Hong Kong PGPN Online Symposium 2020

Highlights Summary

The Post Graduate Program in Paediatric Nutrition (PGPN) Online Symposium held on 20 October 2020 outlined the latest research on the interplay between nutrition, executive functions and child learning. The symposium, supported by the Wyeth Nutrition Science Center Hong Kong (WNSC HK), also provided a platform for scientific exchange and questions from more than 230 healthcare professional participants. The full presentations are available for viewing after scanning the QR codes (exclusive to WNSC HK members).

The Development of Executive Functioning Skills in Preschool Children: Research and Clinical Landscape in Hong Kong

Dr. Fanny Wai Fan Lam (Hong Kong)
Specialist in Developmental-Behavioural Paediatrics
Hong Kong Developmental Paediatrics and Child Neurology Centre

SCAN ME

Why are executive functions important?

"Executive functions (EF) are functions that work together to complete tasks underlying the engagement in purposeful, independent and self-driven behaviors." EF is a meta-cognitive construct that describes skills in self-regulation and encompasses working memory, inhibitory control and cognitive flexibility. It is these very important, inter-related cognitive constructs that together make up EF. These mental processes enable us to plan, focus attention, inhibit distractions, organise and juggle multiple tasks successfully. Impaired EF is implicated in many developmental conditions such as:

- **ADHD** [Attention Deficit Hyperactive Disorder][1]
- **Other DBD** [Disruptive Behavioural disorders][2]
- **SLD** [Specific Learning Disorders][3-5]
- **ASD** [Autism Spectrum Disorder][6, 7]

"You can think of executive functions like the conductor of an orchestra or the air traffic control system at a busy airport."

Neurological underpinnings of brain functions

There are a set of brain functions that activate, organise, integrate and manage other functions. The limbic system within the frontal lobe regulates feeling and emotions. The Anterior Cingulate Gyrus is the connection between the prefrontal cortex and the limbic system and contains spindle neurons which conduct messages with high velocity. Problems in these areas of the brain may lead to difficulties in remembering what to do, making healthy choices, following instructions, rigid or stubborn behavior, shifting attention, managing transitions and regulating emotion and giving clues to the importance of this brain region for successful EF development.

> *"Children are not born with these skills, instead they are born with the potential to develop them."*

Early life development

Tests measuring EF skills show that development is not linear.[8] Although EF skill proficiency begins to develop shortly after birth and builds throughout childhood, there is a window of opportunity for dramatic growth at 3-5 years old (**Figure 1**).[8]

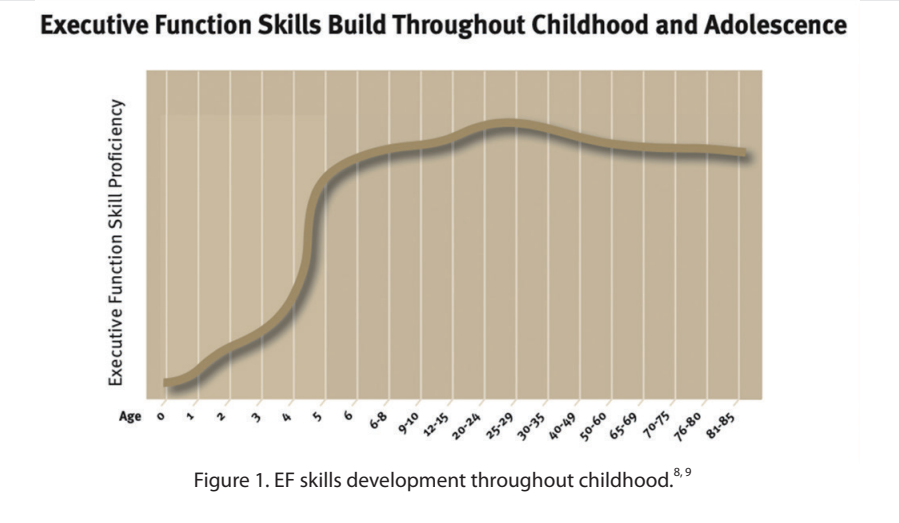


Figure 1. EF skills development throughout childhood.[8,9]

Factors underlying the development of EF

While a loving, attached environment improves EF development, stress from an early age (e.g., alcoholic parents, neglect, etc) appears to disrupt brain architecture and impairs development in areas such as self-care, academic and social settings. Other environmental factors include:

- *Nutrition* – Iodine, Iron, Folate are important for the development of the brain and the emergent cognitive functions (WHO recommends checking iron levels in children with mental delay and begin supplementation before 7 years old)[10]
- *Attachment* – bonding and trust with caregiver[11]
- *Parental scaffolding*[12]
- *Culture*[13]

> *"Undernutrition and deficiencies of iodine, iron, and folate are all important for the development of the brain and the emergent cognitive functions, and there is some evidence to suggest that zinc, vitamin B12, and omega-3 polyunsaturated fatty acids may play a role."* [10, 14]

Mapping Nutrition to Child Cognitive Development and Learning

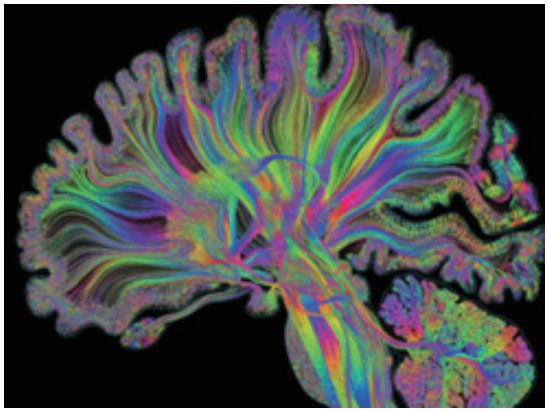
Prof. Sean Deoni (USA)

Associate Professor of Pediatrics (Research)
Associate Professor of Diagnostic Imaging (Research)
Brown University

SCAN ME

The first 1000 days

The brain changes a great deal over the first 1000 days. At the end of the first two years of life, levels of myelination have nearly reached that of an adult.[15, 16] Myelination is central to development; complex cognitive functions and behaviors are a function of the amount of myelination. Myelination is learning.



"When we think of cognitive functioning we think of pre-schoolers, but a brain is actually made across the first 1000 days of life."

RESONANCE study of child development

The RESONANCE study recruited four groups of children and has recorded multiple measurements at many time points including behaviour and cognition, biological specimens, anthropometry, medical and family history, nutrition intake, environment, physical activity, sleep etc.[12] MRI scans were also conducted in the Advanced Baby Imaging Lab when children were asleep, where the images were then used to study patterns of tissue maturation by undertaking structural investigations.[16, 17]

Linking brain and cognitive development

In the RESONANCE study, areas of the brain associated with each other were linked or mapped to different functions. External factors that may have an impact such as age, gender, birthweight, and early nutrition were also investigated. The study results showed that myelination and IQ were correlated, and this was especially pronounced between 400-1600 days **(Figure 2)**.[16, 17]

In addition, children who were breastfed exclusively had more myelination across multiple regions of the brain compared to children who were exclusively formula-fed.[18] Early exclusive breastfeeding was statistically significantly correlated with increased myelination, rate of cortical volume increase and reading and mathematics ability.[15, 18]

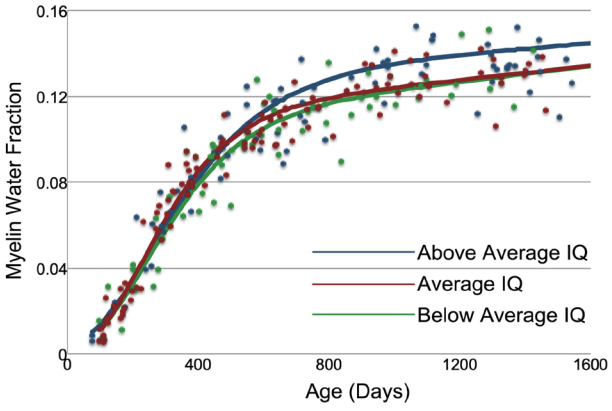


Figure 2. Myelin water fraction (MWF) content and Early Learning Composite Score (IQ) in the first 1600 days of life.[16]

Nutrition and brain development

The RESONANCE study also showed significant differences in different infant formula types and the rate of myelination. The relative quantities of nutrients in the diet can play an important role in myelination e.g., sphingomyelin, folic acid, vitamin D, DHA, cholesterol, phosphatidyl choline (PC), total phospholipids, alpha lactalbumin.[15, 19] The flowchart below shows the postulated link between nutrition and school performance.[15]

Questions from the audience

Find out the answers by watching the live Q&A session here

SCAN ME

- During the COVID-19 pandemic, are there any home-based or digital training tools Dr. Lam would recommend for parents of children with suspected EF-related developmental conditions?
- Would Dr. Lam recommend one of GDS-C or HKCAS-P over the other? Or should both be used for a more comprehensive evaluation?
- Up to what age does Prof. Deoni think key nutrients like DHA and phospholipids can make an impact by supporting myelination and/or brain processes beyond?
- Testing of the gut microbiome was mentioned in Prof. Deoni's child cognitive development studies. How does microbiome serve as an indicator? Is there any evidence that the gut-brain axis is involved?

References

1. Brown, TE, *Attention deficit disorder: The unfocused mind in children and adults., Attention deficit disorder: The unfocused mind in children and adults*, Ed., 2005, Yale University Press, New Haven, CT, US. **2.** Schoemaker, K et al. *J Abnorm Child Psychol* 2013;41,3:457. **3.** Chung, KKH & Mcbride-Chang, C. *J Edu Psych* 2011;103,4:909. **4.** Kudo, MF et al. *Res Develop Dis* 2015;40,51. **5.** Bull, R & Lee, K. *Child Devel Persp* 2014;8,1:36. **6.** Kleinhans, N et al. *Dev Neuropsychol* 2005;27,3:379. **7.** Devine, RT & Hughes, C. *Child Development* 2013;84,3:989. **8.** Center on the Developing Child at Harvard University. *Working Paper No. 11*. 2011; www.developingchild.harvard.edu [accessed 27 October 2020]. **9.** Weintraub, S et al. Neurology 2013;80,11 Suppl 3:S54. **10.** Bryan, J et al. Nutr Rev 2004;62,8:295. **11.** Bernier, A et al. Dev Psychol 2015;51,9:1177. **12.** Hughes, C et al. *J Child Psychol Psychiatry* 2013;54,2:169. **13.** Tardif, T et al. *Biopsychosocial Regulatory Processes in the Development of Childhood Behavioral Problems* 2009;258. **14.** Colombo, J et al. *Am J Clin Nutr* 2019;109,5:1380. **15.** Deoni, S et al. *Neuroimage* 2018;178,649. **16.** Deoni, SC et al. *Brain Struct Funct* 2016;221,2:1189. **17.** Remer, J et al. *Neuroimage* 2020;222,117243. **18.** Deoni, SC et al. *Neuroimage* 2013;82,77. **19.** Schneider, N et al. *eNeuro* 2019;6,4:epub 22 Jul.

In association with

BOSTON UNIVERSITY
Boston University School of Medicine

PGPN
Post Graduate Program in PEDIATRIC NUTRITION

Brought by

MEDINSCRIBE

An educational initiative, supported by

Wyeth® | Nutrition SCIENCE CENTER

Wyeth Nutrition Science Center HK