Fish Oil Supplementation During Lactation: Effects on Cognition and Behaviour at 7 Years of Age

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Background

- Docosahexaenoic acid (DHA) is a dietary omega-3 fatty acid thought to be integral to brain development and subsequent cognitive development.
- Early accumulation of DHA, an n-3 LC-PUFA, especially in the frontal lobes, may contribute to the development of later cognitive abilities known as executive functions.
- Helland et al. (2003) found that early maternal FA status was related to cognitive processing at 4 years of age. A similar effect was noted in sequential processing at 7 years of age in this sample (Helland et al., 2008): higher cognitive abilities were related to maternal FA status during pregnancy.
- Higher LC-PUFA levels have been related to higher prosocial behaviour scores and lower inattention, emotional difficulties, and hyperactivity scores (Kirby et al., 2010).
- The present study investigated whether fish oil consumption during lactation had an effect on socio-emotional and cognitive functioning at 7 years of age.
- Importantly, the Barker (1997) hypothesis has suggested that a mismatch between prenatal and postnatal milieux may be detrimental to the organism in that the fetus is prenatally “programmed” for survival in a certain postnatal environment.

Participants

- Infants were enrolled in a randomized clinical trial (RCT) at birth and lactating mothers were supplemented with fish oil or olive oil for the first 4 months of their infants’ lives.
- Women were chosen based on their fish intake: low fish intake was defined as below the median intake of women in Copenhagen (fish intake less than 12.3±8.2 g/d and less than 0.40 g/d of n-3 LC-PUFA). Women in the low-fish intake group were randomized to experimental (fish oil) or control (olive oil) groups. A high fish intake (greater than 55.2±26.7 g/d or 0.82 g/d of n-3 LC-PUFA) reference group was included.
- Cognitive assessments were conducted at 9 months, 2.5 years, and 7 years.
- 54 boys and 44 girls completed the protocol at 7 years of age (m=7.34, sd=0.29).
- Fish oil (FO: n=36), Olive oil (OO: n=28), High fish intake (HFI: n=34)
- Intervention: 4 grams oil per day ~ 1.5 g/d n-3 LC-PUFA

	Participants		
	Fish Oil	**Olive Oil**	**High Fish**
N (males)	36 (24)	28 (12)	34 (18)
Age (years)	7.4	7.3	7.3
Birth Weight (kg)	3.7±0.4	3.6±0.4	3.7±0.5
OFC at Birth (cm)	36.0±1.2	35.7±1.3	36.1±1.6
Degree of Breastfeeding (%)	97±0.16	96±0.15	96±0.13
Maternal Education Danish Classification	5.39±1.10	5.43±1.17	5.34±1.26

Method

- Puppy-Ball from Woodcock-Johnson III to test processing speed

Circle puppy-ball

- Sun-Moon Stroop to test working memory, inhibitory control, & cognitive flexibility

Rnd 1: Say sun to sun and moon to moon

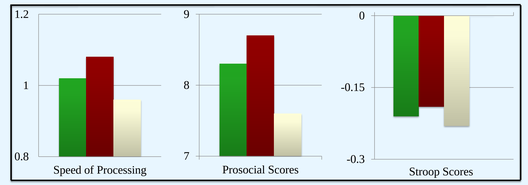
Rnd 2: Say sun to moon and moon to sun

- Interference score = [(# correct sun=moon)-(#correct sun=sun)]/# correct sun=sun
- Strengths & Difficulties Questionnaire (SDQ) – parent report of social interactions
- Weighted infant DHA intake = Breastmilk DHA * % Breastfed
- Maternal DHA Intake = Diet + Supplement
- Infant DHA status = RBC DHA at 4 months of age

Mean±SD (n)	**Fish Oil**	**Olive Oil**	**High Fish**
Speed of Processing	0.96±0.26 (36)	1.02±0.26 (27)	1.08±0.27 (32)
Stroop Scores	-0.23±0.14 (35)	-0.21±0.10 (28)	-0.19±0.13 (32)
Infant RBC-DHA at 4 mo (FA%)	9.04±1.79 (23)	6.49±1.52 (25)	7.30±1.60 (29)
Infant DHA Intake (FA%)	1.22±0.52 (33)	0.42±0.23 (28)	0.74± 0.34 (32)
Maternal n-3 LCPUFA Intake (g/dg)	1.59±0.32 (35)	0.26±0.19 (28)	0.93±0.48 (32)

Results of RCT

- Speed of processing and Stroop scores were submitted to a multivariate analysis of variance (MANOVA) by RCT group (Fish Oil, Olive Oil). No group differences were evident: speed of processing, F(1,62)=0.78, ns; Stroop, F(1,61)=0.30, ns.
- Scores from the SDQ were tested for differences between RCT groups with the Mann-Whitney U-test. There were no group differences, although the prosocial score tended to be higher in the OO group, Z(62)=-1.796, p<0.10. Post-hoc analyses revealed this effect was carried by the boys, and it was significant when analyses were completed with only the boys, Z(35)=-2.264, p<0.05.
- Relative to the FO group, the High Fish reference group had significantly higher prosocial scores, F(1,63)=8.88, p<0.01 and speed of processing scores, F(1,67)=3.77, p<0.05. Stroop scores were not significantly different between the FO and reference groups.



Prenatal DHA	**Postnatal DHA**
Low	Low
High	High
Low	High

Exploratory Analyses

- To determine which variables accounted for variance in continuous variables, backward elimination regressions were employed to build best models.
- Variables used were infant DHA status, infant DHA intake, mean maternal DHA intake, and maternal education.
- Speed of processing was predicted by maternal DHA intake (p=0.05) and maternal education (p=0.04).
- Stroop scores were predicted by infant DHA intake (p=0.05).
- No biomarkers predicted the SDQ scores, but maternal education predicted Peer Problems (p=0.04) and Total Difficulties (p=0.02).

Discussion

- This is the first report of a direct assessment of executive functions in 7-year-olds from an early intervention RCT. No group effect of the intervention was found, but there were significant differences between the experimental and reference groups in speed of processing and prosocial behaviours.
- Exploratory analyses showed that speed of processing is related to maternal intake whereas working memory and inhibitory control are related to infant intake. Neural structures that support speed of processing develop prenatally, whereas those that support working memory and inhibitory control develop in the first year of life. Thus, the data may be indicative of pre- vs. postnatal DHA requirements.
- Alternatively, the data may be indicative of fetal programming of DHA requirements in that children whose mothers had consistent intake, be it high or low, during pregnancy and lactation had better scores than children whose mothers experienced a mismatch in intake (low during pregnancy, supplemented lactation).
- Children with basic underlying cognitive issues go on to develop socioemotional issues as indicated by the lower prosocial scores on the SDQ.

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