“An Ancient Nutrient for the Modern Human Brain”

# Implicación de los ácidos grasos Omega-3 y del DHA en el neurodesarrollo

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*Abordaje Multidisciplinar de los Trastornos del Neurodesarrollo en la Infancia (XII)*

*CURSO DE FORMACIÓN CONTINUADA*

UNIVERSITAT DE BARCELONA

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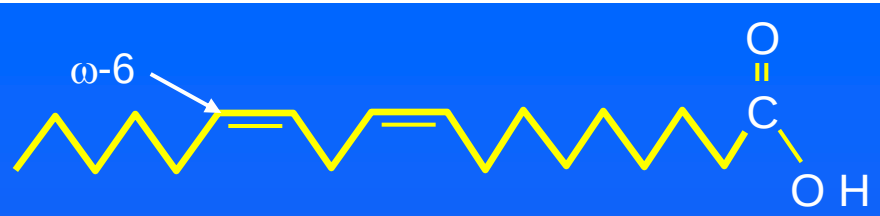
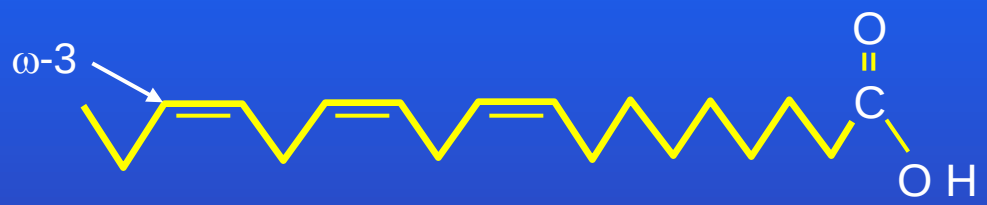
# Ácidos Grasos Omega-3

Ácido Linoléico (LA)
(18:2, ω-6)

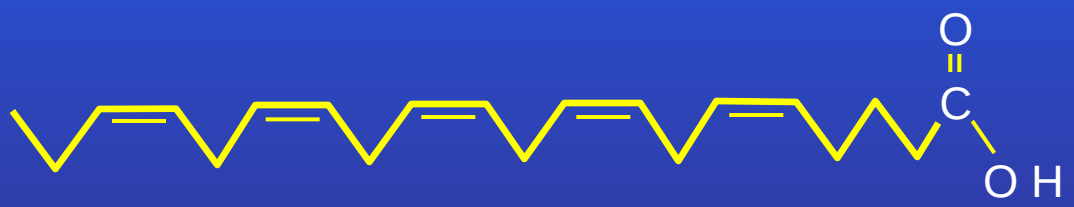



Ácido Araquidónico (ARA)
(20:4, ω-6)


Ácido α-Linolénico (ALA)
(18:3, ω-3)

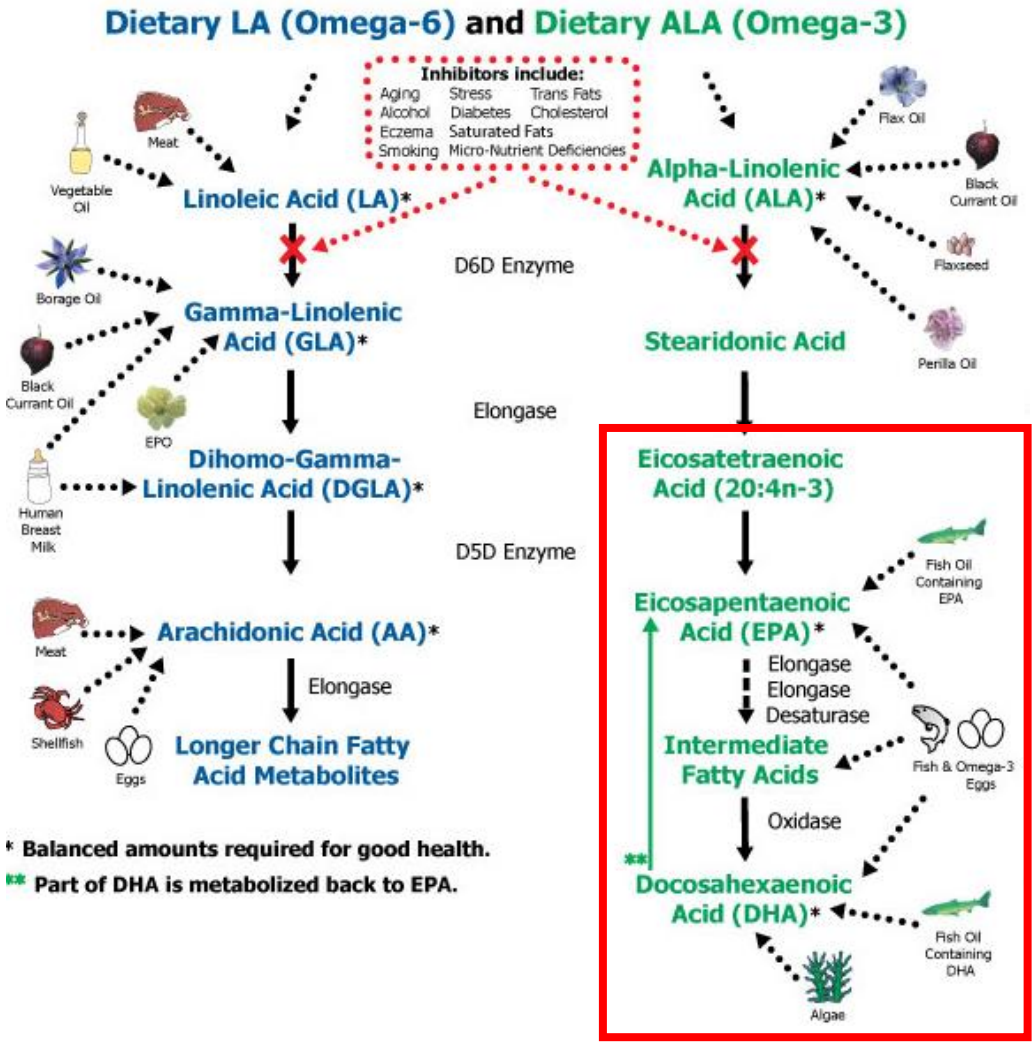



Ácido Eicosapentaenoico (EPA)
(20:5, ω-3)




Ácido Docosahexaenoico (DHA)
(22:6, ω-3)

# Alimentación y Síntesis Endógena




**ALA (18:3n-3)**

↓ ☹

**Stearidonic Acid (18:4n-3)**

↓ 😐

**20:4n-3**

↓ 😐

⇑⇑ **EPA (20:5n-3)**

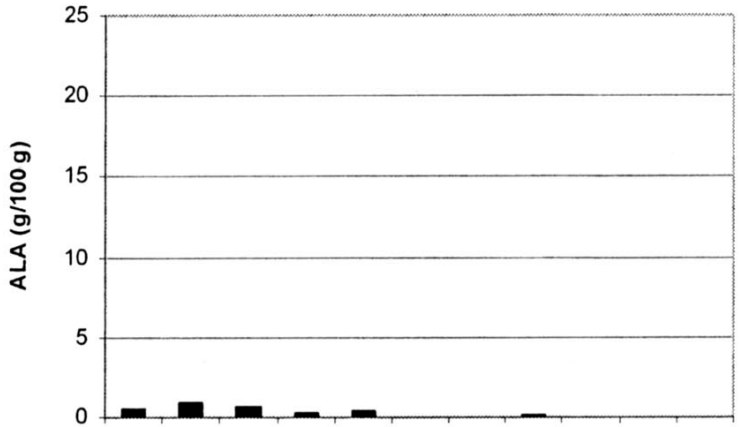
↓ 😐

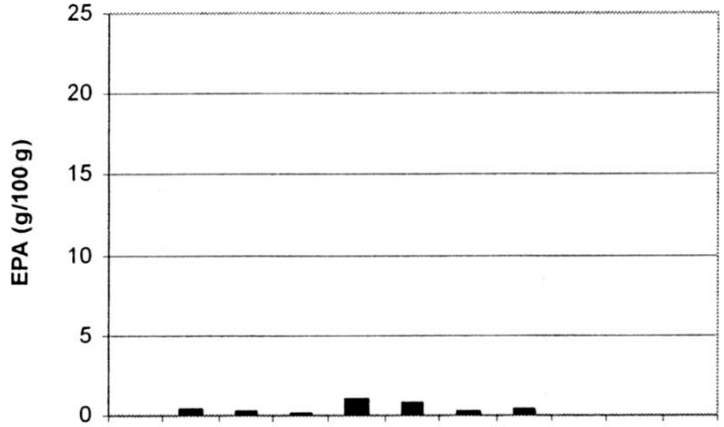
⇑ **DPA (22:5n-3)**

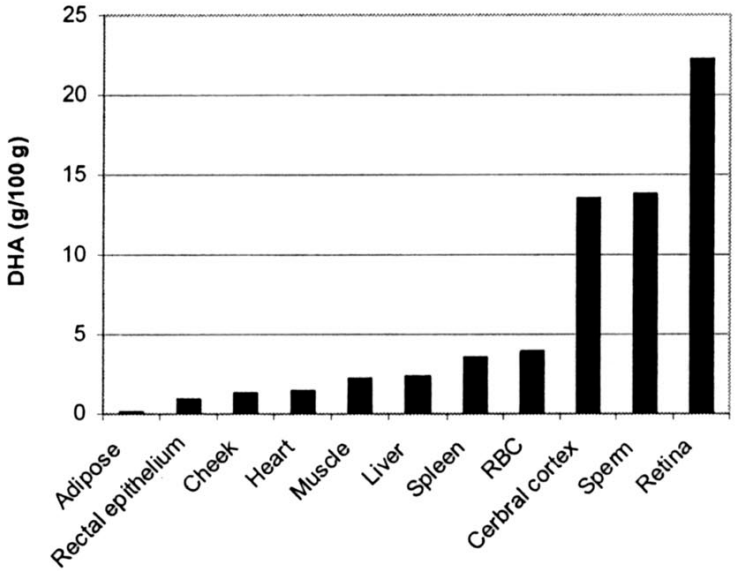
↓ ☹

**DHA (22:6n-3)**

# Ácidos Grasos Omega-3 en el Humano



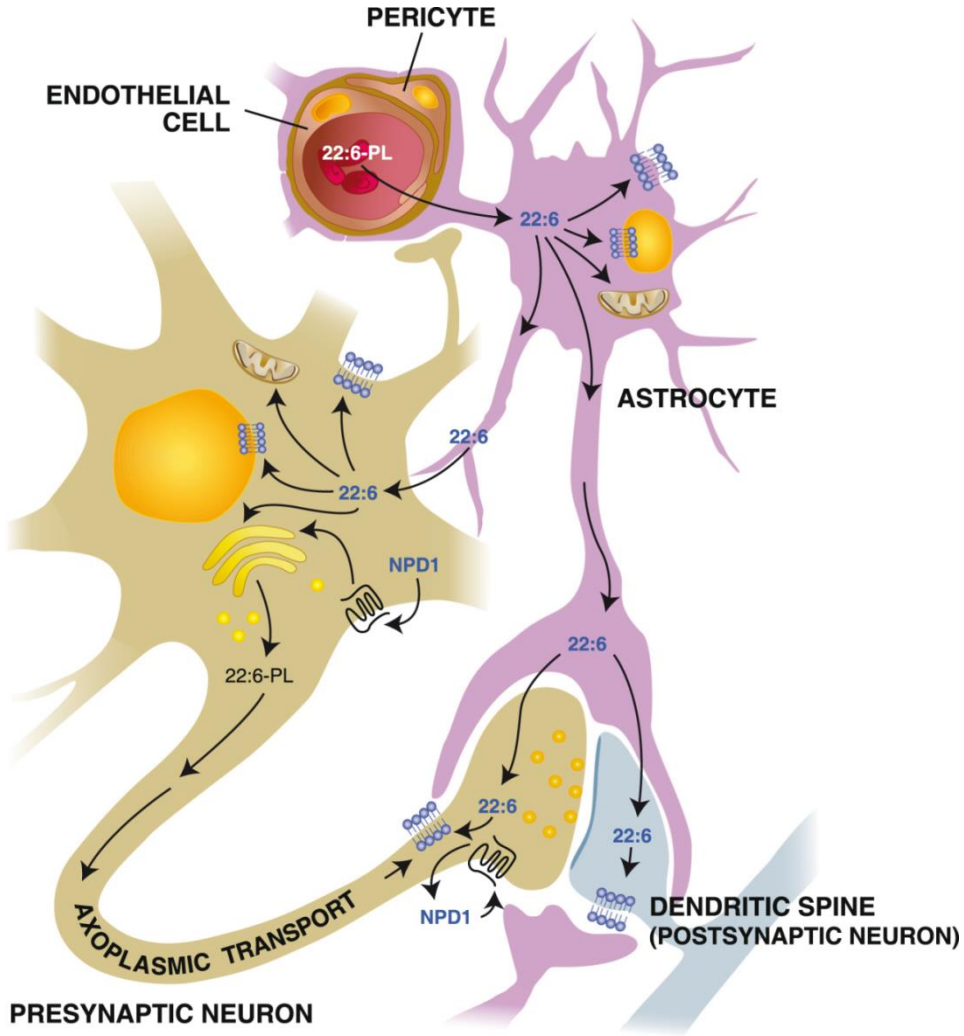




*Estudio transversal del contenido en ácidos grasos en tejidos de adultos de Estados Unidos, Canadá, Australia y Europa.*

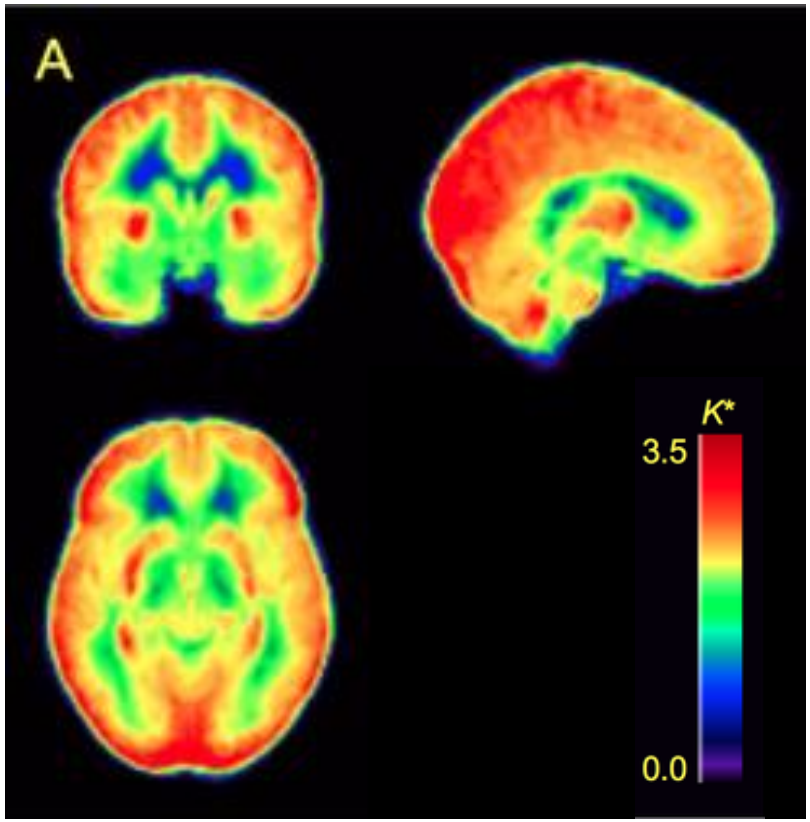
- ❑ **DHA is a major structural lipid in brain tissue and the central nervous system (40% of PUFAs).**
- ❑ **DHA is an essential constituent of brain tissues throughout life.**
- ❑ **Maintenance of a high DHA concentration in brain is essential for proper neuronal function, to influence cell membrane fluidity, enzyme activity, ion channels, and neuroreceptors and their signaling.**
- ❑ **The beneficial effects of DHA extend beyond promoting optimal neuron function and reducing inflammation.**
- ❑ **Recent studies have associated deficits in DHA abundance with cognitive decline during aging and in neurodegenerative disease.**

**Am J Clin Nutr 2006;83(suppl):1467S–1476S.**

# DHA en el SNC



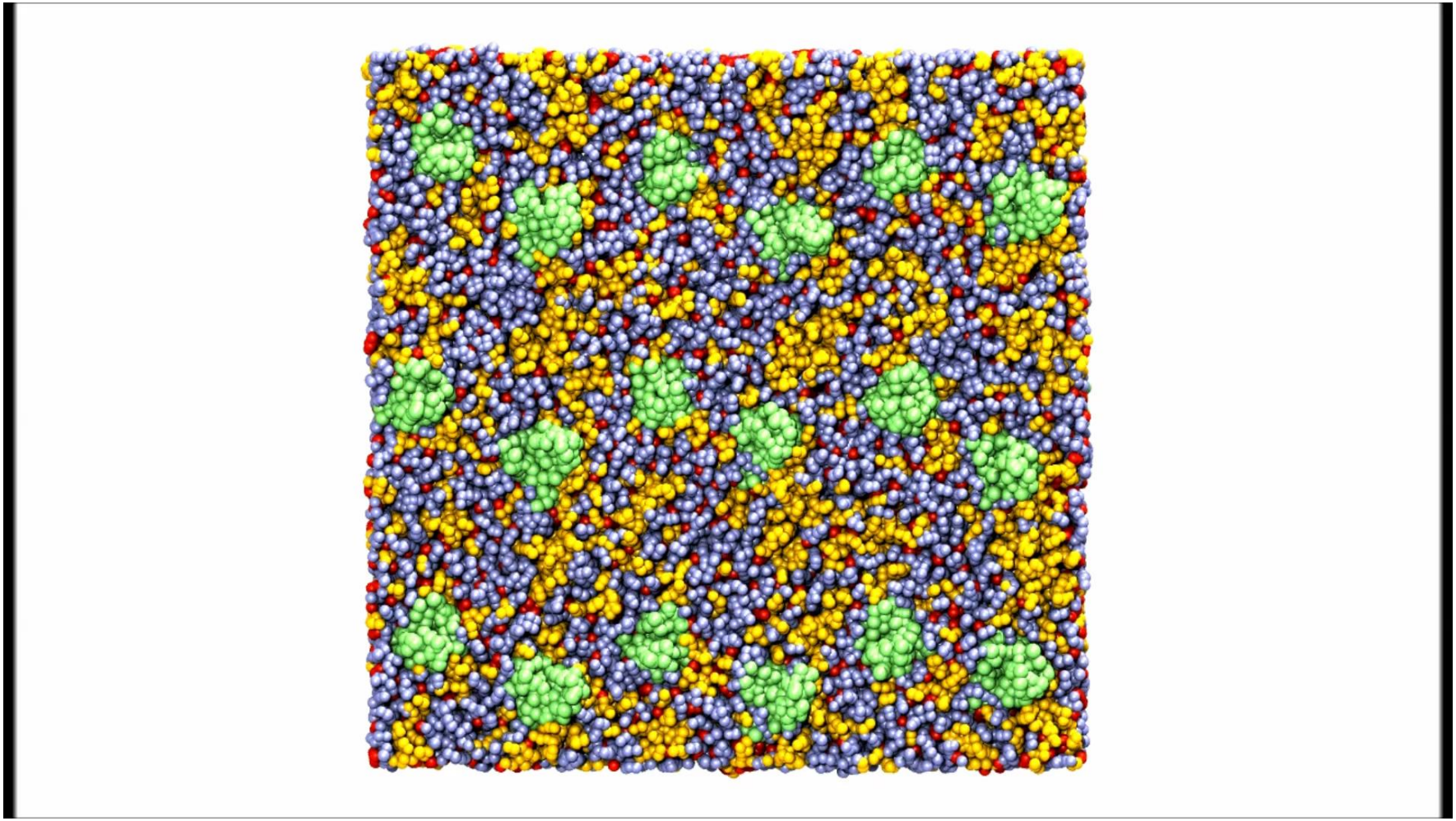

Bazan, N.G. et al. Annu. Rev. Nutr. 2011, 31:21-51




Global DHA Daily Consumption Rate $J_{in} = k^{*}c_{plasma,DHA}$
3.8 ± 1.7 (SD) mg/brain/day

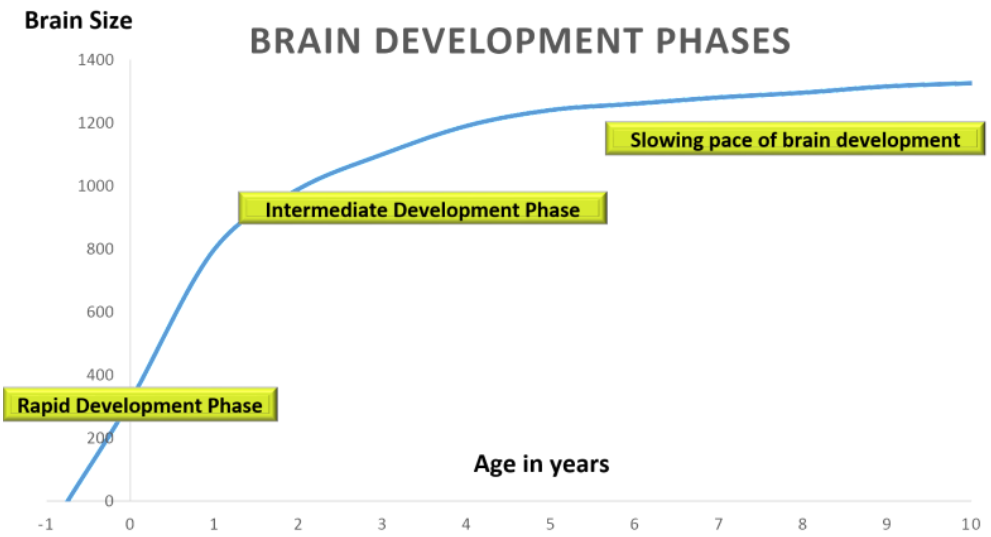
Umhau, J.C. et al. PloS One 2013, 8:e75333
Umbau, J.C. et al. J. Lipid. Res. 2009, 50:1259–1268

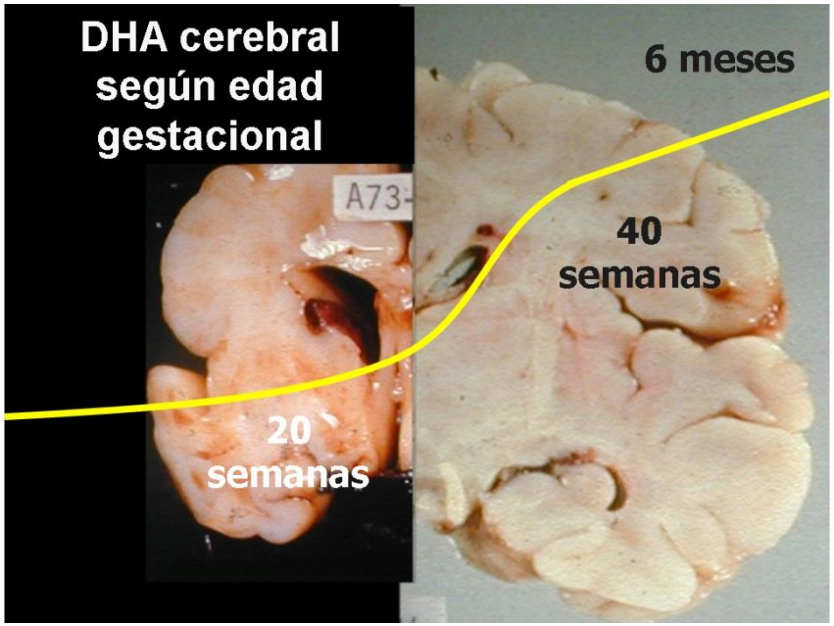
# DHA en el SNC

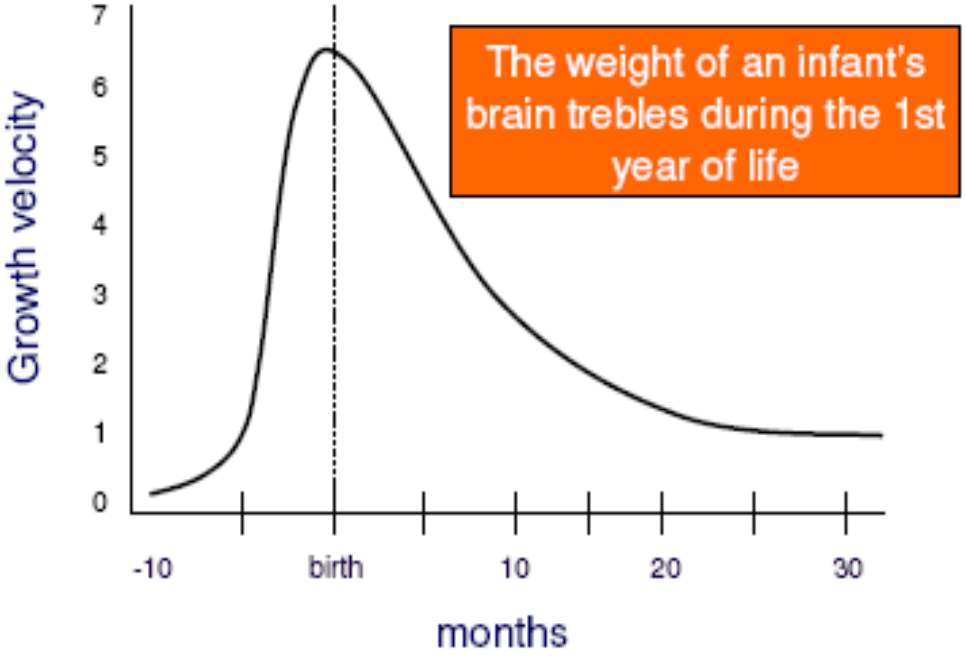


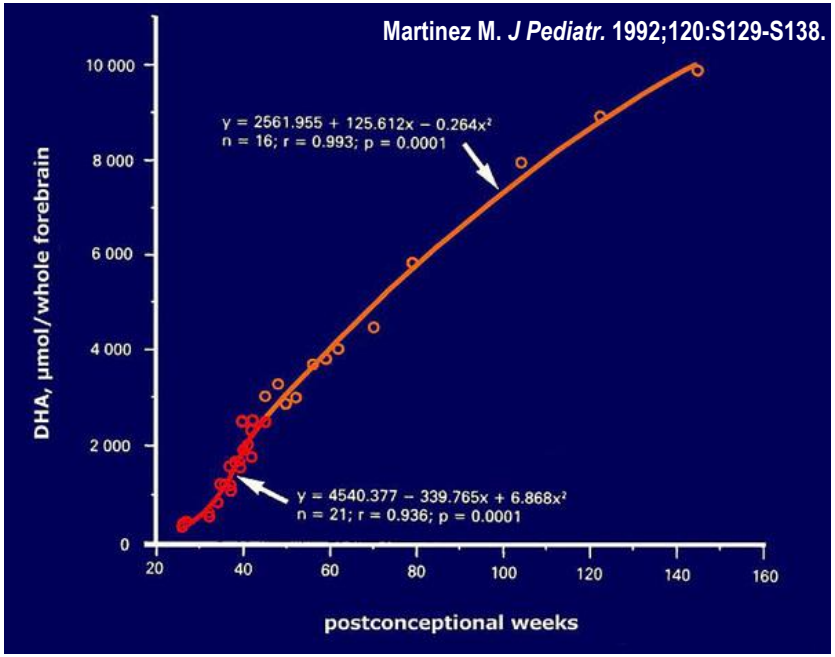
Guixa-Gonzalez et al. Sci Rep 2016, 6, 19839.

# Acumulación Cerebral del DHA



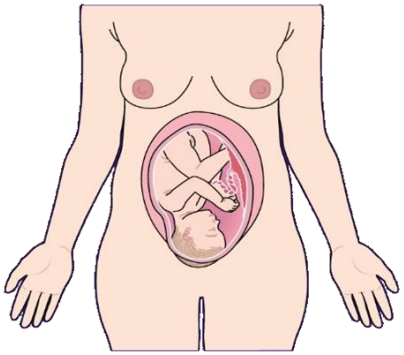



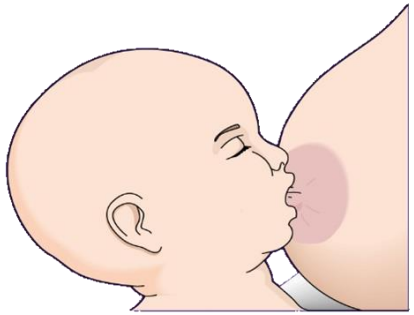



# Suministro Fisiológico de DHA

α-
Linolenic
Acid
⇓
DHA

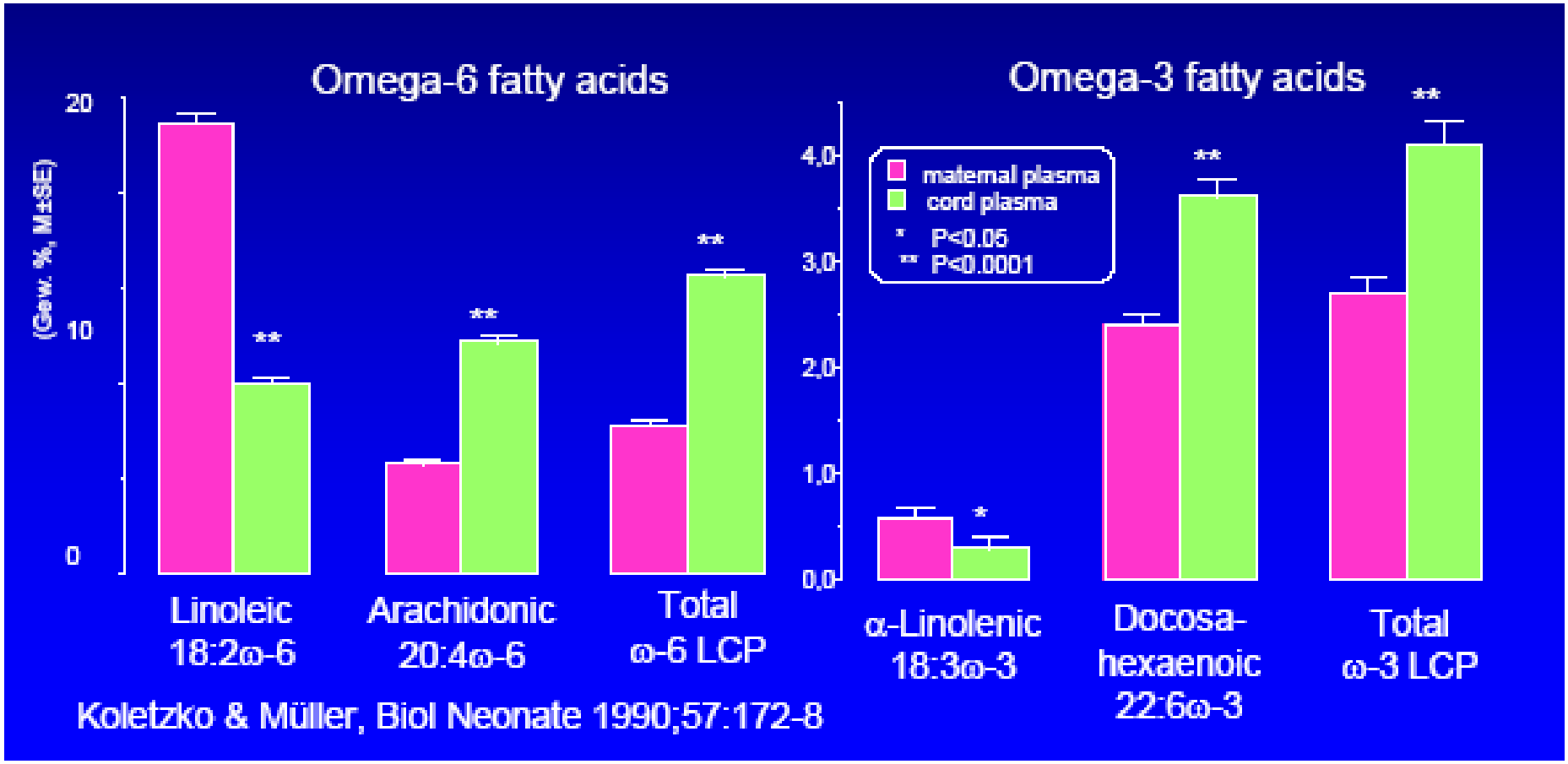




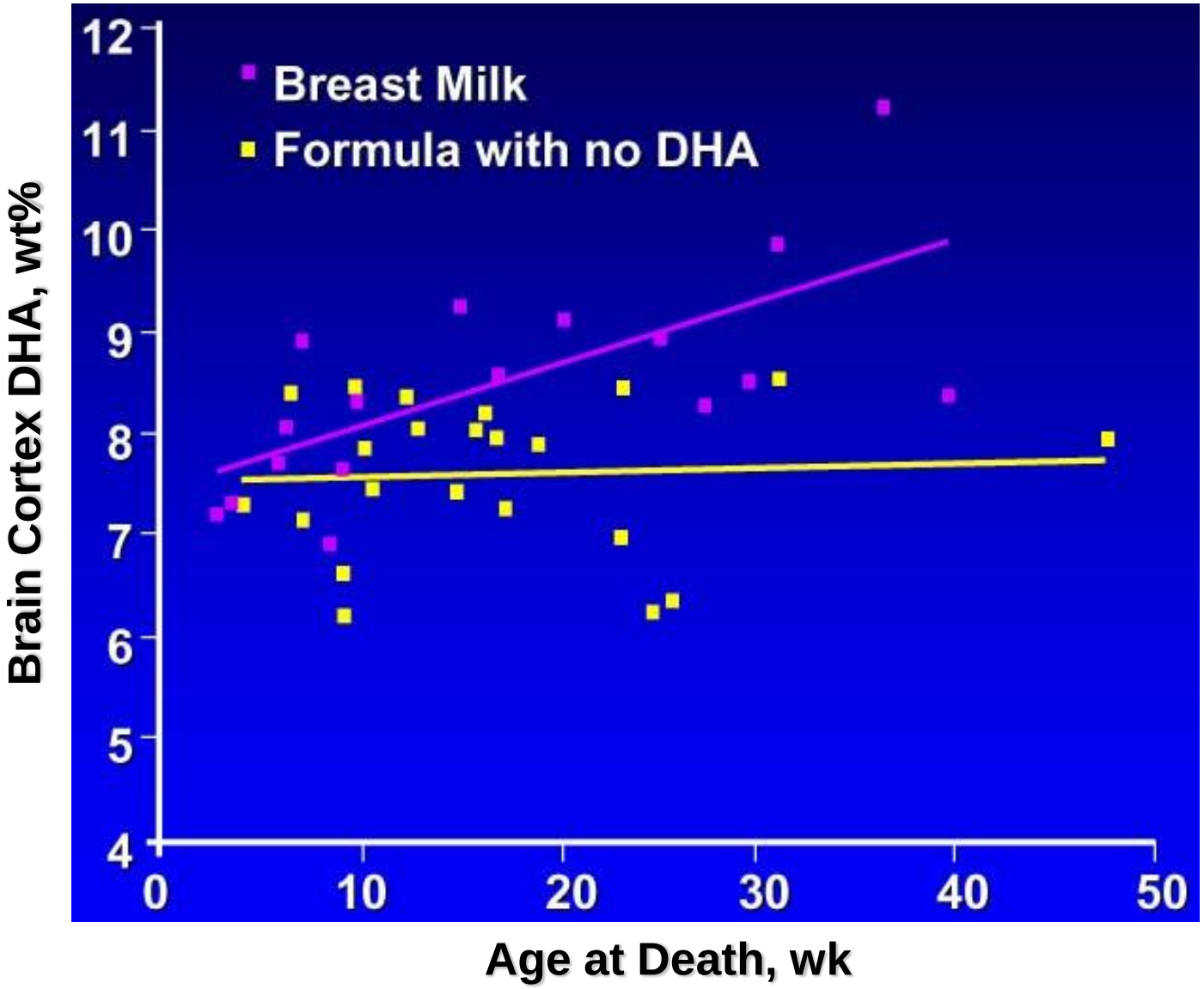
**Convert From Precursor** → **Preformed** → **Preformed** → **Solid foods**

| Convert From Precursor | Preformed | Preformed | Solid foods |
|---|---|---|---|
| Highly Variable Estimated 0.2-0.4% Conversion | In Utero | From Human Milk or DHA-Supplemented in Infant Formula | Fish, Liver, Egg yolk, Brain |

# Transporte Selectivo en la Placenta

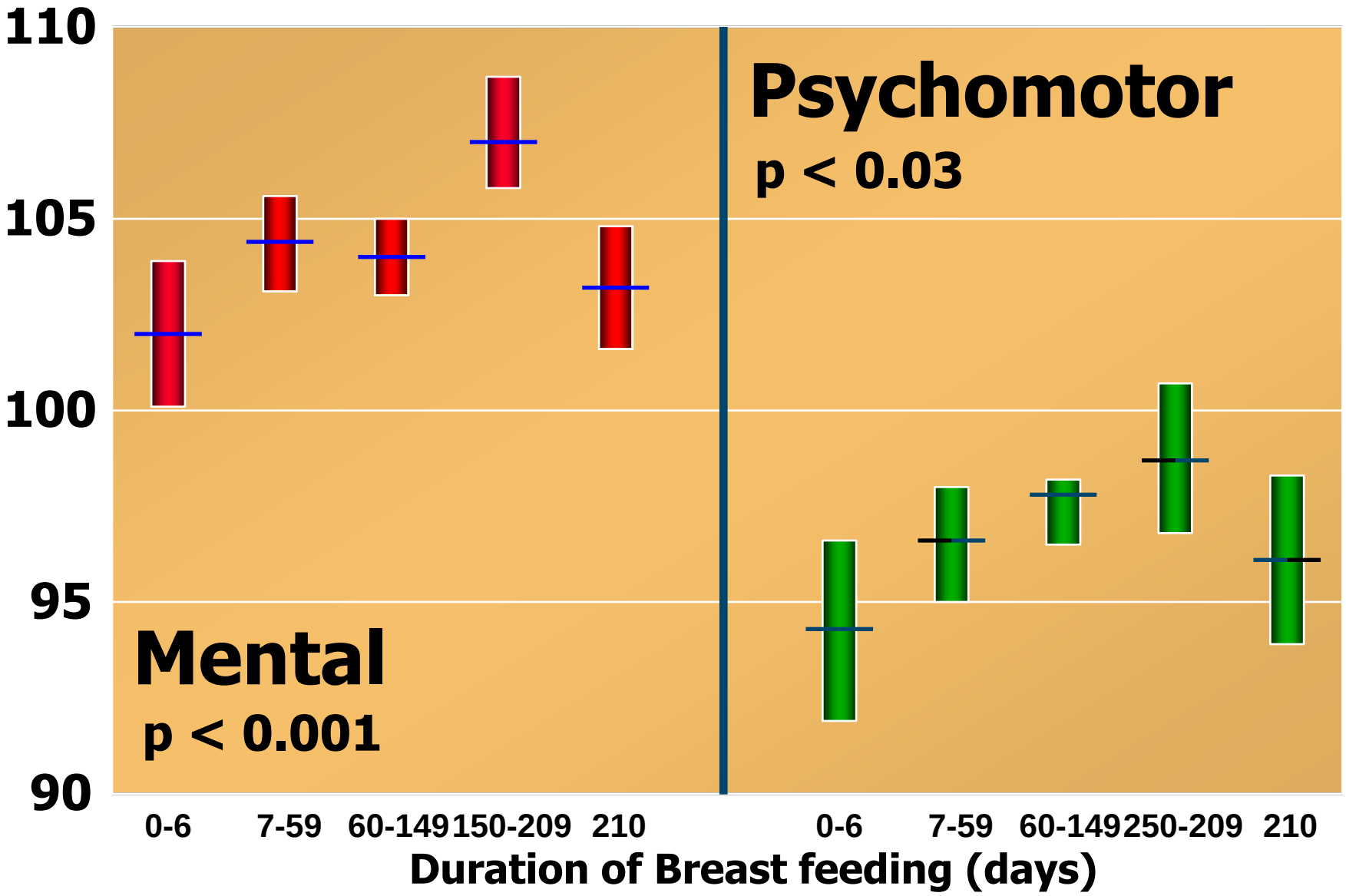


# Dieta Postnatal



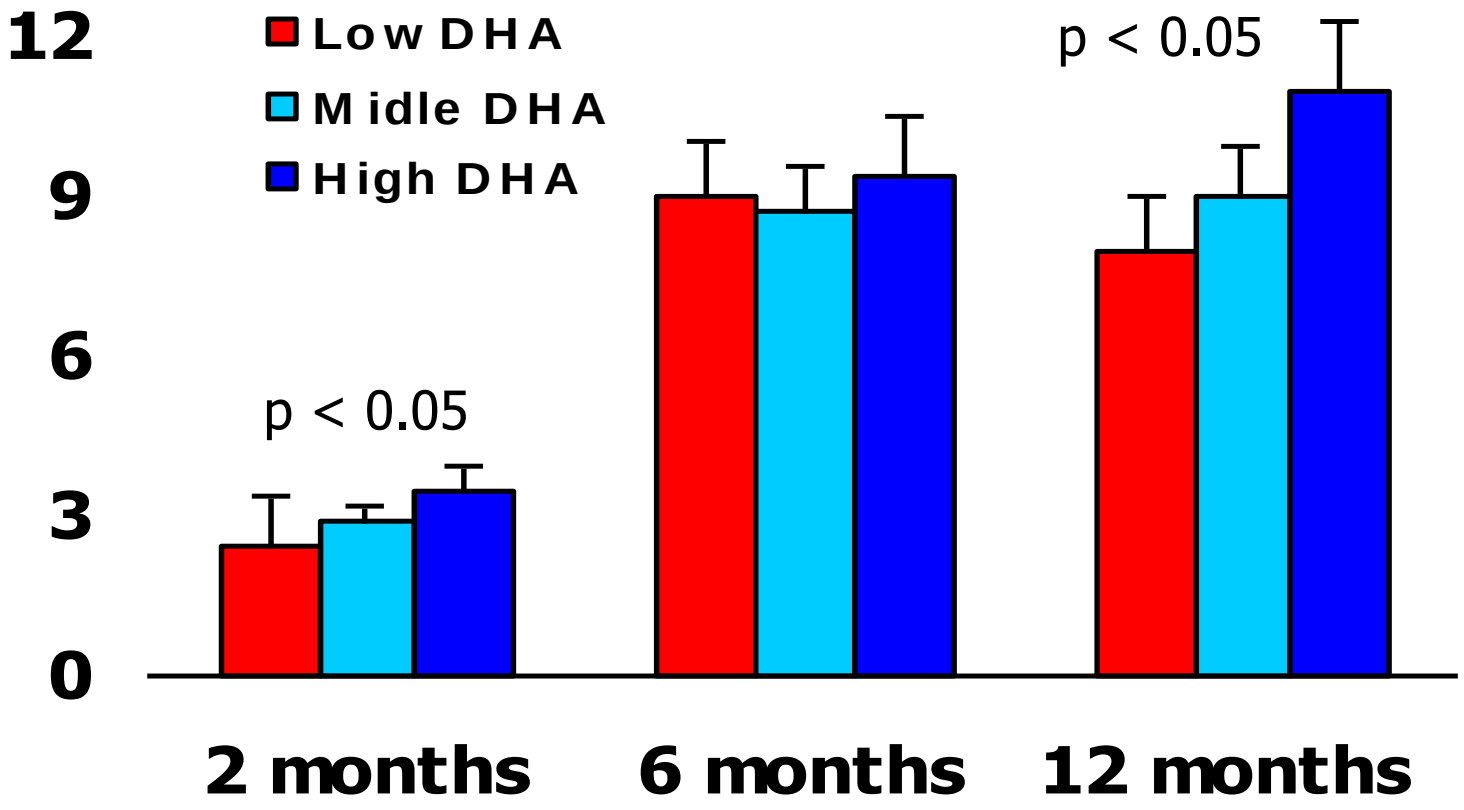

Makrides M, et al. *Am J Clin Nutr*. 1994;60:189-194

# Dieta Postnatal & Neurodesarrollo




de Andraca et al. Rev Saude Publica 1998; 32:138-47.

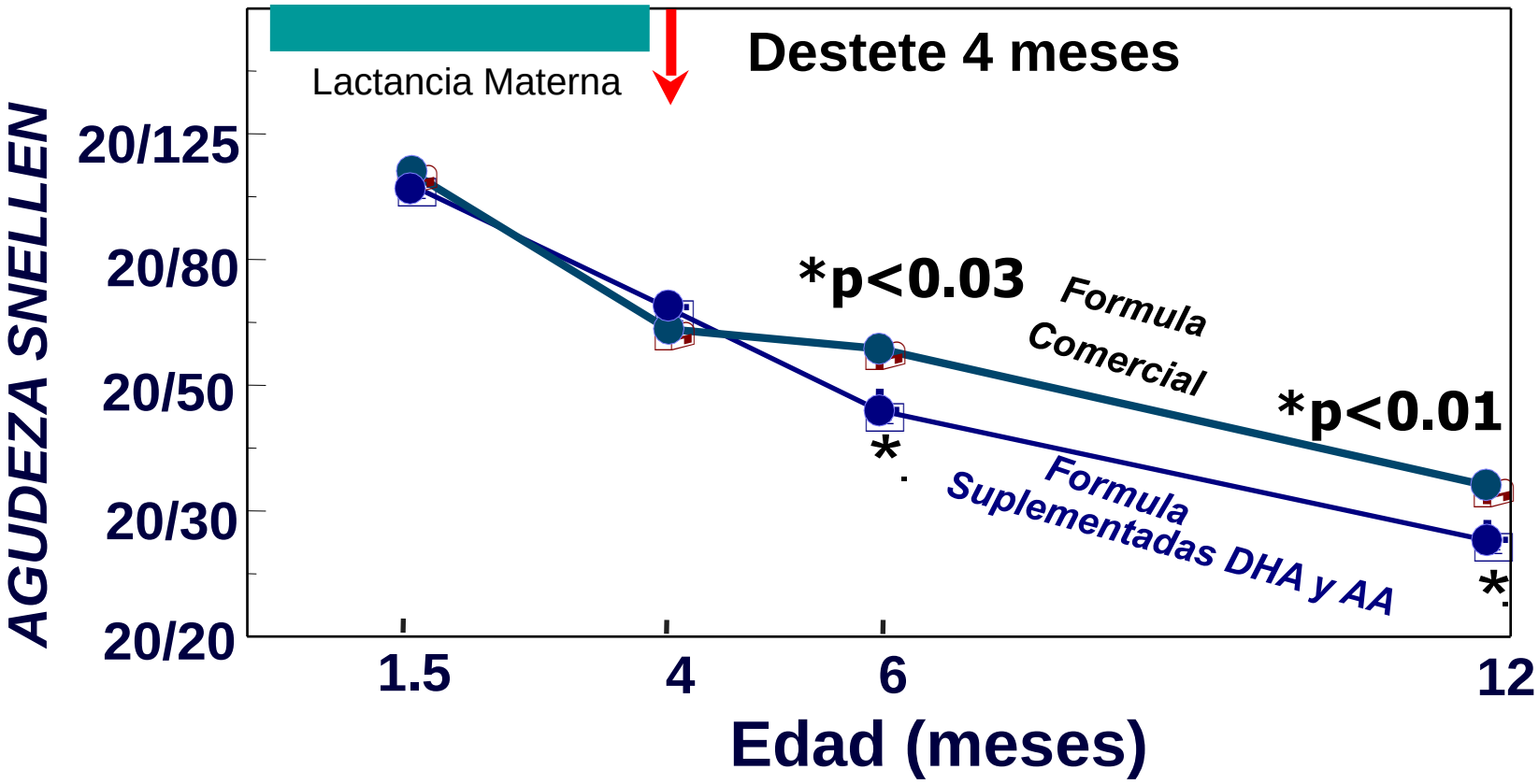
# Visual acuity in infants




Innis, S.M. et al. J Pediatr. 2001; 139:532-8.

# Dieta Postnatal & Neurodesarrollo

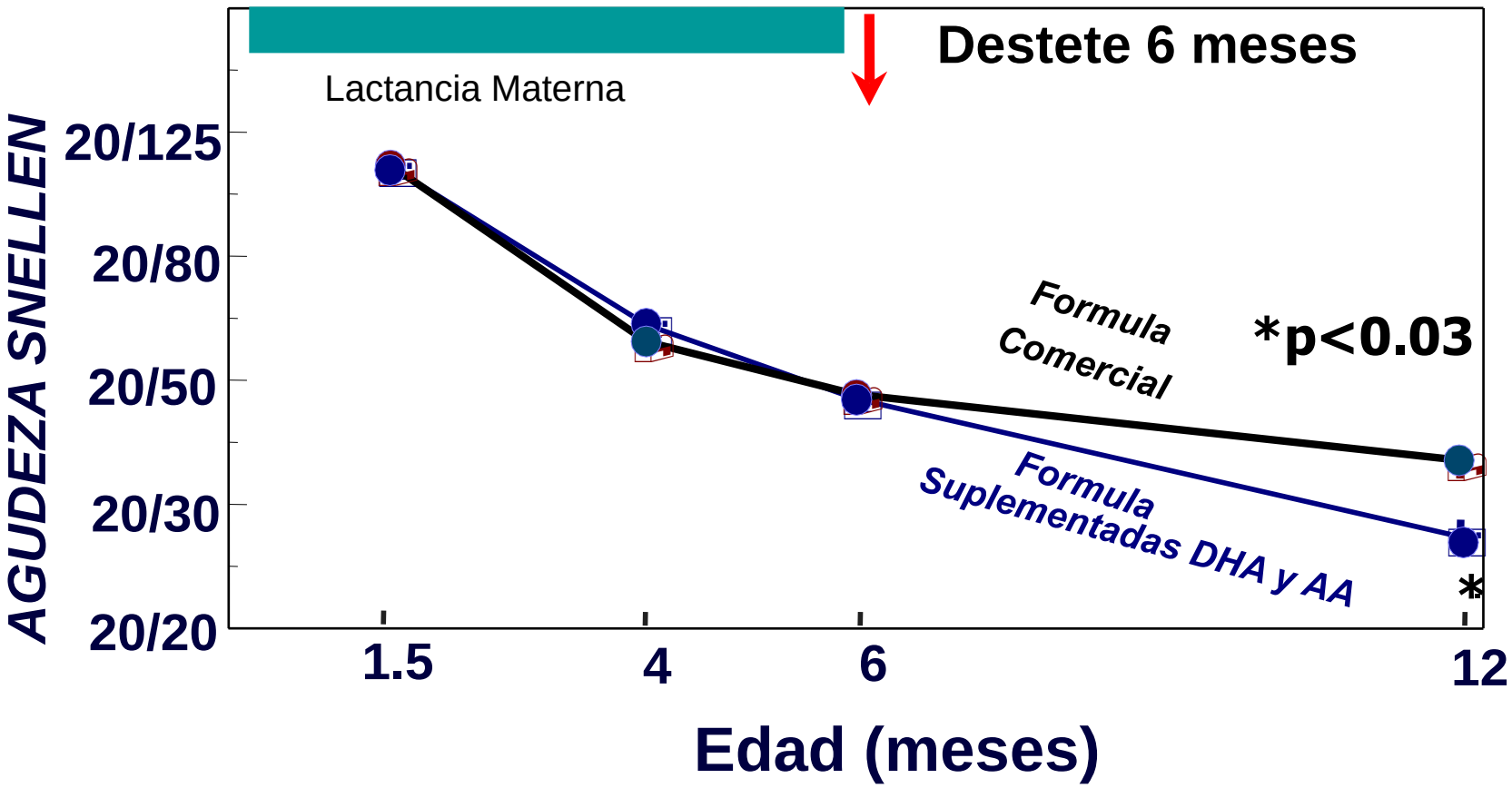
## Visual acuity in infants




Hoffman et al. J.Pediatr. 2003; 142:669–677

# Dieta Postnatal & Neurodesarrollo

## Visual acuity in infants

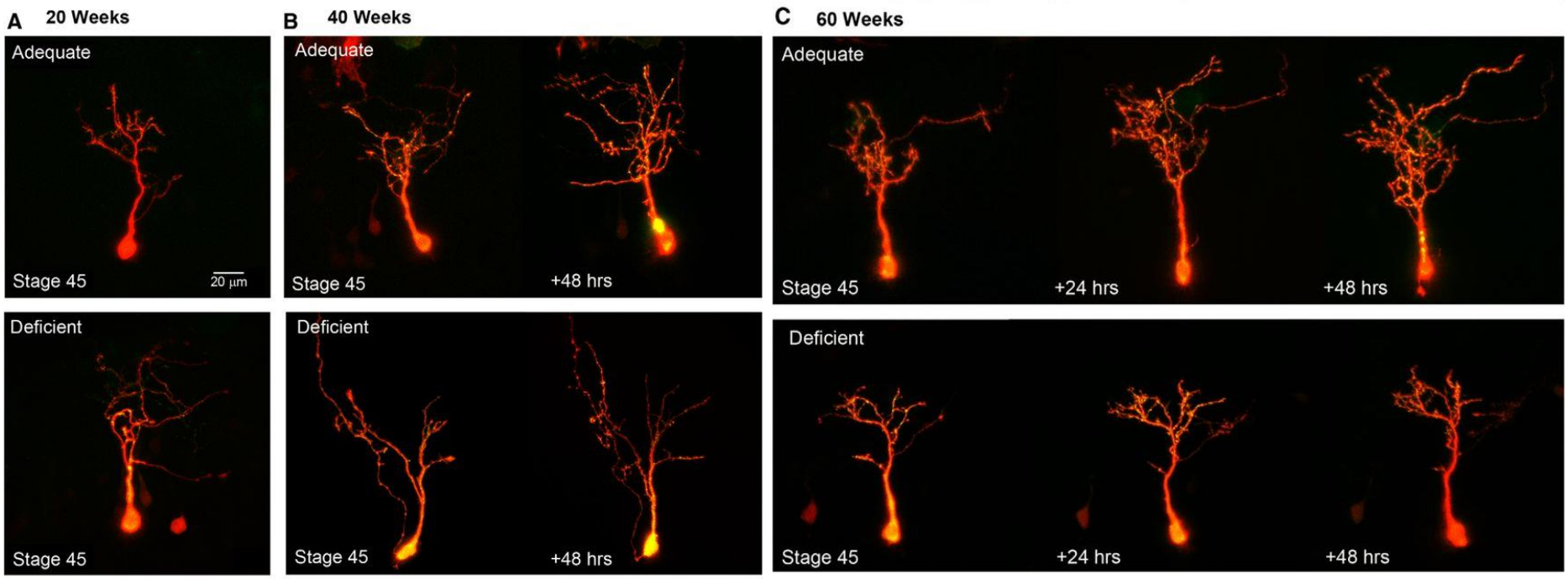


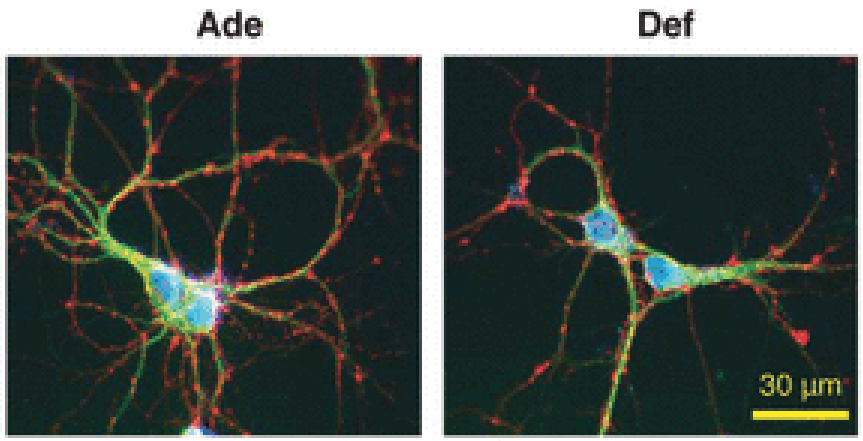

Hoffman et al. J.Pediatr. 2003; 142:669–677

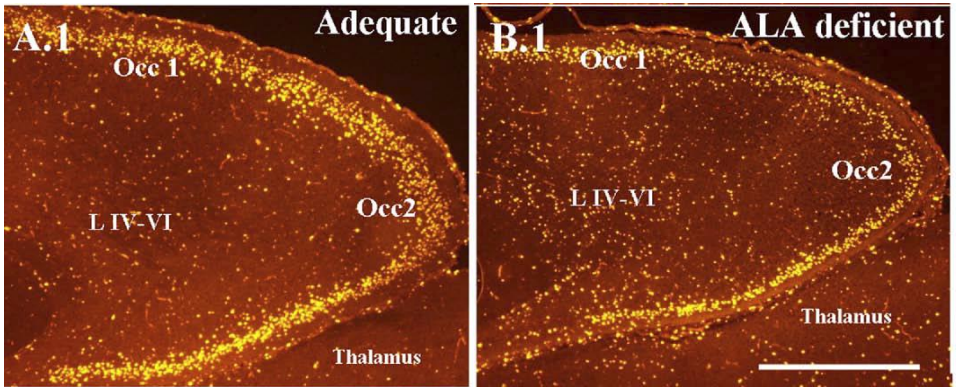
# Efectos de un déficit cerebral de DHA

- ***Neuroanatomical abnormalities that are consistent with deficits in perinatal corticogenesis:***
  - **Exhibit significant reductions in regional cortical and striatal gray matter volumes**
  - **Reduced amygdala and hippocampal volumes**
  - **Reduced corpus callosum and white matter volumes**
  - **Larger cerebral ventricles**
- ***Disrupted dendrític arborisation which affects cell signalling***
- ***Abnormal neuronal development in the hipocampus***
- ***Alterations in dopaminergic and serotonergic systems***
- ***40-60% depletion of dopamine in the nucleus accumbens and frontal cortex***
- ***Lower visual acuity***
- ***Changes in attention that suggest slower brain maturation***
- ***Higher impulsivity and reactivity***
- ***Increased stereotyped behavior***

# Efectos de un déficit cerebral de DHA

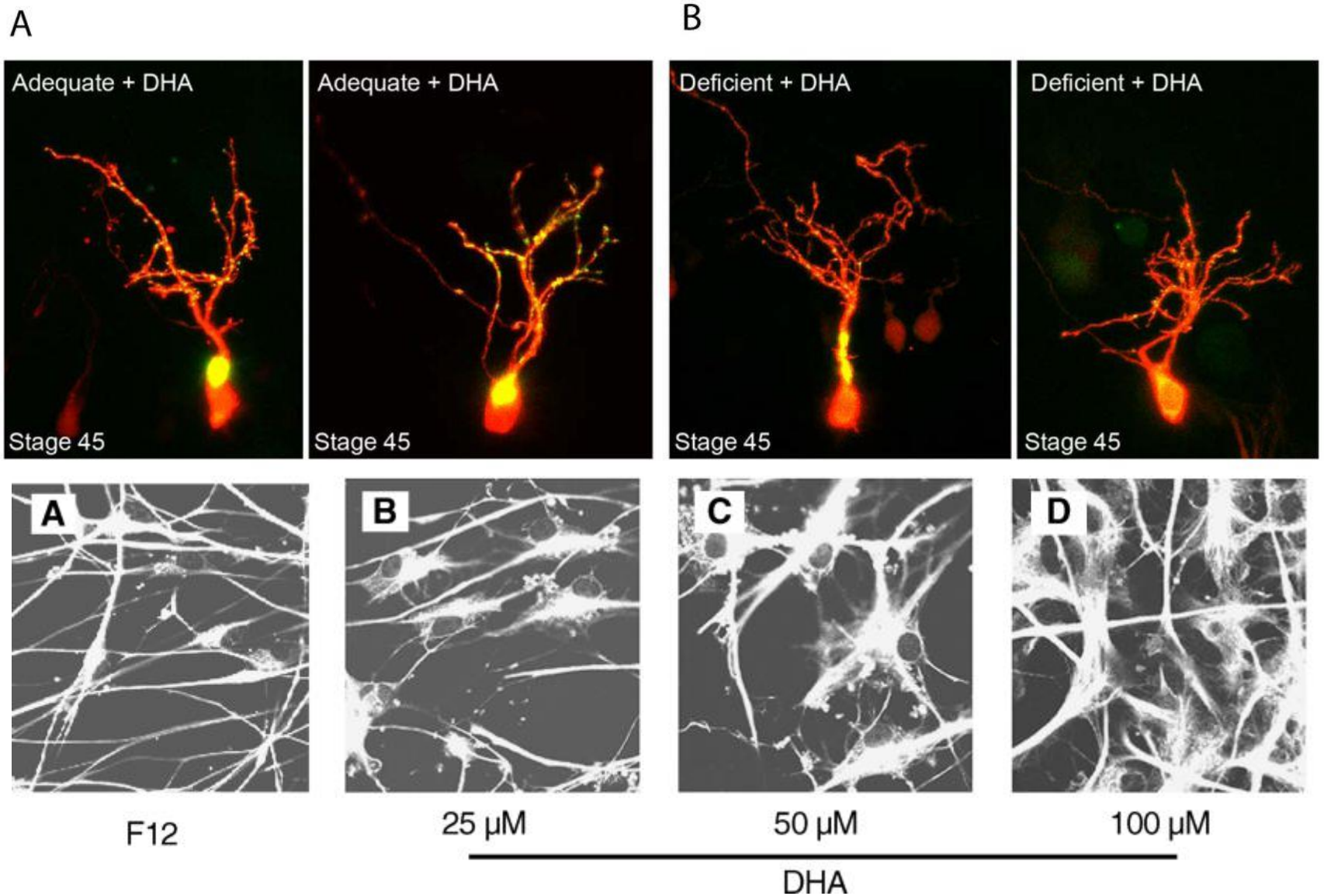


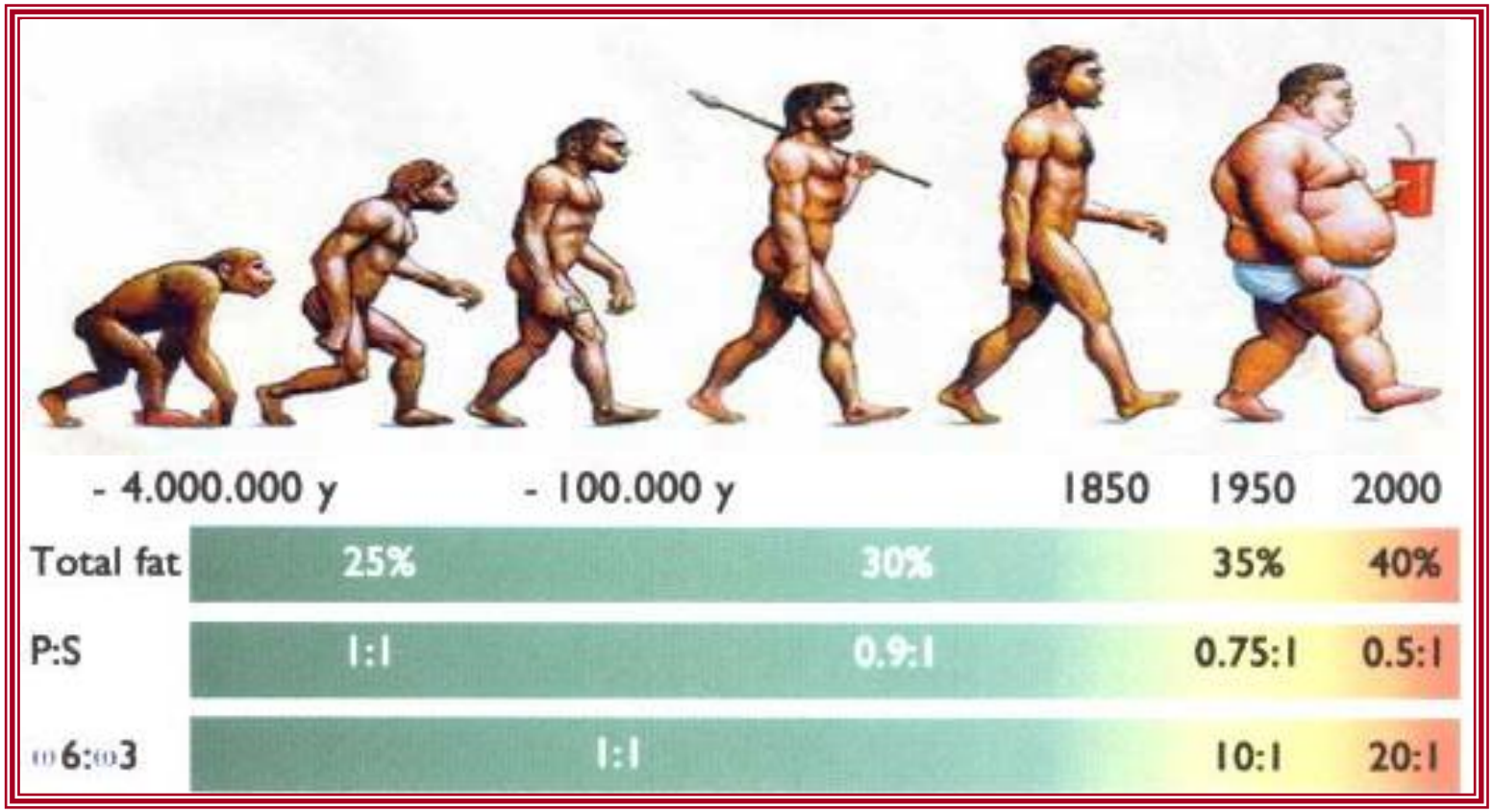

Igarashi et al. J. Neurosci. 2015;35:6079-6092 / Cao et al. J Neurochem. 2009; 111:510-521 / Yavin et al. Neuroscience 2009; 52:1011–1022 / Bhatia et al. PLoS One, 2011. 6:e28451.

# Efectos de un déficit cerebral de DHA



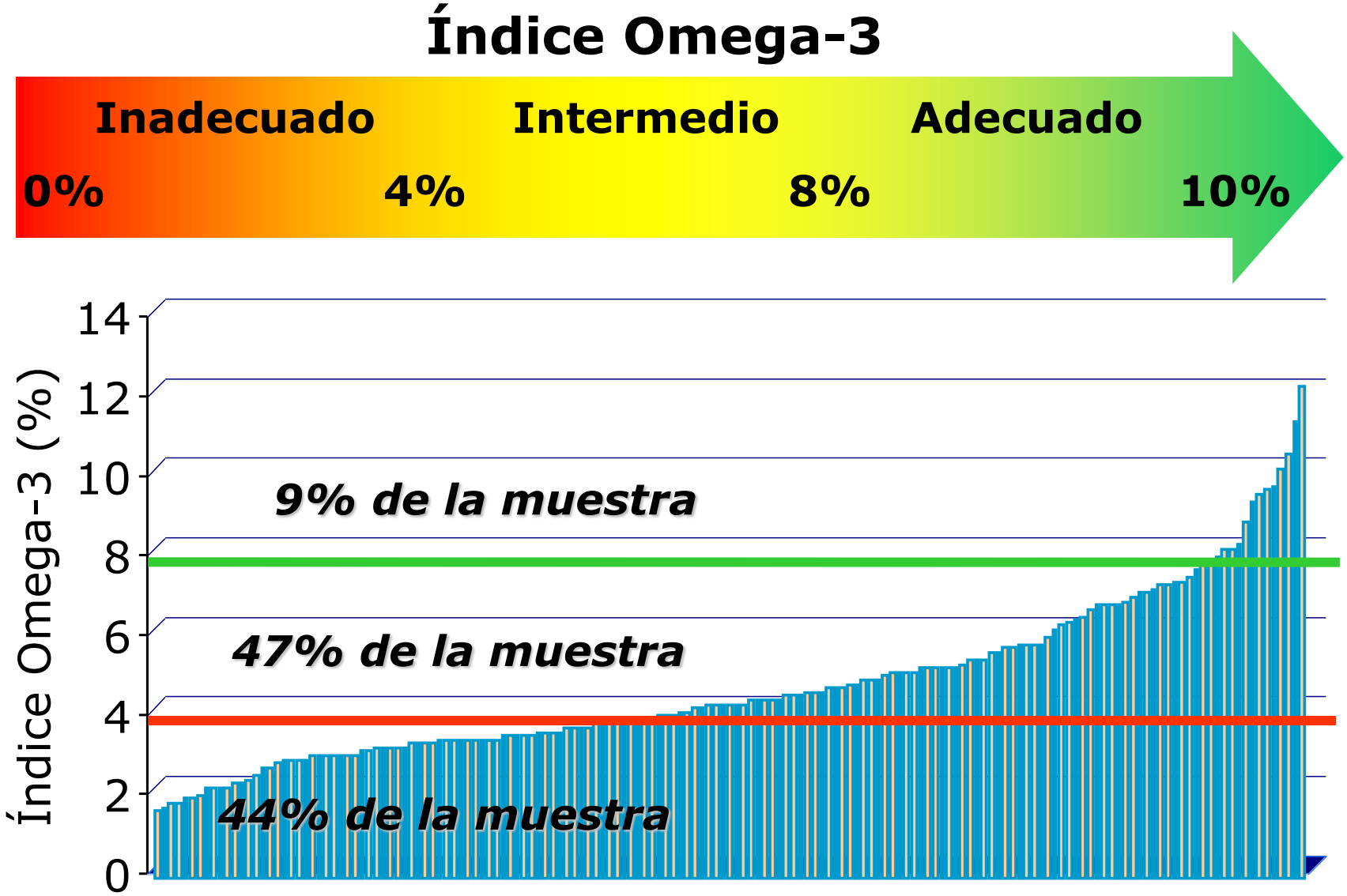

Igarashi et al. J. Neurosci. 2015;35:6079-6092 / Joardar et al. J. Lipid Res. 2006;47:571-581

# Déficits nutricionales: Omega-3




**El 99% de nuestra herencia genética data de nuestros antepasados biológicos evolucionados como *Homo Sapiens*. El 99,99% de nuestros genes fueron formados antes del desarrollo de la agricultura. La mayoría de nuestros genes son antiguos y casi toda nuestra bioquímica y fisiología están adaptados a condiciones de la vida que existió antes. Las dietas modernas están fuera de la sincronización con nuestros requisitos genéticos.**

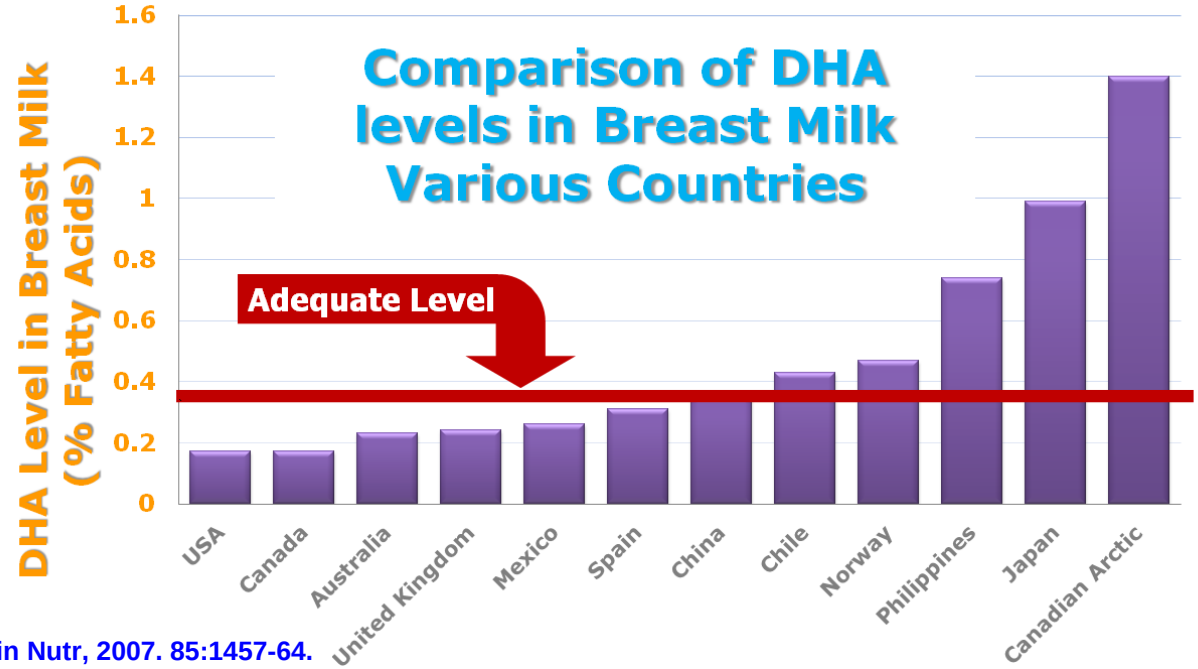
# Déficits nutricionales de Omega-3



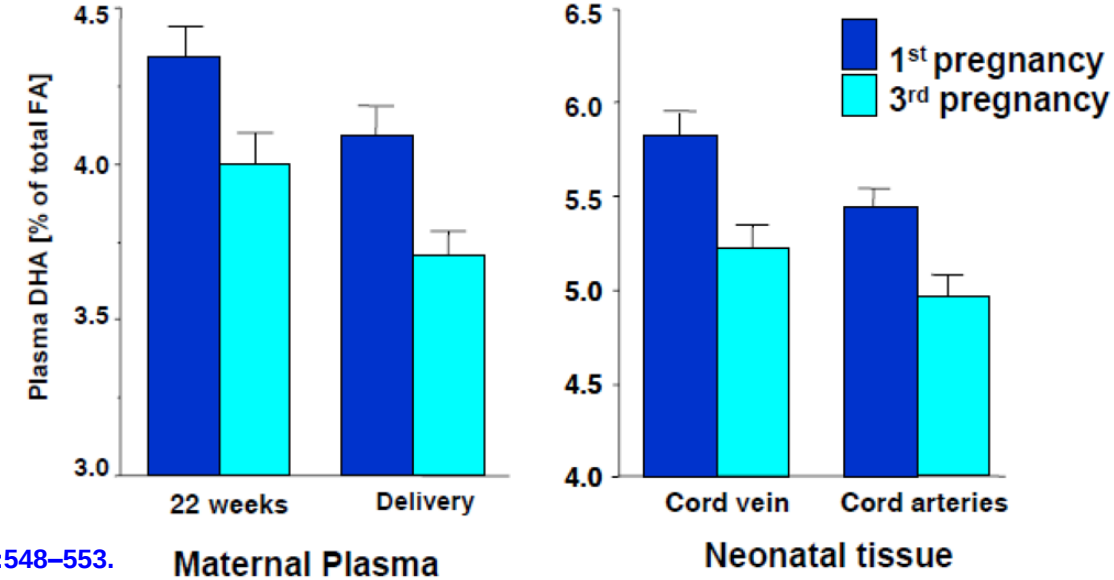

Harris WS and von Schacky. *Prev Med* 2004;39:212-220.

Sands SA et al. *Lipids* 2005;40:343-347

# Déficits nutricionales de Omega-3




Brenna J.T. et al. Am J Clin Nutr, 2007. 85:1457-64.




Al, M.D. et al. Eur J Clin Nutr 1997; 51:548–553.

# Claims de efectos saludables del DHA aprobados por la CE

| Efectos saludables del DHA aprobados por la Comisión Europea | Deberá informarse al consumidor de que el efecto beneficioso se obtiene con… |
|---|---|
| El DHA contribuye al normal funcionalismo visual | …una ingesta diaria de 250mg de DHA en el adulto (Reglamento UE 432; 16 Mayo, 2012) y en los niños de 2 a 18 años (EFSA Journal 2014; 12(10):3840 |
| El DHA contribuye al normal funcionalismo cerebral | |
| El DHA (y el DHA+EPA) contribuye/n al normal funcionalismo del corazón | |
| El DHA contribuye al normal desarrollo visual de los niños hasta los 12 meses de edad | …una ingesta diaria de 100mg de DHA (Reglamento UE 440; 6 Mayo, 2011) |
| La ingesta materna de DHA contribuye al normal desarrollo visual del feto y de los niños alimentados con lactancia materna | (Mujeres embarazadas y lactantes)<br><br>…una ingesta de 200mg/día de DHA adicionales a los 250mg de ingesta diaria recomendada para el adulto (Reglamento UE 440; 6 Mayo, 2011) |
| La ingesta materna de DHA contribuye al normal desarrollo cerebral del feto y de los niños alimentados con lactancia materna | |
| El DHA (o el DHA+EPA) contribuye/n a mantener el nivel normal de triglicéridos en la sangre | …una ingesta diaria de 2g de DHA, o de DHA+EPA. No se deben superar los 5g/día de ingesta conjunta |
| El DHA y el EPA contribuyen a reducir la tensión arterial | …una ingesta diaria de 3g de DHA, o de DHA+EPA. No se deben superar los 5g/día de ingesta conjunta |

# Suplementación en el embarazo y lactancia

**Table 5.** Significant Effects found of n-3 LCPUFA Supplementation during Pregnancy and Lactation on Child Neurodevelopment

| Outcome | N | Mean difference [95 % CI] |
|---|---|---|
| *n-3 LCPUFA Supplementation during pregnancy* | | |
| *Judge et al. 2007*[53] | | |
| *The 2-step problem-solving test at 9 months* | | |
| Intention score: cloth average | 29 | 0·6 [−0·1, 1·4] |
| Intention score: cover average | 29 | 0·7 [−0·6, 2·0] |
| Intention score: total average | 29 | 1·3 [−0·6, 3·2]* |
| Intentional solutions: cloth | 29 | 1·1 [0·01, 2·2] |
| Intentional solutions: cover | 29 | 0·8 [−0·3, 1·9]* |
| Intentional solutions: total | 29 | 0·8 [−0·2, 1·8]* |
| *n-3 LCPUFA Supplementation during Pregnancy & Lactation* | | |
| *Helland et al. 2003*[67] | | |
| K-ABC mental processing composite at 4 year | 84 | 4·1 [−0·2, 8·4]* |
| *n-3 LCPUFA Supplementation during Lactation* | | |
| *Lauritzen et al. 2005*[72] | | |
| MacArthur CDI vocabulary comprehension at 1 year | 89 | −17·0 [−34·6, 0·6]* |

CI = confidence interval. K-ABC = Kaufman Assessment Battery for Children, *: significant difference ($P < 0·05$).

Campoy, C. et al. Br J Nutr. 2012;107 S2:S85-106

# Suplementación en la infancia

**Table 7.** Significant Effects related to n-3 LCPUFA supplementation of infant formula on infant and child neurodevelopment. Data from the Bayley Scales for Infant Development (BSID)

| Outcome | N | Mean difference [95 % CI] |
|---|---|---|
| *Drover et al. 2011*[75] | | |
| *DHA + AA (0·32 %) supplemented vs normal term infant formula* | | |
| MDI score at 18 months | 57 | −6·80 [7·38, 4·02]* |
| *Birch et al. 2000*[83] | | |
| *DHA + AA supplemented vs normal term infant formula* | | |
| MDI score at 18 months | 39 | 7·30 [0·78, 13·82]* |
| PDI score at 18 months | 39 | 3·10 [0·15, 6·05]* |

Bayley Scales of Infant Development: MDI = Mental Developmental Index, PDI = Psychomotor Developmental Index, BRS = Behaviour Rating Scales, CI = Confidence Interval, * = significant difference ($P<0·05$).

Campoy, C. et al. Br J Nutr. 2012;107 S2:S85-106

# Suplementación en la infancia

**Table 6.** Significant Effects related to *n*-3 LCPUFA supplementation of infant formula on infant and child visual acuity

| Outcome | N | Mean Difference [95 % CI] |
|---|---|---|
| Infant formula supplementation | | |
| *Birch et al. 2010* [76] | | |
| Sweep VEP Acuity 1·5, 4, 6, 9, 12 months | 256 | Data not available |
| *Birch et al. 2007* [78] | | |
| *DHA + AA supplemented vs normal term infant formula* | | |
| HOTV acuity (logMAR) RE at 4 years | 36 | 0·042 [0·00075, −0·00072]* |
| *DHA supplemented vs term infant formula* | | |
| HOTV acuity (logMAR) RE at 4 years | 35 | 0·053 [0·014, −0·013]* |
| *Birch et al. 2005* [90] | | |
| *DHA + AA supplemented vs normal term infant formula* | | |
| Sweep VEP Acuity at 4 months | 92 | −0·07 [−0·11, −0·03]* |

PCA = Postconceptional age, VEP = Visual Evoked Potentials, MAR: minimum angle of resolution, HOTV: Amblyopia Treatment Study (ATS) protocol and the Electronic Visual Acuity (EVA) system, CI: Confidence Interval, * = significant difference ($P<0·05$).

**Table 6.** Significant Effects related to *n*-3 LCPUFA supplementation of infant formula on infant and child visual acuity

| Outcome | N | Mean Difference [95 % CI] |
|---|---|---|
| *Hoffman et al. 2000* [34] | | |
| *DHA + AA supplemented vs normal term infant formula* | | |
| Sweep VEP Acuity (logMAR) at 4 months | 42 | −0·06 [−0·13, 0·01]* |
| Sweep VEP Acuity (logMAR) at 12 months | 38 | −0·13 [−0·20, −0·06]* |
| *DHA supplemented vs term infant formula* | | |
| Sweep VEP Acuity (logMAR) at 4 months | 41 | −0·08 [−0·15, −0·01]* |
| Sweep VEP Acuity (logMAR) at 12 months | 40 | −0·14 [−0·21, −0·07]* |
| *Makrides et al. 1995* [97] | | |
| Steady state VEP Acuity (logMAR) at 4 months | 26 | −0·20 [−0·32, −0·08]* |

PCA = Postconceptional age, VEP = Visual Evoked Potentials, MAR: minimum angle of resolution, HOTV: Amblyopia Treatment Study (ATS) protocol and the Electronic Visual Acuity (EVA) system, CI: Confidence Interval, * = significant difference ($P<0·05$).

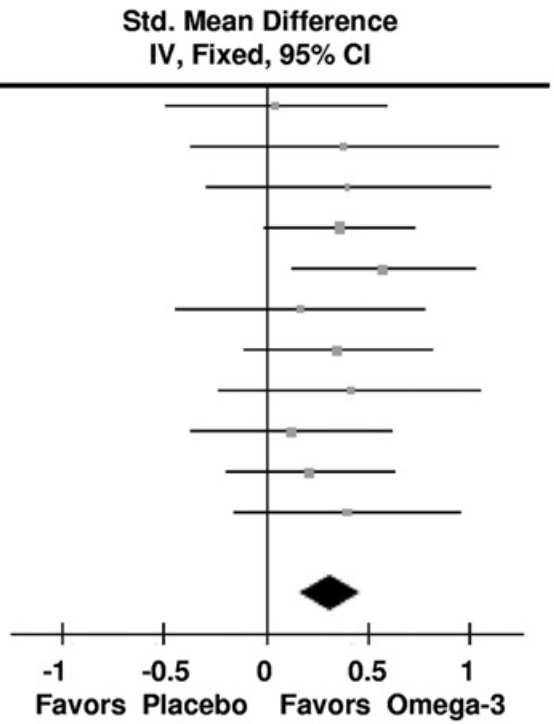
Campoy, C. et al. Br J Nutr. 2012;107 S2:S85-106

# Suplementación en ADHD

- Omega-3 HUFA levels appear to be lower in individuals with ADHD compared with unaffected counterparts but the reasons for this are unclear.
- Several meta-analytic reviews have found that Omega-3 supplementation has a small-medium effect size in improving clinical symptoms of ADHD.

| Study or Subgroup | Weight | Std. Mean Difference IV, Fixed, 95%CI | Year |
|---|---|---|---|
| Voigt 2001[44] | 8.0% | 0.04 [-0.49, 0.58] | 2001 |
| Richardson 2002[42] | 4.1% | 0.38 [-0.37, 1.13] | 2002 |
| Stevens 2003[25] | 4.8% | 0.40 [-0.29, 1.09] | 2003 |
| Richardson 2005[41] | 17.3% | 0.36 [-0.00, 0.73] | 2005 |
| Sinn 2007[45] | 11.6% | 0.58 [0.13, 1.02] | 2007 |
| Vaisman 2008[43] fishoil | 6.3% | 0.17 [-0.44, 0.77] | 2008 |
| Johnson 2008[39] | 11.1% | 0.35 [-0.11, 0.81] | 2008 |
| Vaisman 2008[43] omega-3 | 5.7% | 0.41 [-0.22, 1.05] | 2008 |
| Raz 2009[40] | 9.6% | 0.13 [-0.36, 0.62] | 2009 |
| Gustafsson 2009[46] | 13.8% | 0.22 [-0.19, 0.62] | 2009 |
| Belanger 2010[47] | 7.7% | 0.40 [-0.15, 0.95] | 2010 |
| **Total (95% CI)** | **100.0%** | **0.31 [0.16, 0.47]** | |

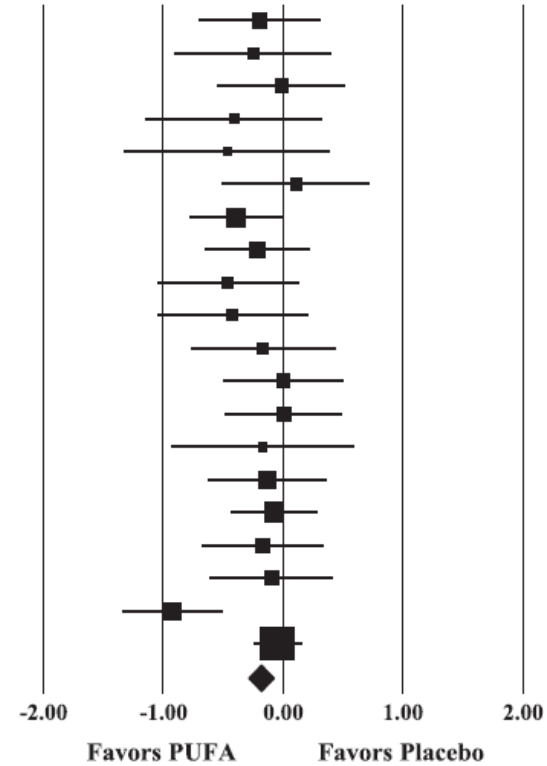
Heterogeneity: $Chi^2 = 3.68$, df = 10 (P = 0.96); $I^2 = 0\%$
Test for overall effect: Z = 4.04 (P < 0.0001)




Bloch and Qawasmi, J Am Acad Child Adolesc Psychiatry 2011; 50:991-1000

# Suplementación en ADHD

| Study name | Std diff in means | Lower limit | Upper limit | *p*-value | Relative Weight |
|---|---|---|---|---|---|
| Aman et al. 1987 | -0.197 | -0.702 | 0.309 | 0.445 | 4.20 |
| Arnold et al. 1989 | -0.251 | -0.909 | 0.408 | 0.456 | 2.49 |
| Voigt et al. 2001 | -0.015 | -0.553 | 0.524 | 0.957 | 3.71 |
| Richardson & Puri 2002 | -0.413 | -1.152 | 0.326 | 0.273 | 1.98 |
| Stevens et al. 2003 | -0.470 | -1.328 | 0.389 | 0.284 | 1.47 |
| Hirayama et al. 2004 | 0.108 | -0.513 | 0.729 | 0.734 | 2.80 |
| Richardson & Montgomery 2005 | -0.392 | -0.784 | 0.000 | 0.050 | 6.92 |
| Sinn & Bryan 2007 | -0.219 | -0.659 | 0.222 | 0.331 | 5.51 |
| Johnson et al. 2009 | -0.463 | -1.059 | 0.134 | 0.129 | 3.03 |
| Vaisman et al. 2008 FA-PL group | -0.423 | -1.059 | 0.214 | 0.193 | 2.66 |
| Vaisman et al. 2008 FO group | -0.169 | -0.775 | 0.437 | 0.584 | 2.94 |
| Kairaluoma et al. 2009 | 0.000 | -0.502 | 0.502 | 1.000 | 4.26 |
| Raz et al. 2009 | 0.004 | -0.491 | 0.499 | 0.988 | 4.37 |
| Bélanger et al. 2009 | -0.171 | -0.943 | 0.601 | 0.665 | 1.81 |
| Gustaffson et al. 2010 | -0.130 | -0.625 | 0.364 | 0.605 | 6.36 |
| Manor et al. 2011 | -0.076 | -0.440 | 0.289 | 0.684 | 7.97 |
| Milte et al. 2012 EPA vs LA | -0.172 | -0.683 | 0.340 | 0.511 | 4.11 |
| Milte et al. 2012 DHA vs LA | -0.096 | -0.612 | 0.419 | 0.714 | 4.04 |
| Perera et al. 2012 | -0.926 | -1.353 | -0.498 | 0.000 | 5.85 |
| Richardson et al. 2012 | -0.050 | -0.256 | 0.156 | 0.636 | 23.52 |
| **Overall (random effects model)** | **-0.192** | **-0.297** | **-0.086** | **0.000** | |




- Omega-3 HUFAs may be a useful adjunct to medication.
- Recent reviews suggest that EPA has greater clinical efficacy; however, it is likely that both EPA and DHA are important.
- Children with learning and behavioural difficulties without a diagnosis of ADHD may benefit from omega-3 supplementation.

Puri and Martins, Prostaglandins Leukot Essent Fatty Acids 2014; 90:179-89

# Suplementación y Meta-análisis

- Overall, there is little evidence that PUFA supplementation provides any benefit for the symptoms of ADHD in children and adolescents. The majority of data showed no benefit of PUFA supplementation, although there were some limited data that did show an improvement with combined omega-3 and omega-6 supplementation.
- Based on the available evidence, LCPUFA supplementation did not appear to improve children's neurodevelopment, visual acuity or growth. In child attention at five years of age, weak evidence was found (one study) favouring the supplementation. Currently, there is inconclusive evidence to support or refute the practice of giving LCPUFA supplementation to breastfeeding mothers in order to improve neurodevelopment or visual acuity.
- Evidence is insufficient to permit any conclusions about the effect of PUFAs on the learning abilities of children with specific learning disorders.
- Majority of the RCTS have not shown beneficial effects of LCPUFA supplementation on the neurodevelopmental outcomes of term infants. The beneficial effects on visual acuity have not been consistently demonstrated. Routine supplementation of term infant milk formula with LCPUFA can not be recommended.

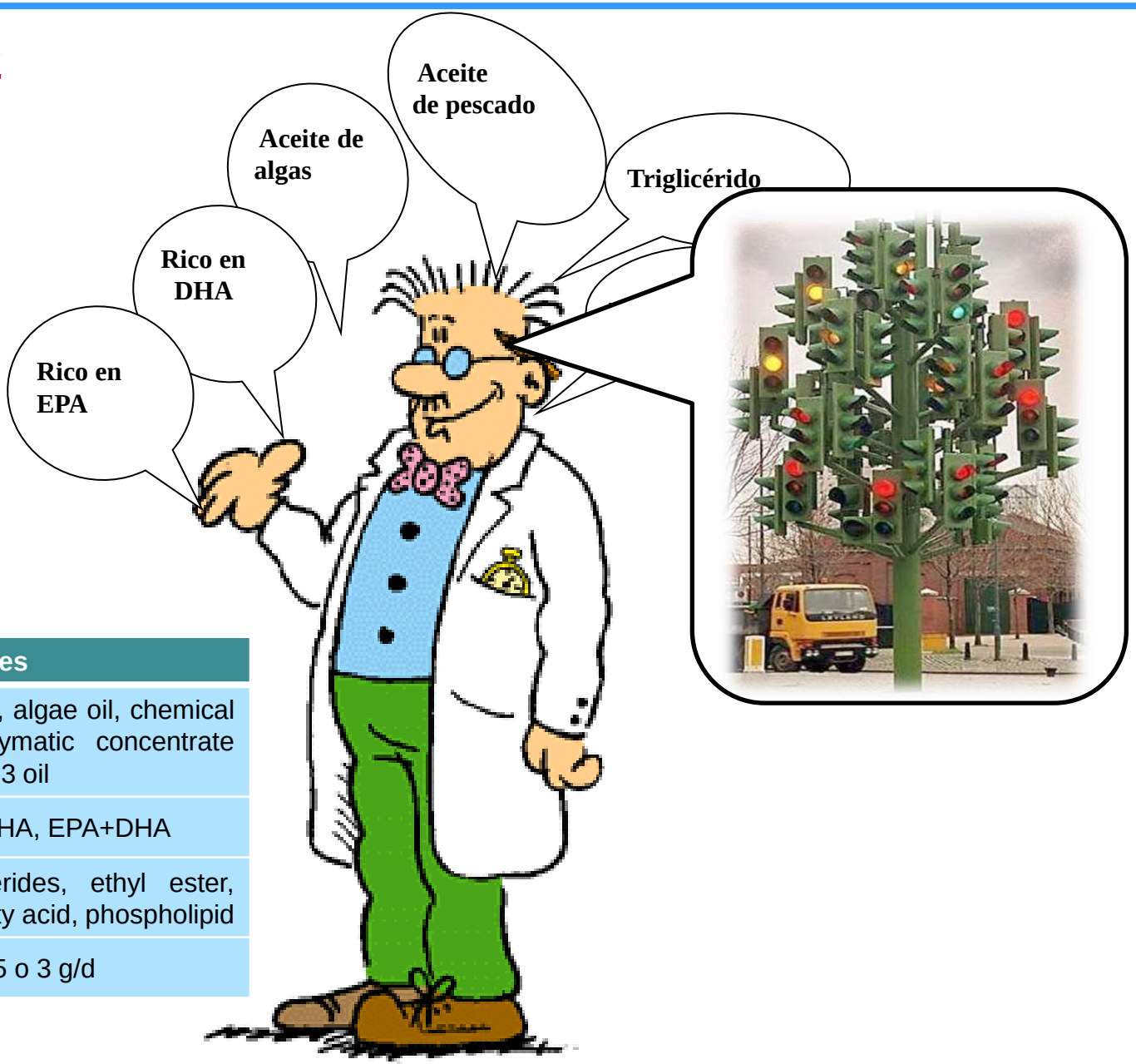
**It is important that future research addresses current weaknesses in this area, which include small sample sizes, variability of selection criteria, variability of the type and dosage of supplementation, short follow-up times and other methodological weaknesses. Well-designed RCTs with clearly defined populations of children with specific learning disorders who have been diagnosed by standardised diagnostic criteria are needed.**

Cochrane Library

Gillies D. et al., Cochrane Database Syst Rev 2012; (7):Cd007986.
Tan M.L. et. Cochrane Database Syst Rev 2016; 9:Cd009398.
Simmer K. et al. Cochrane Database Syst Rev 2011; (12):Cd000376.
Delgado-Noguera M.F. et al. Cochrane Database Syst Rev 2015; 7:Cd007901.

# Suplementación y Meta-análisis

## *Controversia*




| Factor | Variables |
|---|---|
| Type of supplement | Fish oil, algae oil, chemical or enzymatic concentrate omega-3 oil |
| | EPA, DHA, EPA+DHA |
| | Triglycerides, ethyl ester, free fatty acid, phospholipid |
| Dose | 1, 2, 2.5 o 3 g/d |

# Suplementación y Meta-análisis

**Figure 2. Blood omega-6 to omega-3 ratio in patients with ADHD vs. control subjects**

| Study or Subgroup | ADHD Mean | ADHD SD | ADHD Total | Control Mean | Control SD | Control Total | Weight | Mean Difference IV, Random, 95% CI | Year |
|---|---|---|---|---|---|---|---|---|---|
| Stevens 1995 | 10.63 | 6.36 | 53 | 8.01 | 3.47 | 43 | 13.6% | 2.62 [0.62, 4.62] | 1995 |
| Antalis 2006 | 3.59 | 1.06 | 12 | 2.41 | 0.87 | 12 | 22.8% | 1.18 [0.40, 1.96] | 2006 |
| Chen 2007 | 11.07 | 2.35 | 58 | 9.65 | 1.82 | 52 | 22.8% | 1.42 [0.64, 2.20] | 2007 |
| Colter 2008 | 5.86 | 2.04 | 11 | 4.64 | 1.27 | 12 | 17.9% | 1.22 [−0.18, 2.62] | 2008 |
| Mikirova 2013 | 8.3 | 3.6 | 116 | 4.8 | 2.1 | 116 | 22.9% | 3.50 [2.74, 4.26] | 2013 |
| **Total (95% CI)** | | | **250** | | | **235** | **100.0%** | **1.97 [0.90, 3.04]** | |

Heterogeneity: $Tau^2 = 1.16$; $Chi^2 = 22.99$, df = 4 (P = 0.0001); $I^2 = 83\%$
Test for overall effect: Z = 3.60 (P = 0.0003)

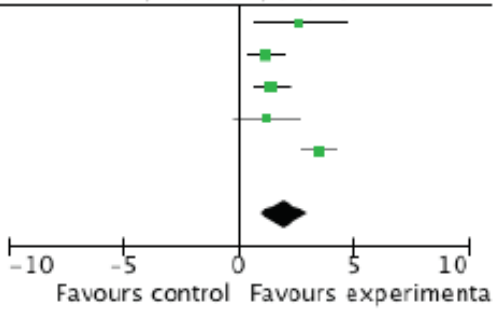
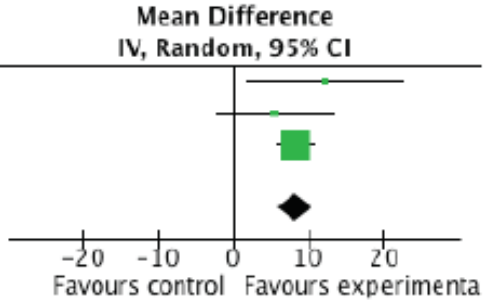



**Figure 3. Blood arachidonic acid (AA) to eicosapentaenoic acid (EPA) ratio in patients with ADHD vs. control subjects**

| Study or Subgroup | ADHD Mean | ADHD SD | ADHD Total | Control Mean | Control SD | Control Total | Weight | Mean Difference IV, Random, 95% CI | Year |
|---|---|---|---|---|---|---|---|---|---|
| Antalis 2006 | 45.81 | 11.83 | 12 | 33.66 | 14 | 12 | 5.0% | 12.15 [1.78, 22.52] | 2006 |
| Colter 2008 | 31.61 | 8.91 | 11 | 26.04 | 10.27 | 12 | 8.7% | 5.57 [−2.27, 13.41] | 2008 |
| Mikirova 2013 | 20.8 | 13 | 116 | 12.5 | 4.2 | 116 | 86.4% | 8.30 [5.81, 10.79] | 2013 |
| **Total (95% CI)** | | | **139** | | | **140** | **100.0%** | **8.25 [5.94, 10.56]** | |

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.99$, df = 2 (P = 0.61); $I^2 = 0\%$
Test for overall effect: Z = 7.00 (P < 0.00001)

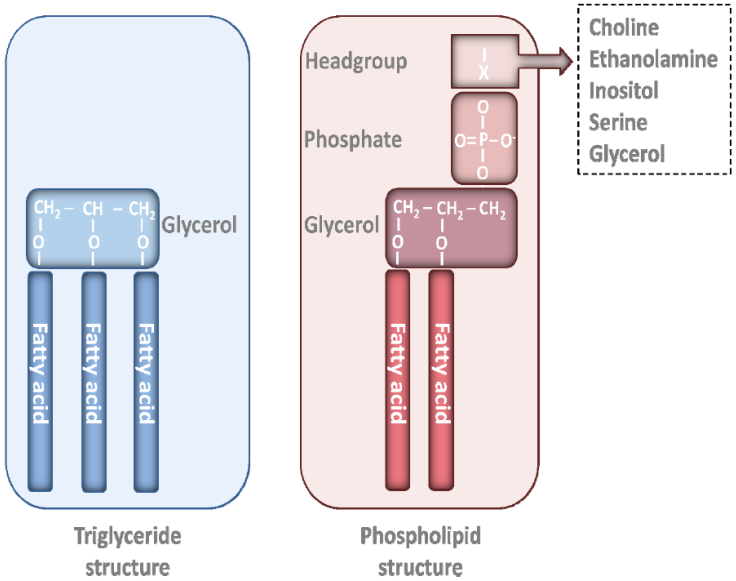


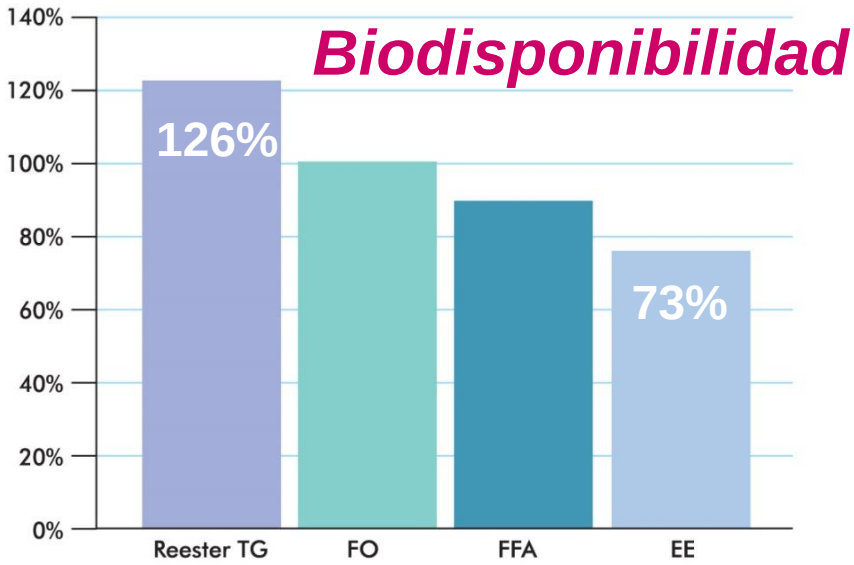

LaChance et al. J Can Acad Child Adolesc Psychiatry 2016; 25:87-96.

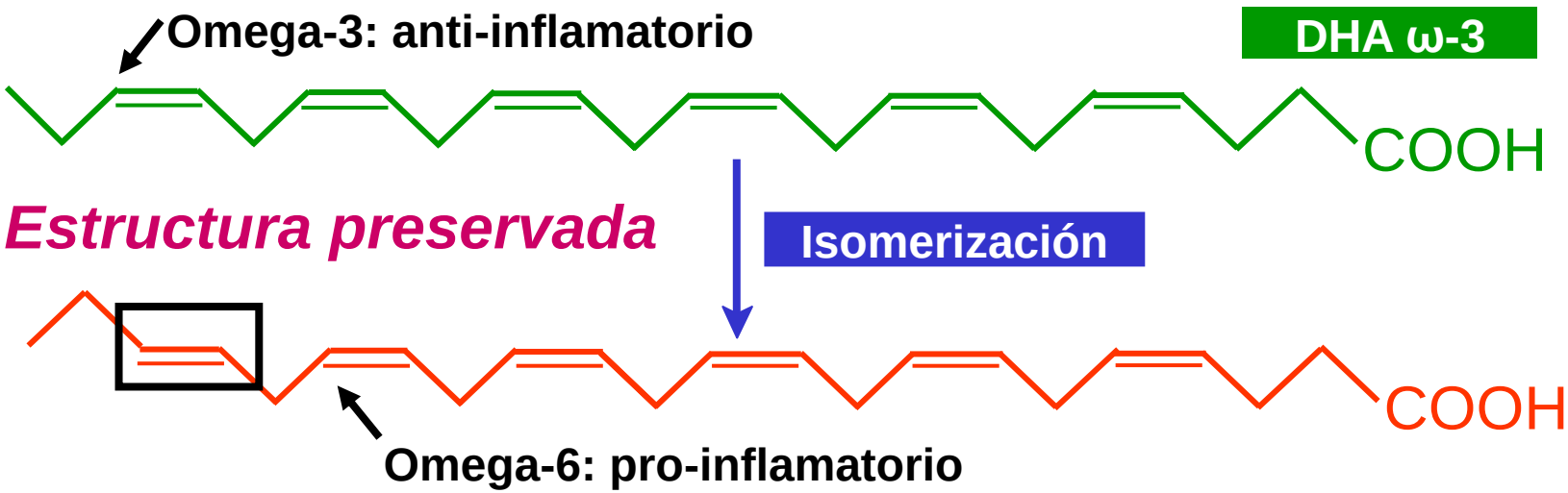
# ¿Cómo ingerir 1 g/d de EPA+DHA?

- **Ingesta de pescado** → **Más eficaz y seguro**
  - 60–90 g diarios de salmón, de sardinas o de caballa
- **Suplementos nutricionales**
  - *Contenido Bajo:* 300 mg EPA+DHA/g (aceite de pescado; 3 g/d) → **Menos dosis**
  - ***Contenido Intermedio-Alto:* 500–800 mg EPA+DHA/g (triglicéridos y fosfolípidos; 1,2-2 g/d)**
  - *Contenido Alto:* 850 mg EPA+DHA/g (esteres etílicos; 1,2 g/d) → **Más biodisponible**

# Aspectos fundamentales

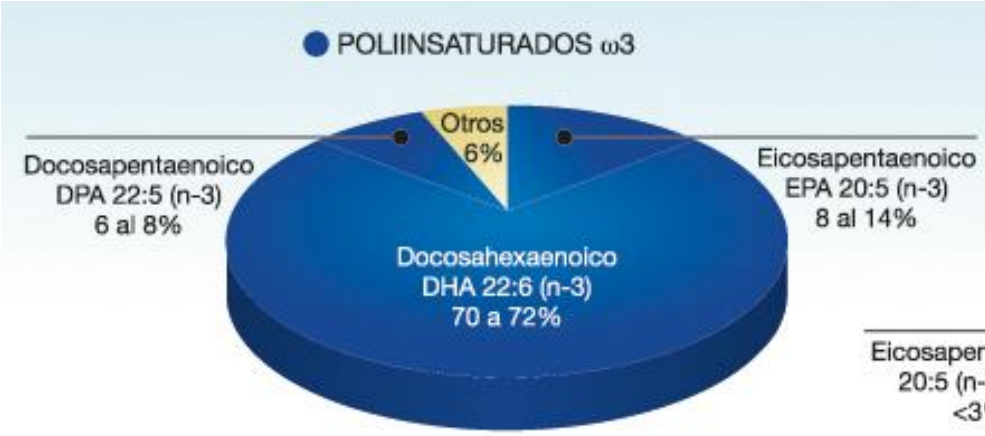


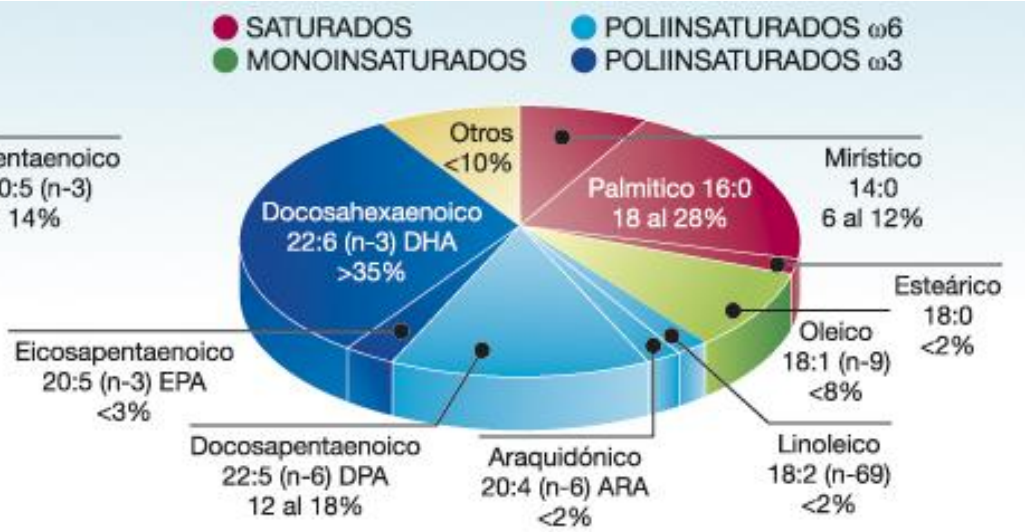



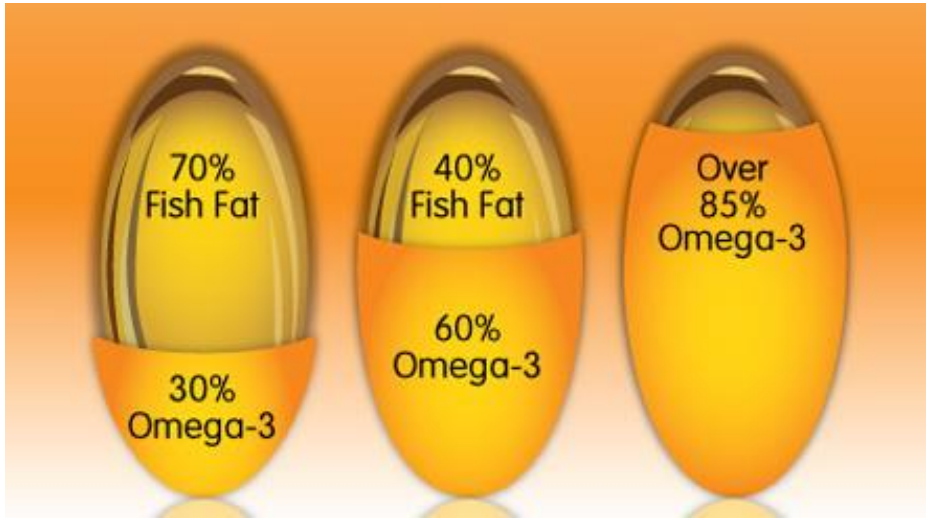




Prostaglandins Leukot Essent Fatty Acids (2010), 83:137-41; Eur J Clin Nutr (2011), 65:247-254

# Aspectos fundamentales




***Eficacia***

# Actividad y Seguridad

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Research Article
SCI
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First published July 6, 2016; doi:10.1152/ajpregu.00005.2016.

## Oxidized fish oil in rat pregnancy causes high newborn mortality and increases maternal insulin resistance

**Benjamin B. Albert,[1] Mark H. Vickers,[1] Clint Gray,[1] Clare M. Reynolds,[1] Stephanie A. Segovia,[1] José G. B. Derraik,[1] Paul A. Lewandowski,[2] Manohar L. Garg,[3] David Cameron-Smith,[1] Paul L. Hofman,[1] and Wayne S. Cutfield[1]**

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1 October 2014

Benjamin B. Albert[1], José G. B. Derraik[1], David Cameron-Smith[1], Paul L. Hofman[1], Sergey Tumanov[2], Silas G. Villas-Boas[2], Manohar L. Garg[3] & Wayne S. Cutfield[1]

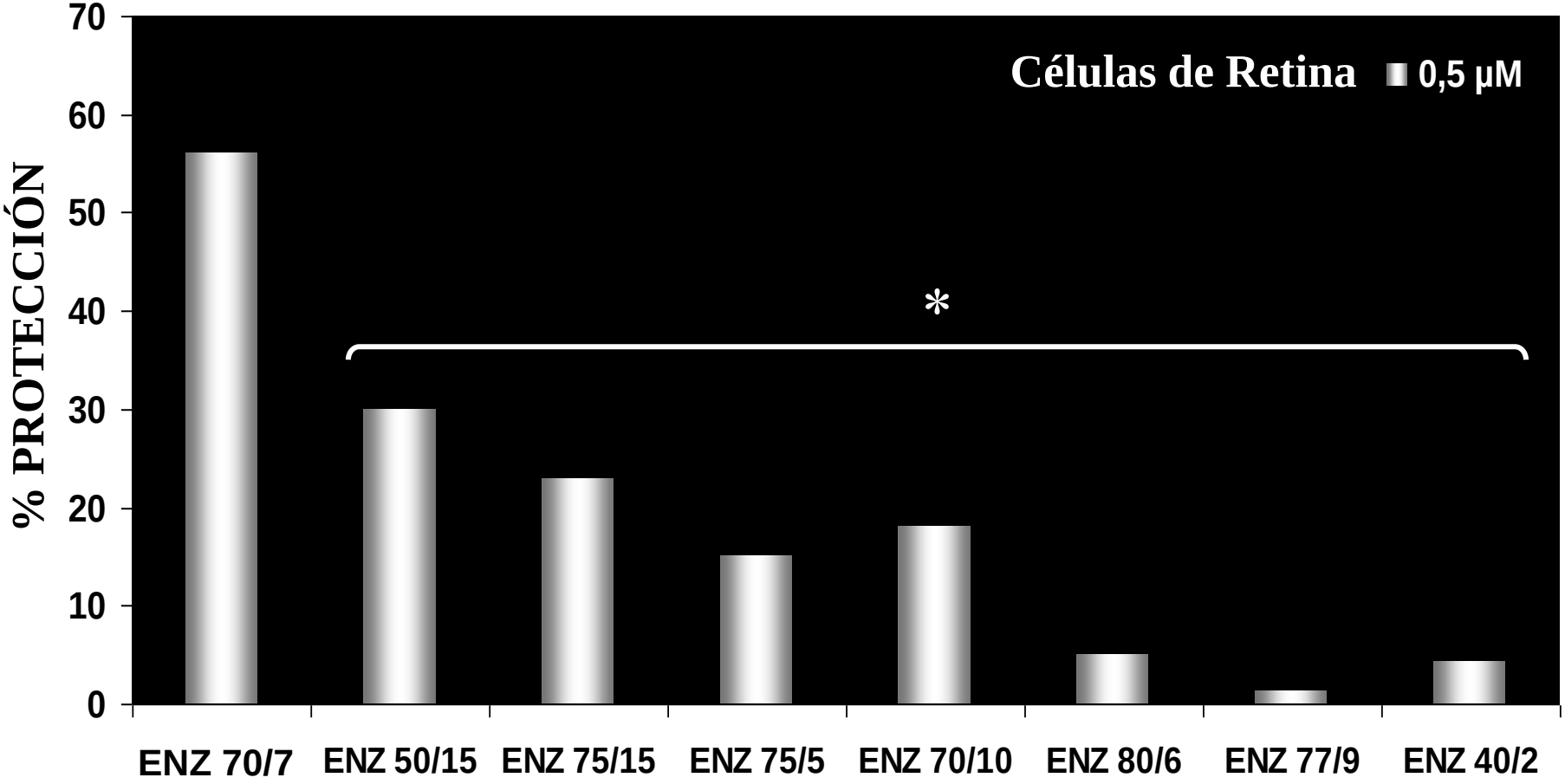
African fish oil supplements: a follow-up study

MARETHA OPPERMAN, SPINNLER BENADE

# Actividad y Seguridad

## *ACTIVIDAD ANTIOXIDANTE CELULAR*

TG-DHA ENZIMÁTICOS EN EL MERCADO




* p<0.05, Enz DHA vs. ENZ 70/7.

# Conclusiones

- **Existen suficientes evidencias que sugieren que el DHA se acumula en el cerebro humano durante los períodos activos de maduración cortical perinatal, y que el DHA desempeña un papel importante en la diferenciación neuronal, la sinaptogénesis y la función sináptica.**

- **Los déficits prenatales en la acumulación de DHA cerebral que no se corrigen a través de la suplementación dietética posnatal se asocian con deficiencias neurocognitivas en las tareas de aprendizaje dependientes del hipocampo y la corteza frontal, y presentan elevados índices de comportamiento con ansiedad, agresión y depresión.**

- **Los bebés prematuros o alimentados con una formula sin DHA presentan un déficit cortical de DHA respecto a los nacidos a término o alimentados con leche humana, lo que se traduce a largo plazo en déficits neurocognitivos, y tienen un mayor riesgo de padecer trastorno por déficit de atención/hiperactividad (TDAH) y esquizofrenia.**

- **En los lactantes, el DHA es importante para el óptimo desarrollo visual y cognitivo. La ingesta habitual de DHA entre los niños pequeños es baja y algunos estudios muestran mejoras en la cognición y el comportamiento como el resultado de la suplementación.**

- **La aplicación nutricional de los ácidos grasos Omega-3, y del DHA en particular, requiere de productos manufacturados con los estándares que se aplican a productos farmacéuticos. Las premisas a tener en cuenta son el contenido en DHA respecto al total de ácido grasos, su biodisponibidad y su método de síntesis y purificación.**

# Gracias por su atención…

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