Omega-6 to omega-3 fatty acid ratio and higher order cognitive function in 7-to-9-year-olds.

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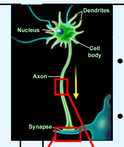
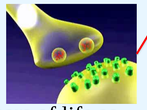
Fatty Acids in the Brain





- Omega-6 (n-6) and omega-3 (n-3) fatty acids are found throughout the brain in phospholipid membranes and concentrated in synaptic vesicles.
- Arachidonic acid (ARA, n-6) and docosahexaenoic acid (DHA, n-3) are related to:
  - neurite outgrowth in the hippocampus and prefrontal cortex (Calderon & Kim, 2004).
  - synaptic transmission (Richards, Bliss, & Richards, 2003).
  - long-term potentiation (Williams et al, 1989).
  - hippocampal volume (Venna et al, 2009).
- It is important to study the impact of nutrition beyond the first two years of life as the brain continues to develop

The n-6 to n-3 fatty acid ratio

- n-6 and n-3 fatty acids work together for brain function (Ikemoto et al., 2001).
- ARA and DHA are synthesized from their essential fatty acid precursors, linoleic acid (LA) and alpha-linolenic acid (ALA), respectively.
- As shown in **Figure 1**, n-6 and n-3 fatty acids are metabolized in the human body by the same desaturases and elongases.
- The mixture of fatty acids that a person consumes determines the production and availability of fatty acids further down the metabolic pathway - such as DHA and ARA (highlighted in yellow).
- The ratio of n-6 to n-3 fatty acids should be the focus of interventions (McNamara et al., 2010).

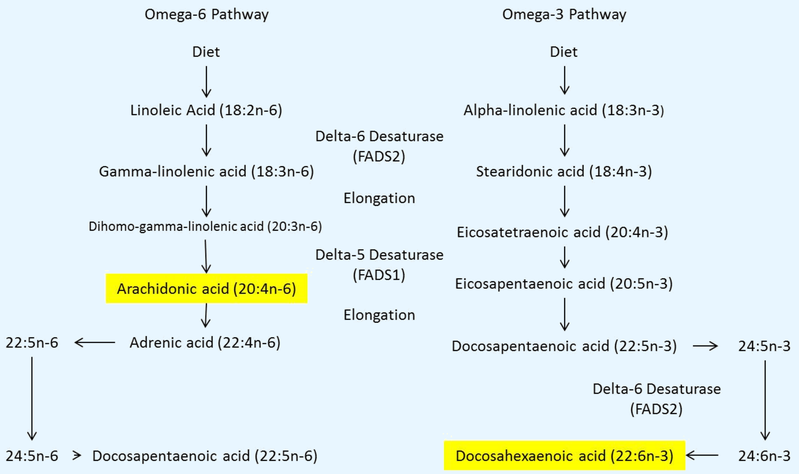


Figure 1. Fatty acid metabolic pathway.

Participants and Method

- Seventy typically-developing children ages 7 to 9 years from Kannapolis, NC participated in this study.
- Three 24-hour diet recalls were collected using the Nutrition Data System for Research (NDSR).
- Parent also completed a Diet History Questionnaire (DHQ) and Temperament in Middle Childhood Questionnaire (TMCQ).
- The Cambridge Neuropsychological Test Assessment Battery (CANTAB) was used for tests of functions such as spatial working memory, planning, and attentional flexibility.
- Information was collected on the child's mode of feeding in infancy, level of physical activity, and exposure to other languages.

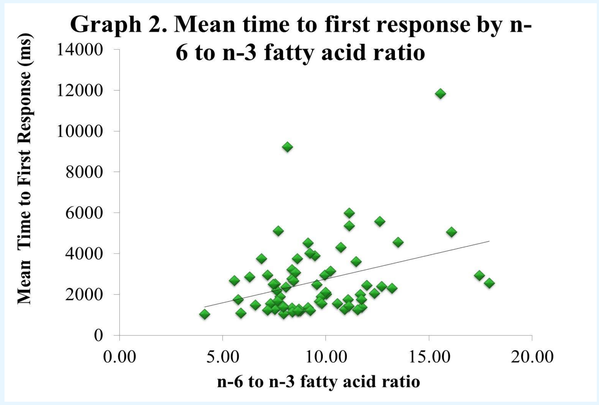
Data Analyses

- The n-6 to n-3 fatty acid ratio was calculated from the NDSR nutrient totals.
- CANTAB provided scores for:
  - latency for solving each task
  - number of errors made in each task
  - number of problems solved in minimum number of moves on a planning task
  - number of trials needed to learn new rules in an attentional flexibility task.
- Child's mode of feeding in infancy, age, level of physical activity, and exposure to other languages were included as covariates.
- CANTAB scores from each task were included in a regression model with any significant covariates to determine if the n-6 to n-3 fatty acid ratio predicted significant variance in CANTAB scores.

CANTAB1, CANTAB2, ...CANTABn = n-6/n-3 + Cov1 + Cov2 + Covn + e

Results

The n-6 to n-3 fatty acid ratio was found to be a significant predictor of the mean time to first response on the eight box spatial working memory task, $F(11,51) = 2.08$, $p=.039$, above and beyond covariates. Children with lower n-6 to n-3 fatty acid ratios took less time to figure out how to find the eight hidden tokens than children with higher n-6 to n-3 fatty acid ratios.



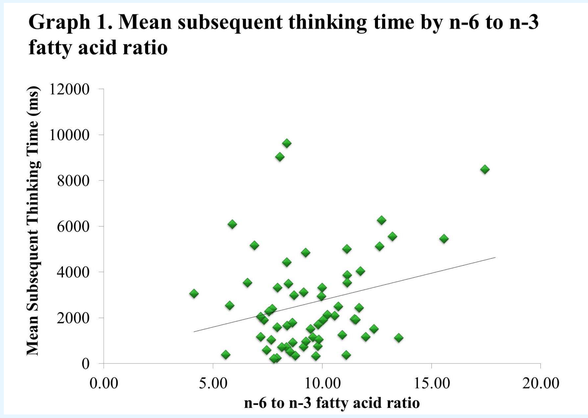
The Spatial Working Memory Task: Eight boxes is the highest number of boxes in which they need to remember where they have already found a blue token so as not to search there again.

Hypothesis

I hypothesized that children with a low n-6 to n-3 fatty acid ratio would perform better on tests of cognitive function than children with a high ratio.

Results

The n-6 to n-3 fatty acid ratio is a significant predictor of the mean subsequent thinking time in the five move Stockings of Cambridge task, $F(11,45)=2.24$, $p=.029$, above and beyond the covariates. Children with lower n-6 to n-3 fatty acid ratios took less time to figure out how to solve the five move Stockings of Cambridge problems than children with higher n-6 to n-3 fatty acid ratios.



The Stockings of Cambridge Task: Five moves is the highest number of moves they need to plan to make the bottom pattern match the top.

Discussion

- These results suggest the continued importance of fatty acids for cognitive function beyond the first two years of life.
- Children with lower n-6 to n-3 fatty acid ratios were found to solve the harder spatial working memory and planning problems faster than children with higher n-6 to n-3 fatty acid ratios
- The n-6 to n-3 fatty acid ratio is a useful tool in understanding how fatty acids affect cognitive function. n-6 and n-3 fatty acid totals did not individually predict performance on any of the cognitive function tasks.

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