Omega-3 and its potential to improve cognitive function

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Programme

• Introduction to marine omega 3 fatty acids
• DHA as a building block in the developing brain
• EPA and depression
• EU health and nutrient claims for EPA and DHA
• The role of DHA for brain maintenance
Introduction to Marine omega 3 fatty acids
YOUR BODY NEEDS OMEGA-3

EPA

DHA
The Distinct Benefits of Omega-3s

- Cognitive development & function
- Visual development & function
- Inflammation
- Cardiovascular function
- Supports EFA status

DHA   EPA   ALA
ESTIMATED AVERAGE DAILY INTAKES
EPA and DHA

Zone of Consensus for Nutritional Intake Recommendations

mg/day
**Sources of DHA/EPA**

**Dietary Sources of DHA and EPA:**
- Fatty fish including anchovies, salmon, herring, mackerel, tuna and halibut
- Fish oil
- Algal oil
- Organ meat such as liver, particularly in game.
- Small amounts are found in poultry and egg yolks

**Dietary Sources of alpha-linolenic acid, (ALA):**
- Walnuts and linseed oil **are not** direct sources of DHA
- Dietary ALA does not produce sufficient DHA
  - The human body can convert ALA to DHA, but the process is **inefficient and variable**
- No known independent benefits on brain or eye development and function
Omega-3 & Omega-6 METABOLISM + HEALTH BENEFITS

Omega-6 Vegetable Oils

- LA
- GLA
- ARA

Omega-3 Green Vegetables

- ALA 18:3
- SDA 18:4
- EPA 20:5
- DHA 22:6

Skin Health

Inflammation

EPA+DHA: Heart Health, Neurological, Others

Brain Health Eye Health

Infant Brain Development

Inefficient conversion in humans
IMPORTANT TO ‘RE-BALANCE’

Hunter/Gatherer  Agriculture

initial industrialized food system = complete imbalance

1900

1970 completely industrialized food system
DHA is the only Omega-3 to Readily Accumulate in Important Neural Tissues

Arterburn et al., AJCN 2006, 83:1467S-76S.
DHA Distribution in the Brain

- DHA represents 10 to 15% of brain total fatty acids
  - DHA represents 97% of brain omega-3 fatty acids,
- DHA preferentially represented in cell membranes:
  1. executive function
  2. working memory
     - sustained attention,
     - problem solving
  3. spatial learning
  4. declarative memory formation (ability to recall facts and events)
The impact of malnutrition on the brain

Evidence of Effects of Malnutrition

Brain neurons in normal 3-yr old

Brain neurons in malnourished 3-yr old
How does DHA work in the brain

- Facilitates electrical transmission between neurones
- Source of essential brain messenger and anti-inflammatory molecules (e.g. resolvens, neuroprotectin D1)

Current theories:

- The “almost infinite” possible conformations of DHA produces constant movement that is imparted to neural membranes
- The DHA molecule transmits electrons along its length and acts a semi-conductor (Crawford, 2008)
- Preserves telomere length of DNA (Farzaneh-Far, JAMA 2010)
- Reduces effects of free-radical damage in frontal cortex cells of the brain.
DHA supports brain cell growth

Cerebral cortex neurons exposed to DHA in cell culture extend branches and make connections much like they do during memory and developmental processes. (Unpublished Martek data, details available on request)
The DHA Molecule has a unique Pi cloud

(source: Crawford et al 2008, Fisheries for global welfare and Environment, 5th World Fisheries Congress pp57-76, published by Terrapub)
DHA n-3 in a Lipid Bilayer - The Movie

Feller & Gawrisch, Curr. Opinion Struct. Biol. 15, 416, 2005
DHA as a building block in the developing brain
DHA in Infant brain development

• DHA has **convincing** benefits for brain (and visual) development in infants (FAO/WHO 2008)
• During gestation, DHA is preferentially transferred across the placenta to the developing foetus.
• The presence of DHA in breast milk is often cited as a possible reason why breast fed babies have superior cognitive function over infants fed with formula NOT supplemented with DHA (Laurentzen et al., Prog Lipid Res (2001) 40: 1-94)
From midgestation on, there is rapid synaptogenesis & myelination (50x)

Huttenlocher & deCourten, Human Neurobiol 1987
Maternal omega-3 status determines infant status

Infant Plasma Phospholipid Omega-3 (wt %)

Maternal Plasma Phospholipid Omega-3 (wt %)

$r = 0.74$

$p = 0.002$

Al et al, Early Human Develop 1990; 24:239-48
POSTNATAL DEVELOPMENT - DENDRITIC TREE

Birth  15 Months  2 Years

Dobbing J, Early Human Devel 3-79-83, 1979
Lassek W & Gaulin S., 2011
“Sex differences in the relationship of dietary fatty acids to cognitive measures in American children”

• Premise: As human females must provide DHA for the growth of the unusually brains of their offspring from maternal fat stored during childhood, their need for DHA is much greater than males.
• Cohort of 4000 children from US Third National Health and Nutrition Examination Survey (NHANES III) aged 6 - 16 years.
• Significant positive correlation of Ω3 intake to improved cognitive test, A corresponding negative correlation was observed with Ω6.
• In female children, positive effect of Ω3 twice as strong as in males
• “It seems possible that the high Ω6:Ω3 ratio in the American diet might contribute to the low ranking of American children in International Testing”
The DHA (Docosahexaenoic Acid) Oxford Learning And Behaviour (DOLAB) Study
DHA activates the frontal cortex of the brain in boys

Docosahexaenoic acid-rich fish oil modulates the cerebral hemodynamic response to cognitive tasks in healthy young adults\textsuperscript{☆,☆☆}

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EPA for infants


• New mothers on Western diets often produce milk considerably lower in EPA than is optimal (Basant, Puri et al, 2008, in Wild-type Food in Health Promotion and Disease Prevention p115-120).
Meta-Analysis of Trials of Omega-3 Fatty Acids in Depression

Best-case analysis;
only 1-g/day doses were included

- Freeman et al, J, Clin Psych., 67:00, 2006
EPA/DHA

- Almost all our marine oils contain both EPA and DHA. Both are important biologically and work together synergistically to improve human health.

- Usually the benefits of Marine Omega 3’s are lumped together - BUT in fact EPA and DHA are very different chemicals that behave in the human body in different ways.

- EPA provides health benefits on its own AND increases the efficacy of DHA.
EPA for Cell Maintenance

• EPA protects the brain and central nervous system
• EPA protects the heart and cardiovascular system
• EPA regulates immunity response
• EPA fights disease by controlling inflammation
• EPA is found in every cell in the body
• EPA needs to be continually replenished. (It is not stored in significant quantities)
• EPA helps maintain health throughout life.
Some key references for EPA and Depression

Sublette et al looked at 15 systematically selected trials in people with major depression disorder or suffering a major depressive episode in the context of bipolar disorder, they reported greater efficacy in individuals with major depressive disorder with supplements containing at least 60% EPA relative to DHA. They did not see beneficial results from DHA only. “Meta-analysis of the effects EPA in clinical trials in depression”. J Clin Psychiatry 2011;72:1577-1584

Low fish consumption, high vegetable oil use was associated with increased risk of depression in Northern Finland. Tanskananen, Hibbeln et al Arch Gen Psychiatry 2001

Beneficial effects of Omega-3 treatment of childhood depression were shown in a DB RCT with an age range= 8 to 12.5 years, treated for 16 weeks with a monotherapy of 400 mg/d EPA + 200 mg/d DHA against placebo. Nemets et al Am J Psychiatry. 2006 Jun;163(6):1098-100

In the large Australian DOMINO cohort, The use of DHA-rich fish oil capsule supplementation during pregnancy did not result in lower levels of postpartum depression in mothers Makrides M., JAMA. 2010;304(15):1675-1683
EU Health and Nutrient Claims for DHA and EPA
EU Nutrient Omega 3 Content Claims

“Source of Omega-3 fatty acids”
• Food contains at least 40 mg DHA and EPA per 100 g and per 100 kcal.

“High in Omega-3 fatty acids”
• Food contains at least 80 mg DHA and EPA per 100 g and per 100 kcal.
Authorised EU Article 13.1 Health Claims


- DHA Contributes to the maintenance of normal brain function (250 mg/d).
- DHA Contributes to the maintenance of normal vision (250 mg/d).
- DHA + EPA Contributes to the maintenance of normal function of the heart (250 mg/d).


- DHA + EPA Contribute to the maintenance of normal blood pressure (3 g/d).
- DHA + EPA Contributes to the maintenance of normal triglyceride concentrations (2 g/d).
- DHA Contributes to the maintenance of normal blood triglyceride levels (2 g/d).
“DHA intake contributes to the normal visual development of infants up to 12 months of age“

“DHA maternal intake contributes to the normal development of the eye of the foetus and breastfed infants”

“DHA maternal intake contributes to the normal brain development of the foetus and breastfed infants”
New EFSA opinion - October 2014

- Scientific opinion on the substantiation of a health claim related to DHA and contribution to normal brain development pursuant to Article 14 of Regulation (EC) No. 1924/2006

- EFSA NDA Panel, EFSA Journal 12(10):3040

- Suggests the wording “DHA contributes to normal brain development with the conditions of use of consumption of 100mg /day DHA for children under 2 years, and 250 mg/day for children aged 2-18 years.

- This opinion now moves to the European Commission for consideration as new legislation.
The role of DHA for maintenance of Brain Health
DHA: Recent Advances Cognitive Health

- Muldoon et al 2010. In a sample of 280 middle aged adults (35-54 yrs) Positive, linear association were observed for improvements of non-verbal reasoning, mental flexibility, working memory and vocabulary for DHA supplementation only. No effects were observed for ALA or EPA. J Nutr 2010 doi: 10.3945/jn.109.119578
Proposed Neuroprotective Properties of DHA

Childrens supplement from South Africa

Vital Kids Study Power Supplement for Children has been formulated to support the needs of highly active children, both mentally and physically.

Packed with omega-3 oils, along with amino acids, vitamins and minerals, it provides important ingredients for a healthy nervous system.

Product from South Africa retailing in 120 capsules.
Commercial development / key brands

- DHA and GABA fortified drinks and diary products in Japan
- DHA/omega 3 fortified foods in USA
- DHA in some specific dietetic foods in EU, notably France and Spain

Key brands:
- Minute Maid Enhanced Pomegranate and Blueberry (Coca-Cola)
- Nutrioli DHA (Ragasa)
- Jones GABA (Jones Soda)
- Gerblé Barre Omega 3 (Nutrition et Santé)
- Kaiku Emmi Actif Memory (Iparlat)
Nutrioli - Cooking oil with DHA from Mexico

Soy is Nutritious
Thank you!

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