future Research in Psychiatry. *Journal of Clinical Psychiatry* , 1954-1967.
- Gilgun-Sherki, Y., Melamed, E., & Offen, D. (2001). Oxidative stress induced-neurodegenerative diseases: the need for antioxidants that penetrate the blood brain barrier. *Neuropharmacology* , 959-975.
- Joseph, J. A., Shukitt-Hale, B., & Lau, F. C. (2005). The beneficial effects of fruit polyphenols on brain aging. *Neurobiology of Aging* , 128-132.
- Peng, N., Clark, J. T., Prasain, J., Kim, H., Wyss, J. M., & White, C. R. (2005). Antihypertensive and cognitive effects of grape polyphenols in estrogen-depleted, female, spontaneously hypertensive rats. *American Journal of Physiology* , 771-775.
- van Gelder, B. M., Tijhuis, M., Kalmijn, S., & Kromhout, D. (2007). Fish consumption, n-3 fatty acids, and subsequent 5-y cognitive decline in elderly men: the Zutphen Elderly Study. *The American Journal of Clinical Nutrition* , 1142-1147.
- Wu X, Beecher GR, Holden JM, Haytowitz DB, Gebhardt SE, Prior RL (2004). "Lipophilic and hydrophilic anti-oxidant capacities of common foods in the United States". *J. Agric. Food Chem.* 52 (12): 4026-37.

