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John Stein,
Magdalen College,
Oxford University



Fish omega-3s & attention

'Invention of agriculture -the biggest mistake ever made by the human race' - *Jared Diamond*

Supported by The Dyslexia Research Trust (www.dyslexic.org.uk), Dyers & Colourists, Esmee Fairbairn, Garfield Weston and Wellcome Trusts, BBC Children in Need



Cod Liver Oil Queue, 1944

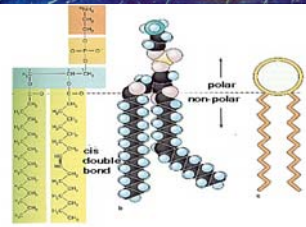
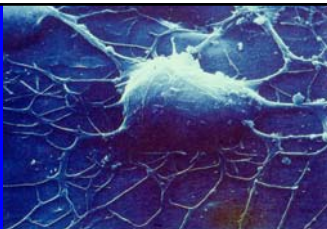


'Most Britons were better fed in 1943 than in 1983' *Dr Hugh Sinclair, Magdalen College, Oxford*

- 20% of the brain consists of omega-3, mainly DHA
- Essential for flexible membranes – rapid neural responses
- Modern diet very deficient in omega-3 unsaturated fats
- Too much omega-6
- Aged 28, he persuaded the WWII government to provide free cod liver oil and orange juice to all pregnant mothers and young children

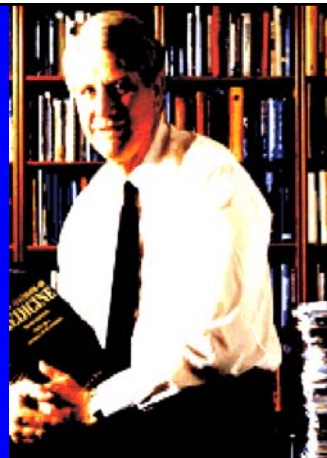


Omega-3s protect neuronal function - 30% of the membrane enclosing this nerve cell consists of long chain omega 3 fatty acid (DHA); improve neuronal function because very flexible



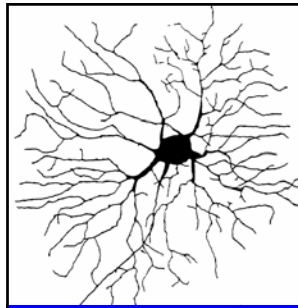
David Horrobin 1939-2003

- Tutored by Hugh Sinclair
- Helped discover how EPA is converted into eicosanoids: thromboxanes, prostaglandins (3 series), leucotrienes (5 series), resolvins
- These are all anti inflammatory and anti stress: IL1 ↓, TNF ↓, cortisol ↓, pain ↓



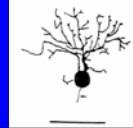
Fabulous Fish!

- By increasing membrane flexibility, speed up neuronal Na, K, NMDA, GABA_A currents; ie accelerate neuronal responses
- Thus improve magnocellular timing functions
- Increase neurogenesis; decrease apoptosis
- Increase neurite outgrowth (syntaxin) and synapse formation
- Hence improve memory (Alzheimer's)
- Strengthen hemispheric lateralisation,
- Protect against inflammation
- Reduce pain transmission (TRPV1 receptors)
- Prevent accumulation of insoluble amyloid precursor protein (Alzheimer's)



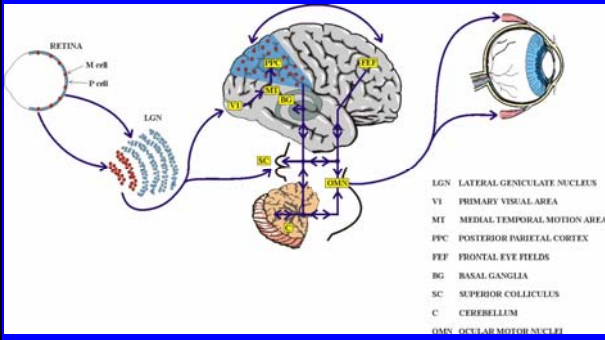
Magnocellular Neurones

Some nerve cells are much larger than others (**magnocellular**) rapid responses for timing events: high sensitivity to motion, flicker; control **attention** and eye movements, very vulnerable to omega-3 deficiency



Most nerve cells are smaller (**parvocellular**): for static responses eg colour, fine detail

Visual magnocellular system directs visual attention & eye movements



Magnocellular Neurones

- A system of large neurones specialised for temporal processing – tracking changes in light, sound, position etc.
- Large, rapid signalling, fast conduction
- All express same surface antigen, CAT 301
- Found throughout the brain: visual, auditory, skin, muscle proprioceptors, cerebral cortex, hippocampus, cerebellum, brainstem
- High dynamic sensitivity requires high membrane flexibility provided by local environment of essential fatty acids, particularly **omega 3s**, found in fish oils
- Hence very vulnerable to omega-3 deficiency
- Doubly vulnerable because impaired development in prematurity, foetal alcohol, developmental dyslexia, dyspraxia, dysphasia, ADHD, ASD, Williams, schizophrenia, depression

Children's attention

Abnormal development of magnocellular neurones probably compromises control of attention

Automatically focussing attention is essential for:

- sequencing sounds for speaking
- sequencing voice sounds for understanding speech
- sequencing letters visually for reading
- sequencing skilled movements
- detecting emotional expression (tone of voice, face, gesture) for social communication

Impairment leads to neurodevelopmental problems:

- Specific language impairment (developmental dysphasia)
- Developmental dyslexia
- Developmental dyspraxia
- Attention hyperactivity (ADHD)
- Asberger's, autism
- Schizophrenia
- Depression
- Antisocial behaviour

Small randomised control trials have shown Omega 3 supplements can improve:

Developmental dyslexia
 Developmental dyspraxia
 Attention hyperactivity (ADHD)
 Asberger's, autism
 Schizophrenia
 Depression
 Antisocial behaviour

Larger trials needed

Conclusions

- Focussing of auditory, visual, motor & social attention requires accurate *temporal* sequencing, mediated by *magnocellular* neuronal systems in the brain
- Magnocellular neurones are particularly vulnerable to poor diet, particularly omega-3 deficiency
- This is why omega-3 supplements have been shown to improve attention, concentration, memory, mood, impulsivity and social behaviour

Policy

- Fund larger studies, as a 'public good', to prove these benefits in at risk groups
- Investigate whether fortifying staple foods with omega-3s would be justified