

NUTRITION & COGNITION



**TOWARDS RESEARCH AND APPLICATION
FOR DIFFERENT LIFE STAGES**

October 19 - 21, 2010

Renaissance Hotel, Kuala Lumpur, Malaysia

Organized by



**International
Life Sciences
Institute (ILSI)
Southeast Asia
Region**



**Nutrition
Society of
Malaysia**

In collaboration with



**Commonwealth
Scientific and
Industrial Research
Organisation**

Symposium Secretariat Office

ILSI Southeast Asia Region, 9 Mohamed Sultan Road #02-01, Singapore 238959
Tel: 65-6352 5220 Fax: 65-6352 5536 Email: nutritioncognition@ilsisea.org.sg
Website: http://www.ilsis.org/SEA_Region/Pages/NutritionCognition.aspx

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Welcome from the Organizers

On behalf of the Organizer, International Life Sciences Institutes – Southeast Asia Region (ILSI SEA Region) and the Co-organizer, Nutrition Society of Malaysia, we take great pleasure in welcoming our distinguished speakers and delegates to this Symposium on Nutrition and Cognition: Towards Research and Application for Different Life Stages.

Interest in cognitive health has been growing over the years, and much research has been done from how to ensure optimal cognitive development from conception, to ways to prevent cognitive decline in the later years. Although many factors may influence cognitive functions, there has been much focus on the role of nutrition on cognition. Advances in research have increasingly shown that nutrition may play a crucial role not only in the physiological development of the brain even before birth, but also the development of cognitive functions, mental performance and behavior throughout life. Increased longevity in many societies leading to larger elderly populations has also spurred research on nutrition for maintenance of cognitive performance and prevention of cognitive degeneration.

The potential for nutrition intervention to influence cognitive development from prenatal conception to cognitive performance at the later life stages is of great interest to researchers, food and beverage producers as well as consumers. In this respect, there is the need to establish evidence-based benefits of nutrients and food components for optimizing cognitive functions that can be substantiated through appropriate assessments tools. These evidence-based benefits in turn need to be properly understood by the consumers.

We appreciate the many eminent experts and scientists from different parts of the world who are joining us here to share their expertise and exchange knowledge. We are grateful to all contributors including many international academic and research institutions and corporate organizations for their generous and enthusiastic support. The Symposium would not be possible without the guidance and hard work of the Scientific and Organizing Committee as well as the staff of the Symposium Secretariat.

We hope that you will have a fruitful and enjoyable Symposium!

Yeong Boon Yee
Executive Director
ILSI Southeast Asia Region

Tee E Siong
President
Nutrition Society of Malaysia

About the Organizers



The International Life Sciences Institute (ILSI) is a non-profit, worldwide foundation based in Washington, DC, USA, established in 1978 to advance the understanding of scientific issues relating to nutrition, food safety, toxicology, risk assessment and the environment. ILSI accomplishes its work through its Branches and the ILSI Research Foundation.

Established in 1993, ILSI Southeast Asia Region (ILSI SEA Region) facilitates and coordinates scientific programs, research and information dissemination in ASEAN, Australia, New Zealand and the Pacific Islands. By bringing together scientists from academia, government, industry and the public sector, ILSI seeks a balanced approach to solving problems of common concern for the well-being of the general public. ILSI receives financial support from industry, governments, and foundations.



Established in 1985, the Nutrition Society of Malaysia (NSM) is a non-profit organization that facilitates networking among its 500 professional members, organizes annual scientific conferences and scientific update sessions, and publishes a peer-reviewed scientific journal. NSM has also conducted several major child, family and women's nutrition education programs.

About the Collaborator



The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is Australia's national science agency and one of the largest and most diverse research agencies in the world. Its research spans the innovation spectrum from undertaking fundamental research to the application of scientific knowledge to current business issues.

CSIRO's Flagships bring together teams of leading researchers from CSIRO, universities, industries and other research organizations to focus significant resources on the most critical challenges facing Australia and the world. The Flagships, including Food Futures and Preventative Health National Research Flagships, are striving for life-changing breakthroughs in essential areas including water, energy, health, food, light metals and the oceans.

Scientific and Organizing Committee

Prof David Benton	University of Swansea, UK
Dr Peter Willatts	University of Dundee, UK
Dr Saskia Osendarp	Unilever R&D Vlaardingen, The Netherlands
Prof Rachel Galli	Simmons College, USA
Prof Richard Head	CSIRO Preventative Health Flagship, Australia
Prof Michael Fenech	CSIRO Food and Nutritional Sciences, Australia
Prof Khor Geok Lin	International Medical University, Malaysia
Dr Tee E Siong	Nutrition Society of Malaysia, Malaysia
Dr Vongsvat Kosulwat	Mead Johnson Nutrition, Thailand
Dr Seiji Aoyagi	Abbott Nutrition R&D, Singapore
Dr Allan Lim	Nestle R&D Centre, Singapore
Mrs Yeong Boon Yee	ILSI SEA Region
Ms Pauline Chan	ILSI SEA Region
Ms Mia Isabelle	ILSI SEA Region

Secretariat Office

Ms Amy Kok	ILSI SEA Region
Ms Joycelyn Seah	ILSI SEA Region
Ms Yeong Li Yuin	ILSI SEA Region

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Day 1 – Tuesday, October 19, 2010

0730 – 0845 **Registration**

0845 – 0915 **Welcome and Opening Remarks**

*Mrs Yeong Boon Yee, ILSI SEA Region
Dr Tee E Siong, Nutrition Society of Malaysia*

Opening Plenary

0915 – 0950 **Cognition – Understanding the Concepts in Health and Disease**

Prof David Benton, University of Swansea, UK

0950 – 1025 **Cognitive Functions Across Life Stages: What Are the Influencing Factors?**

Prof J Steven Reznick, University of North Carolina at Chapel Hill, USA

1025 – 1100 **Morning Break / Posters and Exhibits Viewing**

Theme 1: Role of Nutrition in Cognitive Development

1100 – 1130 **Micronutrients and Cognitive Development: an Overview***

Dr Saskia Osendarp, Unilever R&D Vlaardingen, The Netherlands

1130 – 1200 **LC-PUFAs for Cognitive Development: from Pregnancy to Infancy and Beyond**

Dr Peter Willatts, University of Dundee, UK

1200 – 1230 **Effect of Maternal Nutrition on Offspring Brain Development**

Prof Namsoo Chang, Ewha Womans University, Korea

1230 – 1245 **Q&A**

1245 – 1415 **Lunch / Posters and Exhibits Viewing**

Regional Studies on Nutrition Status for Cognitive Development and Function in Children

1415 – 1445 **Indonesia and Australia: Nutrition Enhancement for Mental Optimization Study**

Ms Lindawati Wibowo, SEAMEO-TROP MED RCCN, Indonesia

1445 – 1515 **India: Nutritional Intervention and Cohort Studies in School Children**

Prof Srinivasan Krishnamachari, St. John's Medical College & Research Institute, India

1515 – 1545 **Thailand: Micronutrients Supplementation Studies in Pregnant Mums, Infants and School Children**

Prof Pattanee Winichagoon, Institute of Nutrition, Mahidol University, Thailand

1545 – 1600 **Q&A**

1600 – 1630 **Afternoon Break / Posters and Exhibits Viewing**

Theme 2: Role of Nutrition in Cognitive Performance and Cognitive Degeneration

1630 – 1700 **Nutrient Requirements for Cognitive Function in Adults and Elderly***

Prof Michael Fenech, CSIRO Food and Nutritional Sciences, Australia

1700 – 1730 **Omega-3 and Dementia: Mechanisms and Effects**

Prof Andrew Sinclair, Deakin University, Australia

1730 – 1740 **Q&A**

* The 2 papers will be presented via video

Day 2 – Wednesday, October 20, 2010

0830 – 0900 **Posters and Exhibits Viewing**

0900 – 0925 **Nutrition and Cognitive Ageing in Older Adults: Findings from the Singapore Longitudinal Ageing Studies**

Prof Ng Tze Pin, National University of Singapore, Singapore

0925 – 0950 **Nutritional and Dietary Risk Factors Related to Mild Cognitive Impairment among Elderly People in Malaysia**

Prof Suzana Shahar, Universiti Kebangsaan Malaysia, Malaysia

0950 – 1015 **Effects of Protein and Amino Acids on Cognitive Performance**

Dr Paramjeet Singh, Cerebos Pacific Limited, Singapore

1015 – 1030 **Q&A**

1030 – 1050 **Morning Break / Posters and Exhibits Viewing**

1050 – 1120 **Functional and Herbal Substances: Effects on Cognitive Performance**

Prof Andrew Scholey, Brain Science Institute, Swinburne University, Australia

1120 – 1150 **Role of Polyphenols on Cognitive Function in Adults and Elderly**

Prof Rachel Galli, Simmons College, USA / Dr Barbara Shukitt-Hale, USDA HNRCA at Tufts University, USA

1150 – 1215 **Functional Ingredients for Enhancing Cognitive Performance: Industry Perspectives on Pre-clinical Innovations**

Dr Rema Vazhappilly, Abbott Nutrition R&D, Singapore

1215 – 1230 **Q&A**

1230 – 1345 **Lunch / Posters and Exhibits Viewing**

Theme 3: Assessment of Cognitive Functions

1345 – 1420 **Nutrition and Cognition - Methodological Approaches to Its Study**

Prof David Benton, University of Swansea, UK

1420 – 1450 **Assessing Cognitive Development in Infants and Young Children**

Prof J Steven Reznick, University of North Carolina at Chapel Hill, USA

1450 – 1520 **Adapting Cognitive Tests to Asian Children Population**

Prof Srinivasan Krishnamachari, St. John's Medical College & Research Institute, India

1520 – 1535 **Q&A**

1535 – 1555 **Afternoon Break / Posters and Exhibits Viewing**

1555 – 1625 **Assessing Cognitive Improvement due to Nutritional Influences in Adults**

Prof Jeroen Schmitt, Nestlé Research Centre, Switzerland

1625 – 1655 **The Australian Imaging, Biomarker & Lifestyle Flagship Study of Ageing: Early Detection and Intervention on Neurodegenerative Disease**

Dr Kathryn Ellis, University of Melbourne, Australia

1655 – 1730 **Panel Discussion : Considerations for Conducting Nutritional Research and Cognitive Assessment in the Region**

Day 3 – Thursday, October 21, 2010

Theme 4: Evidence-based Claims and Consumer Understanding on Cognition

0900 – 1045 **Perspectives on Claims Substantiation in the Area of Nutrition and Cognition**

European Union – *Dr Peter Willatts, University of Dundee, UK*

Australia – *Prof Richard Head, CSIRO Preventative Health Flagship, Australia*

Japan – *Prof Toshio Shimizu, Nagoya-bunri University, Japan*

Southeast Asia Region – *Dr Tee E Siong, TES NutriHealth Strategic Consultancy, Malaysia*

1045 – 1105 **Q&A**

1105 – 1125 **Morning Break**

1125 – 1150 **Industry Perspective of Nutritional Products for Cognitive Function – Omega-3's as a Case Study**

Dr Rob Winwood, Martek Biosciences, USA

1150 – 1215 **Consumer Understanding on Nutrition and Cognition: A Life Course Perspective**

Dr Josephine Wills, European Food Information Council, Belgium

1215 – 1250 **Panel Discussion: Opportunities and Challenges in the Region – Claims and Consumer Understanding on Nutrition and Cognition**

1250 – 1300 **Synthesis and Closing Remarks**

1300 – 1400 **Lunch**

SPEAKERS'
PROFILES



DAVID BENTON is Professor of Psychology at the University of Swansea, UK. After training as a Psychologist, he studied Biochemical Pharmacology and now specializes in the study of the influence of nutrition on psychological functioning. His research objective is to develop either food items, or dietary recommendations, that will facilitate memory and mood. His projects have considered the role of dietary induced changes in blood glucose on mood and cognition; the influence of meals, in particular breakfast and snacks; the impact of various vitamins and minerals; the role of macronutrient intake in mood and cognition; and the influence of food-related substances including lecithin, carnitine, creatine, phosphatidylserine, docosahexaenoic acid and chocolate. Prof Benton has worked with many multi-national food and ingredient manufacturers in Belgium, France, Germany, Japan, Switzerland, UK and the USA. He has produced over 200 research publications and over the last 15 years has received more than 120 invitations to speak from over 20 countries.



J STEVEN REZNICK is Professor of Psychology, and Associate Dean for First Year Seminars and Academic Experiences at the University of North Carolina (UNC) at Chapel Hill, USA. He is also the Director of the Research Participant Core and Co-director of Behavioral Measurement Core at the UNC Neurodevelopmental Disorders Research Center. Prof Reznick's primary research interests are cognitive development in infants, detecting infants who are at risk for an eventual diagnosis of autism, and exploring nutritional influences in early development. He has published numerous books, monographs, chapters and articles and is serving on the editorial board of several journals including *Developmental Science* and *General Psychology Review*. Prof Reznick received his BA in Psychology from UNC Chapel Hill and his PhD from the University of Colorado at Boulder, USA.



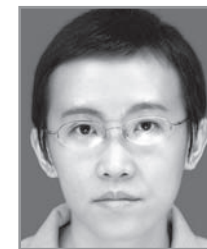
SASKIA OSENDARP is a Science Leader, Child Nutrition at the Unilever R&D Vlaardingen, The Netherlands, as well as a visiting assistant professor in micronutrients and international health at the Department of Human Nutrition at Wageningen University, The Netherlands. Before joining Unilever in 2001, she worked for 10 years in public health nutrition research in developing countries, including Ivory Coast and Bangladesh. From 1994 until 2001 she worked as a nutrition scientist focusing on micronutrient nutrition during pregnancy and infancy at the ICDDR,B: Centre for Health and Population Research in Dhaka, Bangladesh. Dr Osendarp has published numerous papers on the impact of micronutrients on pregnancy outcomes and children's cognitive development. More recently, she worked in the area of micronutrients and obesity in children in transitional countries as well as the impact of fatty acids on children's health and development. Dr Osendarp obtained her MSc in Human Nutrition and her PhD on zinc supplementation during pregnancy and infancy from Wageningen University.



PETER WILLATTS is currently a Senior Lecturer at the School of Psychology of the University of Dundee, UK. He studies cognitive development in infants and young children, and has a special interest in thinking and problem solving. This work has led to the development of several tests of infant problem-solving ability which have been widely used to assess the effects of nutrition on cognitive development. Dr Willatts also studies the effects of early diet and nutrition on cognitive development, and his published research includes the effects of LC-PUFAs on cognition and behaviour in normal children, and the influence of iodine and thyroid hormone insufficiency on the development of children born preterm. He is on the Editorial Board of the journal *Infant and Child Development*, and is an Expert Panel Member of the Working Group of the Scientific Panel on Dietetic Products, Nutrition and Allergies at the European Food Safety Authority. Dr Willatts obtained his PhD in Psychology from the University of London, UK.



NAMSOO CHANG is presently a full Professor of Nutrition in the Department of Nutritional Science and Food Management at Ewha Womans University, Korea. She is an established researcher in the field of vitamin nutrition and metabolism in health and disease, and she has published over 120 archival journal papers and presented many papers in international conferences. She is the Vice President of the Korean Society of Medical Nutrition Science and the immediate past President of the Korean Nutrition Society. Prof Chang has previously served on the WHO/FAO Expert Working Group on Vitamins/Minerals Risk Assessment, NIH/Office of Dietary Supplements Annual Bibliography Projects, and on a number of committees including the Upper Limits committee (chair), Korean Dietary Reference Intakes, etc. In 2009, she was the recipient of the National Medal for Promotion of Science and Technology by the Ministry of Education, Science and Technology, Korea. Prof Chang received her PhD from Rutgers University, USA, and completed her dietetic training at Yale-New Haven Hospital, USA.



LINDAWATI WIBOWO is currently an Academic Staff at the Southeast Asian Ministers of Education Organization - Tropical Medicine and Public Health (SEAMEO-TROPMED) Regional Center for Community Nutrition (RCCN) at the University of Indonesia, Indonesia. A nutritionist by profession, she has special interest in the area of nutrition intervention, epidemiology, and health and nutrition programmatic issues. She has done research on micronutrients supplementation for Indonesian children and has worked with the Nutrition Enhancement for Mental Optimization (NEMO) Study Group, investigating the effect of micronutrient intervention on learning and memory in school children. Ms Wibowo is currently a PhD candidate in International Nutrition at Cornell University, USA, under the International Nutrition Foundation and Nestle Foundation Fellowship. She obtained her MSc in Community Nutrition from SEAMEO-TROPMED RCCN, University of Indonesia, and her Bachelor degree in Environmental Microbiology from Satya Wacana Christian University, Indonesia.



SRINIVASAN KRISHNAMACHARI is a Professor in Psychiatry at the St. John's Medical College and a Vice Dean at the St. John's Research Institute, India. He obtained his training in Psychiatry at the National Institute of Mental Health & Neurosciences, India before joining St. John's Medical College. He has done research in the area of nutrition status and childhood cognitive performance in recent years. Prof Srinivasan has published numerous peer-reviewed publications. He is a member of the editorial advisory board for *Electronic Journal of Biomedicine* as well as a reviewer for numerous journals. He received his MBBS from Maulana Azad Medical College and his MD in Psychiatry from the National Institute of Mental Health & Neurosciences, India.



PATTANEE WINICHAGOON is an Associate Professor at the Institute of Nutrition, Mahidol University, Thailand. Her work in the area of maternal and child micronutrient status, micronutrient intervention and community-based nutrition is well regarded and she has provided advice and consultation to various WFP, UNICEF-EAPRO and AUSAID projects, to name a few. She has also published numerous peer-reviewed articles and monographs. Prof Winichagoon was the Vice Chair of the Scientific Committee for the 19th International Congress of Nutrition held in Bangkok in 2009. She obtained her MSc in Nutrition from University of Hawaii and her PhD in International Nutrition from Cornell University, USA.



MICHAEL FENECH is a Principal Research Scientist at CSIRO Food & Nutritional Sciences, Australia, and an adjunct Professor at the University of South Australia. He has over 20 years of research experience in the fields of genetic toxicology and nutrition. His current research focuses on the use of nutritional genomics approach to determine micronutrient requirements for optimizing genome stability and to define Dietary Reference Values based on DNA damage prevention. He also investigates the practical implementation of the Genome Health Clinic concept which he developed based on the personalized diagnosis of DNA damage and its prevention using dietary and life-style strategies. In 2008, Prof Fenech was awarded the prestigious Alexander Hollaender medal by the US Environmental Mutagen Society for outstanding contributions to environmental mutagenesis research and protection of human health. His publications have been cited more than 6,500 times and his current H-index is 42.



ANDREW SINCLAIR is the Director of the Metabolic Research Unit and Professor of Nutrition Sciences in the School of Medicine at Deakin University, Australia. Professor Sinclair teaches at the undergraduate and postgraduate levels and also supervises higher degree students. Prof Sinclair's research interests cover a range of areas related to fatty acid metabolism in man and animals and the composition of foods (lipids and fat soluble vitamins). His latest research interests are in the role of essential nutrients in brain function (zinc, DHA, DPA α -3), lipidomic analysis of brain regions and omega 3 fatty acid metabolisms in fish and mammals. He is the immediate past President of the Nutrition Society of Australia (NSA) and the current President of ILSI SEAR Australasia. Prof Sinclair serves on the Publication Advisory Board of AOCS and is an Editor for the *British Journal of Nutrition*. He has over 250 publications in peer-reviewed journals.



NG TZE PIN is an Associate Professor at the Department of Psychological Medicine at the National University of Singapore, Singapore. He is also the Director of the Gerontological Research Programme and the Principal Investigator of the Singapore Longitudinal Ageing Studies. His research interest is in the area of chronic diseases epidemiology, aging and health, neuropsychiatric disorders, and clinical epidemiology and health services research. Prof Ng currently conducts randomized controlled trials of physical, nutritional and cognitive interventions for prefrail elderly. He has published over 170 papers and has been invited to speak at various meetings. He received his Doctorate in Medicine from the National University of Singapore in 1993.



SUZANA SHAHAR is a Professor of Nutrition and Dietetics and the Deputy Dean of Research and International Relations at the Faculty of Allied Health Sciences, Universiti Kebangsaan Malaysia, Malaysia. Her research interest is on the nutritional epidemiology in aging and cancer and has led several related projects including Development of Nutritional Screening Tools for Elderly Individuals, Determination of Risk Factors of Breast and Prostate Cancers, Clinical Trials for Prevention of Cognitive Decline and Sarcopenia in Elderly Individuals, etc. She has been involved in several national task forces to formulate the Recommended Nutrient Intake of Malaysia, Malaysian Dietary Guidelines, etc. Prof Shahar is the Chief Editor of *Malaysian Journal of Health Sciences*, an editor of *Sains Malaysiana* and reviewer of several journals. She has published more than 40 articles in journals, 13 books and chapters in books. She is a life member of the Gerontology Association of Malaysia and the Nutrition Society of Malaysia. Prof Shahar obtained her PhD in Human Nutrition from the University of Sheffield, UK.



PARAMJEET SINGH is a Senior Manager at the BRAND'S Health Science Centre, Regional R&D, Cerebos Pacific Limited, Singapore. His research interest is on food and brain-centered total body physiology, how consumed bioactive ingredients influence diverse body functions by acting mainly on the brain. He also investigates the mechanisms of immediate action of known and novel bioactive ingredients on the brain and the secondary pathways for distal effects. Prior to joining Cerebos, Dr Singh was an Assistant Professor at the A*STAR Institute of Molecular and Cell Biology, Singapore, where he also headed the applied cancer research programme at the Cancer and Developmental Biology Division. He has authored several peer reviewed publications in the area of biochemistry. Dr Singh received both his PhD in Biochemistry / Genetics and his bachelor degree from the National University of Singapore, Singapore.



ANDREW SCHOLEY is a Professor of Behavioural and Brain Sciences at the Brain Sciences Institute (BSI), Swinburne University, Australia. He is also the Head of their Herbal and Nutritional Medicine Research Unit and Co-Director of the NICM Centre for the Study of Natural Medicines and Neurocognition. In 1998, he established the Human Cognitive Neuroscience Unit at Northumbria University, UK, and was the Unit's Director until joining the BSI in 2007. Prof Scholey was also Co-Director of the UK's Medicinal Plant Research Centre and remains as Honorary Director of Neurocognitive trials. Prof Scholey has published dozens of journal articles focusing on the potential mood and cognition enhancing effects of natural products. His research uses state-of-the-art methodology, including neurocognitive assessment, brain imaging and various physiological analyses to disentangle the neurocognitive effects of specific nutritional interventions focusing on plant extracts to enhance cognitive performance.



RACHEL L GALLI is an Associate Professor of Psychology and Director of Psychobiology at the Simmons College in Boston, USA. Since 1998, she has been a collaborator with Dr Barbara Shukitt-Hale of the Neuroscience Laboratory at the USDA Human Nutrition Research Center on Aging at Tufts University, USA. Prof Galli's research examines cellular and molecular changes in the brain that may underlie normal aging and the effects of nutritional interventions targeting deficits in learning and memory. She is currently investigating the potential of a normal diet supplemented with fruit high in polyphenols in slowing or even reversing age-related deficits in cognitive and motor function. Prof Galli received her undergraduate degree in Physiological Psychology from Hofstra University, USA, and her PhD from the Brain, Behavior and Cognition program at Boston University, USA.



REMA VAZHAPPILLY is a Research Scientist at Abbott Nutrition, Pacific Asia R&D, Singapore, working on early stage development of novel food ingredients for cognition enhancement. Prior to joining the company, she had over 9 years of post-doctoral experience in molecular neuroscience at Hong Kong University of Science and Technology and National University of Singapore. Her research previously focused on N-methyl D-aspartate Receptor, a receptor protein which play major role in cognition, neurodegenerative and neuropsychiatric diseases. Dr Vazhappilly had authored several publications in peer reviewed journals. She received her PhD from University of Hong Kong, Hong Kong, China.



JEROEN A J SCHMITT is currently the Head of Clinical Evaluation at Nestlé, Switzerland. The Clinical Evaluation group ensures high quality Clinical Operations for Nestlé clinical trials worldwide. He is also an Adjunct Professor at the Brain Sciences Institute of Swinburne University, Australia. From 2006 to 2010, he was the Head of the Cognitive Sciences Group at Nestlé Research Center, investigating the role of nutrition in mental health and cognition throughout life in clinical and pre-clinical studies. He had also worked as an Assistant Professor in Biopsychology and Psychopharmacology at Maastricht University, The Netherlands, investigating the role of serotonin and dopamine in human cognitive behavior by using human intervention studies with antidepressants, as well as tryptophan and tyrosine depletion methodologies. For the past 5 years, Prof Schmitt has chaired ILSI Europe's Mental Performance Taskforce, which promotes methodological research in the field of nutrition and cognition. He received his PhD in Psychopharmacology at Maastricht University, The Netherlands.



KATHRYN ELLIS is a Research Psychologist with the Department of Psychiatry, University of Melbourne, Australia. She is also the Head of the Clinical Research Group at the Mental Health Research Institute, the National Manager of the Australian Imaging, Biomarker & Lifestyle Flagship Study of Ageing (AIBL) study, and the Manager of the biomarkers discovery stream of Dementia Collaborative Research Centre 2 – Early Diagnosis and Prevention. Her main research interests include cognition, neuroimaging and Alzheimer's disease, with a focus on identifying risk factors for cognitive decline. Dr Ellis obtained her PhD in behavioural neurosciences from Swinburne University, Australia. She conducted research focusing on cognition, psychopharmacology and neuroimaging undertaken during a year's placement at Imperial College of London, UK.



RICHARD HEAD is the Director of CSIRO Preventative Health Flagship, Australia, and a coordinator of the 'Promoting Health' Sector Domain across CSIRO. Under his leadership, the Flagship engages with 7 CSIRO Divisions, over 30 Australian and 8 international or overseas research institutions and agencies. He specifically oversees development of early detection and intervention in colorectal cancer, Alzheimer's disease and obesity. Prof Head was formerly the Chief of CSIRO Division of Health Sciences and Nutrition and has also served as Professor of Clinical and Experimental Pharmacology at the University of Adelaide, Australia. He has over 40 years of research experience in investigating the etiology of chronic diseases that affect societies. Prof Head has published extensively in the field of biomedical science and managed science portfolios of significant size. He is a member of numerous professional organizations and is a board member of Australian e-Health Research Centre and School of Molecular and Biomedical Science at the University of Adelaide, Australia.



TOSHIO SHIMIZU is a Professor at the School of Health and Human Life in Nagoya-bunri University, Japan, and President of FrescoJapan Co. Ltd. He is also a Lecturer at the Niigata University of Pharmacy and Applied Sciences, Japan. Prof Shimizu is very involved in regulatory science, mainly on functionalities and health claims of foods, especially Food for Specified Health Use (FOSHU) and dietary supplements. He is a Council member of the Japanese Clinical Nutrition Association and the Organization for Japan Supplement Adviser Authority as well as a Committee member for qualifying Nutrition Representatives in the National Institute of Health and Nutrition. He has published numerous scientific publications on R&D and regulation of functional foods and biotechnology of food. Prof Shimizu received his PhD in biochemistry from the University of Tokyo, Japan.



TEE E SIONG is a Nutrition Consultant for TES NutriHealth Strategic Consultancy, Malaysia. He was the Head of the Cardiovascular, Diabetes and Nutrition Research Center of the Institute for Medical Research (IMR) in Kuala Lumpur until his retirement in 2002 after serving for 30 years. He is currently a Nutrition Advisor to the Food Safety and Quality Division (FSQD) of MOH Malaysia and the Chairperson of the following sub-committees: (1) National Codex Sub-Committee on Nutrition and Foods for Special Dietary Uses; (2) Expert Working Committee on Nutrition, Health Claims and Advertisement; and (3) Working Group on Food/Drug Interface products. He is also a member of the National Advisory Committee on Food Regulations and the National Coordinating Committee on Food and Nutrition. Dr Tee serves as Scientific Director on the Board of ILSI SEA Region and is also the President of the Nutrition Society of Malaysia. He has published over 150 scientific articles and papers and made over 200 presentations on various aspects of food and nutrition in seminars and conferences within and outside Malaysia.



ROB WINWOOD is currently the Director of Scientific Affairs in Europe and Asia at Martek Biosciences, USA. He has held a series of senior technical and business development positions in various global food ingredient companies including Archer Daniels Midland, Kelco International and Tunnel Avebe Starches. He is a specialist in vegetable oils and macromolecular fermentation and has recently served as President and Vice-President of Biopolymer International. Dr Winwood has a doctorate and honours degree in Food Science. He is a Chartered Scientist and Fellow of the Institute of Food Science and Technology. He is also a member of International Society for the Study of Fatty Acids and Lipids and serves on the scientific committee of GOEOmega3 and the lipids committee of the Society of Chemistry for Industry. Dr Winwood has written a book on the UK Food Manufacturing Industry and has authored numerous scientific publications. He has been an invited speaker at many conferences around the globe.



JOSEPHINE WILLS is the Director General of the European Food Information Council (EUFIC), Belgium. Based in Brussels, the organization aims to enhance the public's understanding of food safety and quality, and health and nutrition related issues, and the active role they play in safe food handling and choosing a well-balanced and healthy diet. Prior to joining EUFIC, she worked for Mars in science, communication, and regulatory roles for 18 years, latterly as European Head of Scientific and Regulatory Affairs for all product categories. Dr Wills has published over 80 scientific papers, edited four books and lectured extensively worldwide. She obtained her bachelor degree from the Royal Veterinary College in London and her PhD from the University of Bristol Veterinary School, UK. She also completed several years of postdoctoral research at the University of Manchester Medical School, UK.

SYMPOSIUM ABSTRACTS



OPENING PLENARY



CHAIR

Dr Tee E Siong
Nutrition Society of Malaysia, Malaysia

Cognition – Understanding the Concepts in Health and Disease

David Benton

University of Swansea
UK

Aimed at the non-specialist, a general introduction to the nature and measurement of cognition will be given. A general conclusion is that any measure of cognition, although intended to mainly assess one dimension, will also reflect a range of other factors. As such, test results need to be interpreted and should not be viewed as an 'assay' that reports a particular aspect of cognition as a single number. The choice of tests must be matched to the sample being studied. It is the pattern of responses to a series of tests that allow an effect to be interpreted.

The term "cognition" includes a range of functions and processes that allow us to perceive, evaluate, manipulate, store and use information obtained from the environment. It is suggested that cognitive functioning can be clustered into six main domains: executive functions, memory, attention, perception, psychomotor and language skills. In turn, each of these cognitive domains can be subdivided. As an example, memory is not a single item but rather a multi-dimensional process. Information has to be processed and then stored, perhaps for many years. The mechanisms for remembering something for a few seconds, for example a telephone number, differ from those involved in retaining information for years. Before it can be used information needs to be recovered from the store. It is a common experience that we are aware we know something but cannot bring it to mind. In addition, the mechanisms that store different types of information differ: is it a verbal, auditory, visual, spatial or a motor skill? It has been established that there are various types of long-term memory. There is a basic distinction between declarative and non-declarative memory; declarative memories can be stated verbally while non-declarative memories, such as how to ride a bicycle, cannot be expressed in words. The distinctions do not end here; there are two types of declarative memory i.e. semantic and episodic. Semantic memory reflects general knowledge about the world that is not unique to us and is not recalled in the context of a particular time, for example knowing that the capital of Malaysia is Kuala Lumpur. In contrast, episodic memory reflects personally experienced events, such as your wedding, memories based in time and place. It is apparent that a wide range of tests are required to assess the many permutations of these dimensions of memory.

Cognitive tests are designed to primarily measure a particular aspect of cognitive functioning with as much selectivity as possible. It is, however, inevitable that any behavior is the outcome of the complex interaction between many aspects of cognitive functioning. In addition, a range of tests is necessary as the test chosen needs to be appropriate for the subjects being tested. You would not give the same test of memory to a child, people differing greatly in their intelligence, or somebody suffering with dementia. To be meaningful, a test must not be too hard or too easy for the particular individual.

Given the slow and variable nature of aging, it is important that studies of cognitive change use sensitive and appropriate measures of memory to monitor what are initially subtle changes in functioning. Whereas the ability to retain items for a short period and semantic memory are relatively spared by aging, over time episodic memory in particular declines.

An important influence on the rate of cognitive decline is 'cognitive reserve', the capacity of the brain to deal with the effects of disease without manifesting clinical symptoms. Those with initially greater intelligence are said to have a greater 'cognitive reserve', i.e. greater ability to resist both normal aging and disease. Thus the influence of prenatal diet on brain development, and then nutritional influences during childhood and adolescence, may impact on the incidence of dementia in later life. As the brain develops more rapidly than the rest of the body, great demands are placed on the diet to supply the building blocks necessary for brain development. At the end of the first year of life the brain is fifty

percent of its adult weight whereas the body weight is about fifteen percent of the adult. In infancy, given the lack of development, it is difficult to measure cognitive functioning. The approach taken tends to be to assess the age at which particular skills develop although such measures only to a limited extent predict later intellectual functioning.

As we age the brain shrinks, a process that begins as a young adult and proceeds over many decades. As it is widely believed that diet can influence the rate of cognitive decline, the aim must be to slow the rate of decline. As such, dietary interventions need to start as a young adult and may be influential over many decades.

In summary, considerable care should be taken when choosing a cognitive test, or ideally a range of cognitive tests as it is often difficult to interpret one test in isolation. The test should be chosen to reflect the level of ability of the sample being studied and their stage of cognitive development or cognitive decline.

Cognitive Functions Across Life Stages: What Are the Influencing Factors?

J Steven Reznick

University of North Carolina at Chapel Hill
USA

The factors that influence cognitive function can be categorized into three broad domains and then subcategorized at various levels within each domain. The broad domains of influence are biological infrastructure, environment, and mental mediation. The subcategories within biological infrastructure include influences like genes, the proteins produced by genes, and the biological systems that we label as neurological, muscular, skeletal, etc. Environment includes broad influences like culture and education; more proximal influences like family and interpersonal relations; and relatively specific factors like nutrition and exposure to environmental toxins. Finally, mental mediation refers to intuitive influences like our perceptions; our mental representations; and our ability to think, and to monitor and modify our goal-directed behavior.

From a developmental perspective, prenatal development entails extremely rudimentary cognitive functions that are influenced primarily by biological infrastructure, some environmental influence via the mother's body, and no apparent mental mediation. Cognitive function changes dramatically during the first year of life, with strong influences of biological infrastructure and the environment, and relatively minor influence of mental mediation. The balance among influences shifts during the second year, reflecting changes in biological infrastructure, environment, and mental mediation. During childhood, the biological infrastructure becomes relatively stable, the environment remains extremely important, and the influence of mental mediation becomes increasingly potent. This balance among influences remains relatively stable until the transition from childhood to adolescence and then from adolescence to adulthood, both of which reflect a significant reemergence of the influence of biological infrastructure. Cognition in adulthood is affected primarily by environment and mental mediation, and this configuration remains relatively stable in most people until the point in aging when biological infrastructure begins to deteriorate.

The mechanisms whereby cognitive functions are influenced across life stages are complex: each domain of influence has multiple levels, and the paths of influence are almost always bilateral. For example, a child's retina affects what the child sees, the graphic characteristics of a stimulus affects what the child sees, and the child's awareness of, and interest in, a stimulus affects the child's movement towards or away from the stimulus, which also affects what the child sees. Genetic "recipes" can influence the configuration of the retina, an environmental influence like consumption of long-chained fatty acids can facilitate development of the retina, and eye glasses can affect the child's visual acuity if the child is willing to wear them, which might be affected by parental sanctions or by how peers react.

It seems reasonable to expect that scientific exploration of cognitive function will eventually provide expansive models that describe how the various influences fit together at various stages in the lifespan. However, given the complexity of these models, it is important to recognize that we cannot generate models until we have a thorough understanding of each component. And, this thorough understanding of influences on cognitive development will not emerge until we have developed techniques to measure cognition and the relevant influences. A considerable amount of recent research has focused on measuring the internal biological infrastructure, and progress is being made. However, it is important to note that the behavioral manifestations of cognitive functions are not only particularly relevant in these models but also particularly difficult to measure. Stakeholders who seek to identify the factors influencing cognitive functions across life stages will have limited success until they have fostered the development of appropriate measurement techniques to provide valid and reliable operational definitions of constructs like "cognitive development", "mental optimization", "cognitive function", "cognitive aging", "cognitive impairment", and "cognitive performance", all of which are terms mentioned in the titles of presentations that we will hear at this conference.

THEME I: ROLE OF NUTRITION IN COGNITIVE DEVELOPMENT

CHAIRS

Prof David Benton
University of Swansea, UK

Prof Khor Geok Lin
International Medical University, Malaysia

Micronutrients and Cognitive Development: an Overview

Saskia Osendarp

*Unilever R&D Vlaardingen
The Netherlands*

The brain requires adequate nutrition for optimum growth, development and maturation. Several micronutrients are known to be essential for the proper structure of brain tissue, for healthy neurochemistry and for the growth and maturation of the brain. Inadequate intakes of these micronutrients may hinder proper development. As the brain develops in the fetus right through to adulthood, growth occurs at different rates in different areas, with different levels of impact of micronutrients on the developing cognitive functions.

There is strong evidence for beneficial effects of iron and iodine on several aspects of cognitive performance, particularly in children who are deficient in these micronutrients. For other micronutrients, in particular vitamin B12, folate and zinc, evidence for positive effects of supplementation on improved mental development is emerging. Interventions with multiple micronutrients have been shown to improve certain domains of cognitive development in school-aged children, whereas other domains seem less affected.

Hence, micronutrient malnutrition and its impact on child development may have major social consequences. Epidemiologic evidence suggests that over 200 million children are being hampered in their development, as a result of, among others, chronic nutrient deficiencies. In later years, this restricted potential will present enormous social and economic problems.

LC-PUFAs for Cognitive Development: from Pregnancy to Infancy and Beyond

Peter Willatts

*University of Dundee
UK*

Long-chain polyunsaturated fatty acids (LC-PUFAs), especially docosahexaenoic acid (DHA) and arachidonic acid (ARA), are key building blocks in the brain. There is a rapid uptake of DHA and ARA by the infant brain, beginning in the third trimester of pregnancy and continuing throughout the first two years of life (Martinez, 1992). LC-PUFA synthesis is inefficient in both the foetus and young infant, and a supply of preformed LC-PUFAs is necessary to meet the needs of the rapidly developing brain. During pregnancy, the mother provides her unborn baby with increasing amounts of LC-PUFAs which are actively transported across the placenta. Breast-fed infants continue to receive LC-PUFAs because breast milk contains all the required fatty acids. However, DHA supply to the unborn baby during pregnancy, and DHA content of breast milk may both be low if maternal diet does not include foods that are sources of preformed DHA (Connor et al., 1996; Helland et al., 2001; Yuhas et al., 2006). Many infant formulas now contain LC-PUFAs, ensuring that bottle-fed infants can receive an adequate supply.

A large number of studies have examined whether variation in the supply of preformed LC-PUFAs to both the foetus and the newborn can influence infant cognitive development. Many have reported no effects of LC-PUFAs on measures of performance obtained with global tests of infant development such as the Bayley Scales. However, these findings are generally inconclusive because global tests of development do not adequately assess cognitive abilities developing during the first two years of life (Willatts & Forsyth, 2000; Eilander et al., 2007). Global tests of infant development were originally designed to detect delayed development, and place undue emphasis on perceptual and motor skills, rather than important cognitive functions.

An alternative approach has been to study the effects of LC-PUFAs on specific cognitive functions such as information processing and problem solving. Speed of information processing in infants can be assessed by measures of visual attention (look duration) during visual paired comparison or habituation tests. Infants fed a formula supplemented with DHA and ARA show faster information processing during the first year of life compared to infants fed a control formula, and one observational study reported a significant relation between higher maternal DHA status at delivery, and faster infant information processing on a test of visual habituation at 4 and 6 months (Colombo et al., 2004).

A second assessment is means-end problem solving, which involves the deliberate achievement of a sequence of steps to achieve a goal. Simple examples include finding a toy that is hidden under a cover, or pulling a cloth to retrieve an out-of-reach toy resting on the far end. Means-end problem solving ability develops rapidly between 6 and 12 months (Willatts, 1999), and several randomised clinical trials have found that supplementation with LC-PUFAs, especially DHA, in pregnancy and the first six months of life improves the development of this type of problem solving (Willatts et al., 1998; Judge et al., 2007).

LC-PUFAs contribute to the development of several cognitive abilities in infancy, but it is important to show whether these advantages continue into later childhood or gradually disappear over time. Although the number of follow-up studies is relatively small, the results show that these effects of LC-PUFAs can extend beyond infancy to influence efficient information processing in later childhood (Jensen et al., 2005; Helland et al. 2003). Although more research is needed, it appears that optimal provision of LC-PUFAs early in life may have long term benefits for cognitive function.

In contrast, studies of the effects of LC-PUFA supplementation on cognition in older children are less clear. Although evidence is accumulating that LC-PUFAs may have cognitive and behavioural benefits for children with learning difficulties such as dyslexia or ADHD, studies of LC-PUFA supplementation in normal children have found little or no effects on cognition and behaviour.

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Effect of Maternal Nutrition on Offspring Brain Development

Namsoo Chang

Ewha Womans University

Korea

This paper presents a collective overview on the studies related to the effect of maternal malnutrition on brain development of the offspring. Although brain growth is known to be remarkably spared relative to the rest of the body during maternal undernutrition, a large body of literature shows that an exposure to an undesirable maternal nutrition can not only alter the brain development during fetal or postnatal life, but also cause damages on cognitive abilities that can have a long lasting and irreversible effect. In a developing brain, the demand for proteins and long chain essential fatty acids is far greater than that in an adult one, and these macronutrients are known to be critically important for the synthesis of nucleic acids, neurotransmitters, growth factors and brain structures, as well as formation of cell membranes, synapse and myelin. Among other micronutrients, minerals such as iodine, iron and zinc, and vitamins such as choline, folate, vitamin B6 and vitamin B12 are known to be particularly important for normal brain development and function. Maternal deficiencies of these nutrients have shown to impact brain development of the offspring negatively. In recent years, there have been other discoveries from studies on how maternal overnutrition caused alterations in the brain development that are related to the regulation of appetite and feeding behaviors. In the presentation, more emphasis will be placed on the role of micronutrients that are involved in one-carbon metabolism and of iodine and zinc.

Regional Studies on Nutrition Status for Cognitive Development and Function in Children

Indonesia and Australia: Nutrition Enhancement for Mental Optimization Study

Lindawati Wibowo

SEAMEO-TROPED Regional Center for Community Nutrition, University of Indonesia
Indonesia

Little is known about the combined effect of micronutrients and essential fatty acids on cognitive function in school-aged children. This intervention study is done to assess the effect of micronutrients, long-chain n-3 fatty acids, or both on indicators of cognitive performance in well-nourished and marginally nourished school-aged children.

Methods. Four treatment groups were constructed by a factorial design: micronutrients (M; contains iron, zinc, folate, vitamins A, B6, B12, C), long chain n-3 fatty acids (Fa; consists of docosahexanoic acid and eicosapentaenoic acid), micronutrients and long chain n-3 fatty acids (MFa), and placebo (P) groups. The research was conducted in two study sites to acquire samples from both populations of marginally-nourished and well-nourished school-aged children (6-10 years old) whom resided in Jakarta-Indonesia and Adelaide-Australia, respectively. The sample size (60 children per treatment group) was calculated to detect an effect size of 0.4-0.7 SD for most of the cognitive test scores with 80% power and $\alpha=0.05$. In sampling the subjects, there were 42 schools in Australia and 6 schools in Jakarta randomly selected as the cluster units, and then all children within those schools were followed up on the opportunity to participate. After screening, a total of 396 children in Australia and 384 children in Indonesia were randomly allocated into treatment groups. The interventions products were produced by one manufacturer (Unilever Netherlands BV) in the form of powdered fortificants, indistinguishable in color, and color-coded. Within 12 months study period, all children were recommended to consume the interventions products - dissolved in 100 mL of a soy-based fruit drink - 6 days/week. At baseline and after 12 months intervention, the biochemical status of these children was assessed; while their cognitive performance was measured at baseline, 6 months, and 12 months.

Results

Australia. Although the drop-out rate was relatively high (30%), but no baseline characteristics differences were found between those who completed and those who dropped out from the study. Among those who completed the study, about 62% of their parents did not consent to blood sampling. Thus, based on a small number of children (ranging from 24 to 31 children per group) with adherence to feeding regimen around 76% (assessed by return sachet count), it was found that M treatment improved concentrations of serum ferritin, body iron stores, red blood cell folate, vitamin B12. Additionally, Fa treatment has also significant effects on changes in plasma EPA, plasma DHA, and total plasma n-3 fatty acids. A significant positive treatment effect was observed only among children in M treatment group on their verbal learning and memory (estimated effect size: 0.23 with 95% CI: 0.01, 0.46), but not on the other factors (i.e. general intelligence and visual attention).

Indonesia. Majority of the selected children completed the study (96%) with relatively high adherence to feeding regimen (86%, based on direct observation by teachers) and also agreed on blood sampling (89%). The M treatment improved concentrations of serum ferritin, hemoglobin, red blood cell folate, and vitamin B12; decreased serum transferrin receptor concentration; improved body iron stores. Both the M and Fa treatments increased changes in plasma DHA and total plasma n-3 fatty acids.

There was a non-significant trend for improved scores on verbal learning and memory test only among the girls in M treatment group (estimated effect size: 0.32 with 95% CI: -0.01, 0.64), but no treatment effect was observed on general intelligence and visual attention.

Conclusion. In well-nourished school-aged children, fortification with multiple micronutrients may result in improvements in verbal learning and memory.

Limitation of the study. With respect to the applied sampling technique, there may be threats to validity of the analysis due to misspecification of the analytical model and low power (Murray, 1998). When the variations due to schools as cluster units was not taken into account in the analysis and the "independence of errors" assumption was violated, the treatment effects on the outcomes indicators cannot be precisely detected due to underestimation of the variance of condition mean and thus, overstated the significance of the result. Another possible case is that between-cluster variation may not be constant over different treatment groups, thus, inducing intraclass correlation (usually positive) and reducing the effective sample size for the trial and power. The "insignificant" findings may partly explain by this matter since the sample size of this study was not multiplied by an (appropriate) design effect or variance inflation factor (VIF). In Australia, minimally, adherence to feeding regimen of children with blood samples and those without blood samples should be tested for the difference for identifying any threat of response bias.

This presentation is based on the Nutrition Enhancement for Mental Optimization Study published in the following paper:

The Nemo Study Group (Baghurst KI¹, Bryan J¹, Calvaresi E¹, Hughes D¹, Wilson C¹, Lukito W², Karyadi E², Hussaini M², Mikarsa H², Osendarp SJM³, van Klinken BJ-W³, van de Knaap HCM³, Transler C³). Effect of a 12-mo micronutrient intervention on learning and memory in well-nourished and marginally-nourished school-aged children: parallel, randomized, placebo-controlled studies in Australia and Indonesia. *Am J Clin Nutr* 2007;86:1082-93.

¹ CSIRO, Human Nutrition, Adelaide, Australia

² The SEAMEO-TROPED Regional Center for Community Nutrition, University of Indonesia, Jakarta Pusat, Indonesia

³ The Unilever Food and Health Research Institute (UFHRI), Unilever R&D, Vlaardingen, Netherlands

Regional Studies on Nutrition Status for Cognitive Development and Function in Children

India: Nutritional Intervention and Cohort Studies in School Children

Srinivasan Krishnamachari

*St. John's Medical College & Research Institute
India*

Brain functions in infants and children are particularly vulnerable to nutritional deficiencies especially during its phase of rapid development. Recent decade has seen a considerable interest in studying the impact of nutritional intervention on cognitive abilities in infants and children. While many factors influence the functional outcome of nutritional intervention in children, baseline nutritional status and home environment are particularly critical.

This presentation will share data from studies conducted at St. John's Research Institute, Bangalore. Specifically the presentation will focus on the effect of fortification with multiple micronutrients and omega-3 fatty acids on cognitive performance in school children (the CHAMPION Study), the effect of NaFeEDTA fortified whole wheat flour on cognitive performance in school children, and the impact of maternal nutritional status during pregnancy on later development of cognitive abilities in school going children. In addition, results from a study on the effect of home environment on cognitive performance in school going children will be presented. Finally, issues related to the conduct of a nutritional intervention study in a developing country setting will be highlighted.

Regional Studies on Nutrition Status for Cognitive Development and Function in Children

Thailand: Micronutrients Supplementation Studies in Pregnant Mums, Infants and School Children

Pattanee Winichagoon

*Institute of Nutrition, Mahidol University
Thailand*

Micronutrient deficiencies, specifically iodine, iron and possibly zinc, have been shown to compromise cognitive ability of infants and young children. Micronutrient interventions, whether supplementation or fortification, not only correct the clinical deficiencies or improve biochemical indicators, but also improve functions. We have conducted randomized controlled trials on micronutrient interventions in children and pregnant women to assess the impacts on biochemical status, growth, morbidity and cognitive functions.

The randomized placebo controlled study in school children (n = 569) in Thailand was to test the efficacy of multiple fortified micronutrients (vitamin A, iron, iodine and zinc) in the seasoning powder of instant noodle products. At baseline, there were high prevalence of low zinc and urinary iodine excretion (UIE). While the prevalence of anemia was high (31%), only 16% of anemic children were iron deficient. Marginal vitamin A deficiency was found in 23%, of which only 3% was < 0.7 µmol/L. Age, hemoglobinopathy and serum retinol were significant predictors of hemoglobin. After 31 weeks of intervention, fortification group had significantly improved iodine and zinc status, but was not statistically different in term of anemia prevalence. Moreover, fortification reduced respiratory-related illnesses and diarrhea, despite relatively low incidence of these morbidities. For visual recall, the fortified group recalled 0.5 items more than the unfortified group, but there was no difference in the digit span forward and backward.

In Vietnam, a randomized controlled trial with factorial design of micronutrients fortification (15 nutrients) in biscuits and deworming was conducted among school children (n=510) for 4 months. Improved biochemical status was observed for key micronutrient deficiencies, namely, increases in serum ferritin, retinol, zinc, iodine and reduction of anemia. The fortification was found to enhance the impact of deworming by lowering the infection rates measured at 2 and 4 months after intervention. Multi-micronutrient fortification significantly improved digits span forward and Raven's Colored Progressive Matrices tests, especially in anemic children.

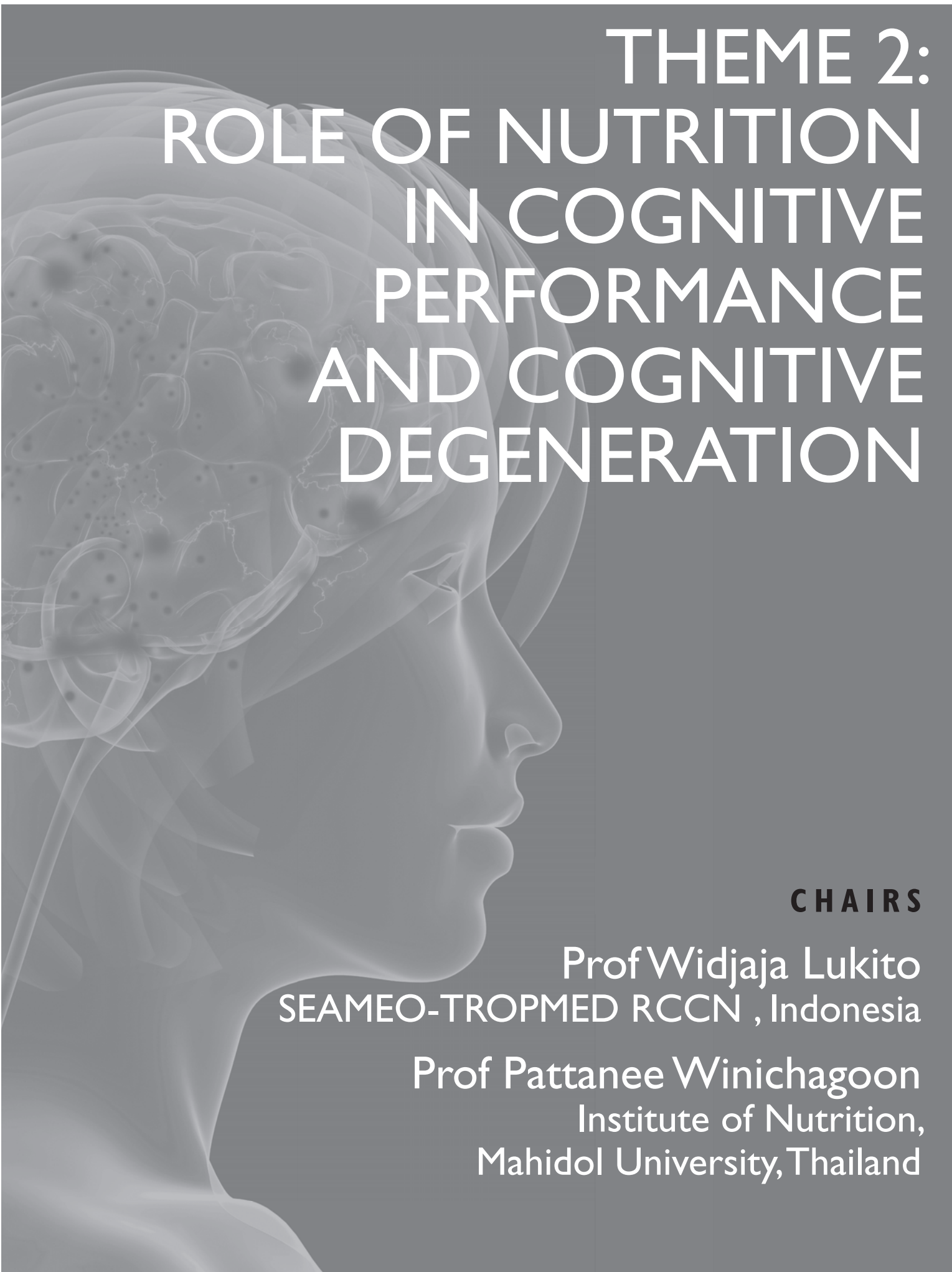
The two studied populations above were similar in terms of the co-existence of multiple micronutrient deficiency. Thai children had higher means of serum zinc and retinol, but lower in median urinary iodine compared to Vietnamese children. Anthropometric measures were better among Thai school children (mean HAZ -1 and WAZ -1.2) compared to that of Vietnamese children (-1.4 and -1.5, respectively). The Thai study assessed fortification of iodine, iron, vitamin A and zinc, while the Vietnam study combined 15 micronutrients including all 4 micronutrients in the Thai study. The difference in some of these features may contribute to the differences found in the impacts of fortification on various parameters, including the results of cognitive tests performed.

In another study, we conducted a supplementation trial with either iron, zinc or combined iron and zinc, or placebo during infancy. Breastfed infants were recruited when they were 4-6 month old and the supplementation was given for 6 months. At baseline, anemia (28.8%) and low zinc (31%) were prevalent, while iron deficiency (<5%) was surprisingly low. After the supplementation, hemoglobin concentration was maintained in both groups that received iron, but dropped in the group with no iron. Similarly, serum ferritin dropped by almost three times in the groups not receiving iron. Serum zinc also improved the most in the zinc group. There was significant interaction between iron and zinc on ferritin and zinc status; iron+zinc group had lower end point ferritin compared to the group receiving iron only. This

leads to the question of whether deficiencies in these micronutrients had long term impacts or residual effects on cognition in later years. Therefore, these infants were followed up when they were about 9 years old (n=560, 90% of the original cohorts). There was no significant difference on any of the cognitive outcomes (IQ, Raven's CPM scores) among infants in the four intervention groups at 9 years of age. However, differential effects of supplementation on full scale IQ and Raven's CPM score were observed by household income level during infancy. Importantly, growth in weight and head circumference in early infancy and length growth in late infancy consistently showed impacts on intellectual function at 9 years old. More on this paper will be presented in a poster in this conference.

Lastly, a randomized controlled trial on iodine supplementation during pregnancy is ongoing. Pregnant women were recruited from their first booking (gestational age <14 wks) at Ramathibodi hospital in Bangkok. The median urinary iodine excretion was only 107 µg/L, and TSH was 1.33 uIU/ml (84% in the normal range); the studied population had mild-to-moderate iodine deficiency. The trial seeks to answer whether iodine supplementation during pregnancy is necessary to prevent undesirable pregnancy outcomes and cognitive compromise in infants. Either iodized capsule (200 mg/d) or placebo was given from early till the end of pregnancy. Thyroid volume of the women during pregnancy and 6 weeks postpartum, birth outcomes and thyroid volume of infants were assessed within a week after birth. Neonatal Behavioral Assessment Scale (NBAS) test within the first week and at 6 weeks were performed. At 1 year of age, Bailey test is also administered. This study will have important policy implication for prevention and control of iodine deficiency during pregnancy.

A few issues emerged from nutrition intervention trials on cognitive function of children. Firstly, when the intervention included multiple micronutrients, it is not possible to tease out which nutrient(s) and the relative importance among the nutrients that contributed to cognitive improvement. Secondly, there is a need to address whether the chosen tests were appropriate or sensitive enough to respond to the combined interventions. Thirdly, tests such as Wechsler's Intelligence Scale for Children III (WISC III) or Raven Progressive Colored Matrices were recommended as they are non-verbal and cross-cultural, could be translated to Thai or Vietnamese and validated. However, when using these tests on rural children who are not generally exposed to the same environment as urban, better-off children, the lower scores obtained may be a result of this non-exposure rather than a reflection of the actual cognitive ability.



THEME 2: ROLE OF NUTRITION IN COGNITIVE PERFORMANCE AND COGNITIVE DEGENERATION

CHAIRS

Prof Widjaja Lukito
SEAMEO-TROPED RCCN , Indonesia

Prof Pattanee Winichagoon
Institute of Nutrition,
Mahidol University, Thailand

Nutrient Requirements for Cognitive Function in Adults and Elderly

Michael Fenech

*CSIRO Food and Nutritional Sciences
Australia*

There are various aspects of cognitive dysfunction (e.g. language, processing speed, eye-hand coordination, executive functioning, verbal memory and learning, visual memory and learning, visuoconstruction) which may result from neural deficits in specific brain regions (e.g. hippocampus, cerebellum, insula, thalamus) either due to inherited genetic defects, acquired genetic defects during foetal development or as a result of accelerated ageing. Such effects may also be mediated by accumulation and aggregation of toxic peptides such as synuclein or A β 42 in the case of Parkinson's and Alzheimer's disease respectively. The propensity of accumulating genetic defects that impact the regenerative potential of neural cells (e.g. telomere shortening, DNA oxidation) and their mitochondrial function (e.g. mitochondrial DNA deletions, point mutations) is often affected by deficiency in nutrients required for genome maintenance (e.g. folate, vitamin B12) or excessive intake of minerals (e.g. iron, copper overload) that could exacerbate homeostatic imbalance in redox pathways. Furthermore the impacts of these dietary factors may depend on common polymorphisms in genes involved in the uptake and metabolism of micronutrients required for genome maintenance or appropriate processing of neurotoxic peptides. The presentation will provide an update on the most compelling examples of gene-nutrient interaction relevant to cognitive function and Alzheimer's disease.

Omega-3 and Dementia: Mechanisms and Effects

Andrew Sinclair

*Deakin University
Australia*

Alzheimer's disease, the most common dementia among older adults, is a neurodegenerative disease characterized by malfunctioning or loss of neurons. Although the most popular symptom of Alzheimer's disease is memory loss, other mental functions including mood and language can be impaired. The biochemical hallmarks of Alzheimer's disease include neuritic plaques (β -amyloid) and neurofibrillary tangles (aggregates of the cytoskeletal protein tau), and other factors, including inflammation, may play a role in disease pathogenesis. Despite putative molecular targets, to date, therapies for Alzheimer's disease target common symptoms. However, there are no medications able to reverse or prevent the progression of Alzheimer's disease.

With the development of transgenic cell culture and animal models to study β -amyloid deposition, initial studies on the role of omega-3 PUFA in Alzheimer's disease were undertaken. Evidence from these and other models suggested that omega-3 PUFA supplementation attenuated β -amyloid deposition, a hallmark of Alzheimer's disease. Furthermore, mechanistic studies have demonstrated that along with having anti-inflammatory properties, DHA promotes neuronal survival via Akt, Bcl-2 and brain derived neurotrophic factor signalling pathways. Collectively these studies, along with post-mortem studies demonstrating lower brain DHA in brains of Alzheimer's patients, provide mechanistic support for a series of clinical studies examining the relationship between omega-3 PUFA intake and Alzheimer's disease risk and symptoms. In addition, research by Cole and Frautschy in 2006 claim that docosahexaenoic acid protects from amyloid and dendritic pathology in an Alzheimer's disease mouse model.

Data from epidemiological studies (11 prospective and 3 cross-sectional studies and one case-control study examining n-3 PUFA status (dietary intake or blood levels) and risk of developing Alzheimer's disease) reveal some suggestive evidence of benefit of dietary omega-3 PUFA. Overall, one study showed a positive relationship between plasma phospholipid levels and risk of Alzheimer's disease, while two studies demonstrated no significant effect and 12 studies reported an inverse relationship between Alzheimer's disease risk and omega-3 PUFA status.

There is data from three randomized clinical trials of n-3 PUFA supplementation in patients with probable Alzheimer's disease. The study with longest duration (6 months) administering a combination of DHA and EPA found improvements in cognitive decline in a subgroup of patients with mild Alzheimer's disease. In another small study, patients with mild cognitive impairment also had improved memory, while a study using EPA found no benefits.

In summary therefore, cell culture animal models show promising mechanistic support for DHA in Alzheimer's disease. Non-randomized epidemiological studies examining omega-3 PUFA intake or blood levels support a role of DHA in the prevention of Alzheimer's disease. Data from clinical trials are limited, but suggestive that DHA may be of benefit to patients with milder forms of Alzheimer's disease. Larger, randomized clinical trials in the prevention and treatment of Alzheimer's disease are needed before conclusions can be drawn.

Cole GM, Frautschy SA. (2006) Docosahexaenoic acid protects from amyloid and dendritic pathology in an Alzheimer's disease mouse model. Nutr Health. 2006;18(3):249-59.

Nutrition and Cognitive Ageing in Older Adults: Findings from the Singapore Longitudinal Ageing Studies

Ng Tze Pin

*National University of Singapore
Singapore*

There is much experimental data from laboratory studies to support an important role of nutritional factors in the protection against dementia and maintenance of healthy cognitive functions in older adults. The list of factors includes micronutrients and phytochemicals known to possess anti-oxidant and anti-inflammatory properties, such as vitamins from vegetables and fruits, polyphenols (catechins) from green tea, and polyunsaturated fatty acids (PUFA) from fish. However, human data are limited to a few observational findings from epidemiological studies.

Data from the Singapore Longitudinal Ageing Studies (SLAS) clearly show that malnutrition is not only common in the elderly, but SLAS participants found to have low albumin and haemoglobin were also more likely to show cognitive impairment and cognitive decline.

Folate. It is critically involved in methylation reactions in the brain necessary for the production of monoamine neurotransmitters and membrane phospholipids. Among non-demented older adults in the SLAS, low levels of serum folate were associated with poor cognitive performance on memory and language. High level of homocysteine, independently of folate, was associated with deficits in constructional ability and processing speed.

B12. There was evidence to suggest gene-micronutrient interaction for B12. The association between serum B12 and global cognitive function (MMSE), episodic memory (RAVLT immediate recall) and attention/working memory (Digit Span backward) was significantly more pronounced in individuals with the APOE-e4 genotype, suggesting a greater susceptibility to the influence of vitamin B12 variations.

Fish and omega-3 PUFA. They have been shown in some studies to be potentially protective against dementia. SLAS participants who regularly consumed omega-3 supplements were found to be less likely to show cognitive decline.

Green Tea. Tea and tea polyphenols (including catechins and derivatives), particularly those from green tea, are known to possess potent neuroprotective activity. The SLAS data shows that regular tea consumption was associated with lowered risks of cognitive impairment and decline, as well as better performance on a wide range of cognitive functions, effects not similarly observed with coffee drinking.

Curcumins. Found in the curry spice (turmeric), curcumins have strong anti-inflammatory and anti-oxidant properties. Recent experimental studies have shown that curcumins in the diet reduce plaque burden in the brain of transgenic Alzheimer's disease mice. In SLAS subjects, regular curry intake was found to be associated with better cognitive performance.

Randomized controlled trials should provide definitive evidence to support the beneficial effects of nutritional factors for dementia prevention.

Nutritional and Dietary Risk Factors Related to Mild Cognitive Impairment among Elderly People in Malaysia

Suzana Shahar

*Universiti Kebangsaan Malaysia
Malaysia*

Mild Cognitive Impairment (MCI) represents a unique transitional state between normal aging and the clinical features of dementia, with affected individuals experiencing cognitive decline affecting their daily function but the functional activity remains intact. Recognising the aging phenomenon, there has been an increasing interest to identify risk factors of MCI and early detection to provide some insights into possible measures for prevention. Older age, cardiovascular risk factors including alcohol consumption, hypertension, diabetes mellitus, presence of apolipoprotein E ϵ 4 allele (ApoE 4), cortical atrophy at neuroimaging, sign and symptoms of vascular diseases, and depression have been recognized as established risk factors among elderly people in the West. However, the magnitude of this mental health problem and its risk factors among Asian population are yet to be discovered. Nutrients including vitamin C and E, vitamin B6, B12 and folate have been associated with cognitive impairment. However, as compared to nutrient, analysis of dietary pattern is more useful because it provides evidence and basis for dietary recommendations. Individuals do not consume food in a form of nutrient, but as a meal serving built up by a variety of foods with nutrient combination inside.

In order to explore the role of nutrition and dietary factors in an Asian population, a cross-sectional study was conducted in an urban area of Malaysia (Cheras Community Prospective study) in 2008-2009. A part of a larger study to investigate the effect of fish oil supplementation on MCI among Malaysian elderly, this study involved 333 elderly people aged ≥ 60 years (40.9% men, mean age 66 years), permanent residents of public housing areas managed by Kuala Lumpur City Hall. Subjects were excluded from the study if they had documented evidence of a psychiatric diagnosis or mental disorders, history of head injury, concomitant diseases (such as being on renal dialysis, history of cancer, stroke), or if they were handicapped. Subjects were assessed for cognitive status using neuropsychological test including Mini-Mental State Examination (MMSE), Dementia Rating Scale (DRS), Geriatric Depression Scale (GDS shorten version), Wechsler Memory Scale-Revised (WMS-R) and digit span test of Wechsler Adult Intelligence Scale-III. A comprehensive nutritional status assessment was done, comprised of anthropometric, functional, food intake and biomarkers. Genetic polymorphism of apoE was assessed in 62 MCI and 124 non-MCI subjects using restriction fragment length polymorphism analysis.

The results indicated that the overall prevalence of MCI was 21.1% (15.1% am-MCI and 6.0% nam-MCI), with women having a higher percentage of all type-MCI and am-MCI, whilst men had a greater tendency for nam-MCI. The major predictors for men were hypercholesterolemia and smoking habit. In women, risk of MCI was higher among women who were married, not exercising regularly, overweight and obese. Allele E4 was not associated with incident MCI, however, subjects with vitamin A (adjusted OR 4.683; 95% CI=1.084-20.235) and vitamin E (adjusted OR 7.331; 95% CI=1.382-38.902) deficiency were at a higher risk of developing MCI. In women, energy intake of MCI and non MCI subjects were 1334 ± 271 kcal/d and 1262 ± 304 kcal/d, respectively. Whilst in men, the corresponding figures were 1479 ± 323 kcal/d and 1441 ± 278 kcal/d, respectively.

Six groups of food dietary pattern were developed based on their importance for cognitive function. Percentages of MCI and non MCI subjects fell into respective dietary patterns were as follows: fruits rich diet (13% vs 13%), vegetables (11% vs 12%), high fat diet (50% vs 45%), fish eater (95% vs 96%), high sugar (5% vs 3%) and poor dietary pattern using

Healthy Eating Index (HEI) (11% vs 10%). A higher percentage of non MCI subjects consumed fish rich in omega-3 fatty acid (i.e. Black pomfret) ($p < 0.05$). Among women, the MCI subjects had significantly higher intake of fat than the non MCI ($p < 0.05$).

In conclusion, MCI affected a fifth of the study population. Several sociodemographic and cardiovascular factors, together with vitamin A and E deficiencies and unhealthy lifestyle and dietary patterns were associated with risk of MCI among subjects. It is essential for Malaysians to engage with healthy lifestyle including being physically active and adhere to a wholesome diet rich in antioxidants and fish, and low in fat, to prevent cognitive decline with aging.

Effects of Protein and Amino acids on Cognitive Performance

Paramjeet Singh

*Cerebos Pacific Limited
Singapore*

About half dozen of amino acids are involved in the brain chemistry of cognition, mainly as promoters or precursors of neurotransmitter synthesis. It has naturally followed that dietary amino acids and proteins are considered capable of affecting brain functions such as cognition by influencing the availability of the crucial amino acids. As it turns out, the measured cognitive benefits in generally well-fed and healthy populations have been less than inspiring, and often contradictory. However, there is increasing evidence for benefits to the brain from consuming a couple of very short peptides, at least one of which is naturally present in the human brain.

Functional and Herbal Substances: Effects on Cognitive Performance

Andrew Scholey

*Brain Sciences Institute, Swinburne University
Australia*

Cognition involves multiple processes interacting in complex, and possibly idiosyncratic ways. It is therefore unsurprising that monopharmacological treatments for cognitive decline and dementia have had little impact on the disorders. It may be that by affecting multiple systems, nutraceuticals and herbal medicines - 'nutra' - may offer a more promising approach. Unlike more mainstream pharmacological agents, nutra agents may contain dozens of active components. It appears that certain plants have evolved with a combination of properties which, in concert, may affect multiple neuronal, metabolic and hormonal systems. Since behavioral processes are themselves modulated by such systems, the effects of herbal extracts may particularly depend upon complex interactions within and between physiological systems.

This field offers unique challenges to psychopharmacology. Nevertheless, over the past two decades there has been a rapid growth in research into the human behavioral effects of nutritional interventions and herbal extracts. This paper will briefly draw on specific examples from a systematic assessment of the behavioral effects of nutra interventions including Ginseng, Sage, Bacopa, polyphenols and components of tea and coffee. This work is in its infancy but may uncover promising candidates with which may optimise day-to-day cognitive functioning, maintain psychological wellbeing throughout the lifespan and even treat conditions where mental function becomes fragile – including dementias.

Role of Polyphenols on Cognitive Function in Adults and Elderly

Rachel Galli

*Simmons College
USA*

Barbara Shukitt-Hale

*USDA Human Nutrition Research Center on Aging at Tufts University
USA*

Aging is characterized by losses in neuronal function, which are accompanied by behavioral declines (motor and cognitive function) in both animals and humans. There is evidence to suggest that oxidative stress and inflammation are involved in impairments of motor and cognitive skills observed in neurodegenerative disorders, as well as in normal brain aging. Research with animal models has shown that the behavioral deficits seen in aging can be slowed or even reversed by supplementing a normal diet with blueberries, walnuts or other fruits and vegetables rich in phytochemicals.

Fruits and vegetables are known to contain numerous polyphenols, and although initially it was assumed that the vitamin components of fruits and vegetables were the primary source of dietary antioxidants, it is now well established that the polyphenolic components contribute substantially to the overall dietary antioxidant intake. However, we found that antioxidant activity alone was not predictive in assessing the potency of fruits and vegetables at reducing behavioral deficits in aging. Therefore, we postulate that fruit and vegetable polyphenols possess a multiplicity of actions, aside from antioxidative, and that differences in the polyphenolic composition may account for the positive effects observed in our model with some fruits and vegetables high in antioxidants, but not others.

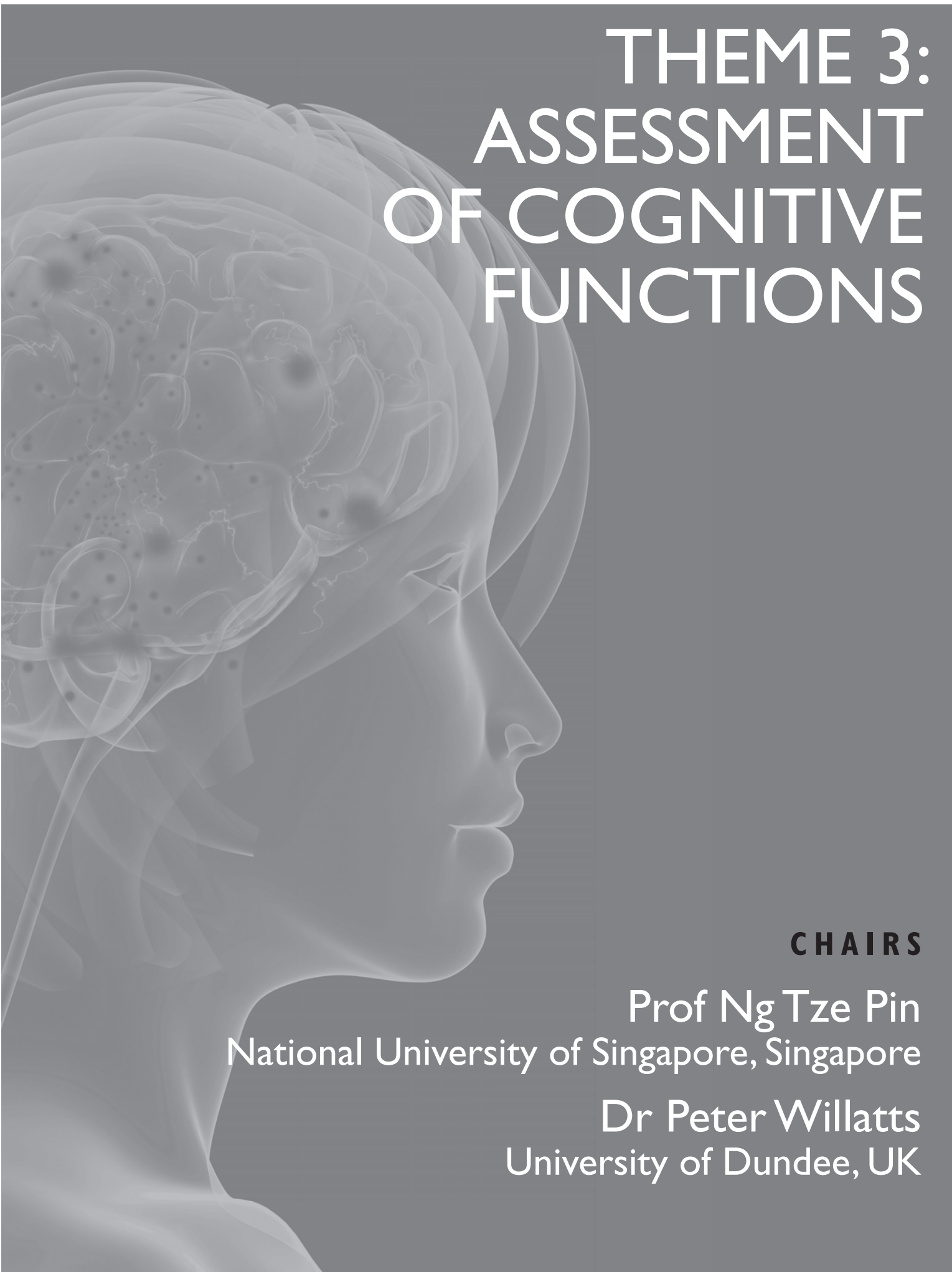
Functional Ingredients for Enhancing Cognitive Performance: Industry Perspective on Pre-clinical Innovations

Rema Vazhappilly

*Abbott Nutrition R&D Asia-Pacific Center
Singapore*

There is an increased prevalence of dementia in Asia due to the growing aging population that outnumbers the rest of the world. This rising prevalence of dementia has caused a high global demand for cognitive enhancers or brain health products. Pharmacological approaches or “smart drugs” developed for cognitive enhancement have been known to be riddled with adverse side effects and conflicting outcome. Owing to the lack of an effective pharmacological approach, there is an emerging interest in developing nutraceuticals and therapeutic nutritional products to manage or improve dementia. Nutritional intervention may be an effective strategy as nutrition may modulate cognitive processing at many levels through multiple cell signaling pathways. Therefore several research studies have focused on identifying food ingredients with cognition enhancing properties. Though several ingredients or compounds have been identified, there are several challenges in developing a nutritional product for cognitive enhancement. This talk will cover challenges involved in coming up with a pre-clinical innovation and its translation to a nutritional product from an industry perspective.

THEME 3: ASSESSMENT OF COGNITIVE FUNCTIONS



CHAIRS

Prof Ng Tze Pin
National University of Singapore, Singapore

Dr Peter Willatts
University of Dundee, UK

Nutrition and Cognition - Methodological Approaches to Its Study

David Benton

*University of Swansea
UK*

The brain develops particularly in the last third of pregnancy and the first two years of life. Therefore dietary deficiencies at this stage can potentially have long-term implications for cognitive development. Unfortunately at this stage, immaturity limits the ability to measure the cognitive ability of children. The most widely used test is the Bayley Scales of Infant Development that assesses motor, language and cognitive development of those less than three years. A major problem is that the test poorly predicts later functioning, other than when it is used to screen for those performing particularly poorly who require early intervention.

In later life, there is a decline in functioning known to begin in the early twenties and continues over throughout life. This observation raises many methodological issues as experimental designs need to match the phenomenon being studied. In theory, dietary interventions will need to start at young adult and be monitored over many decades. If early brain development is important in determining subsequent age related changes, ideally the mother's nutrition will also need to be monitored prior to birth and in the early years of life.

Although the greatest weight is placed on information from randomized, double-blind, placebo controlled studies, it is clear that such an approach is not possible given this perspective. People cannot be randomly allocated to a diet that they then follow throughout their life. In such circumstances, attention is directed to epidemiological data. The matter of causality is addressed by requiring that the data satisfies a range of strict criteria. It was said that causality can be established if exposure preceded the outcome, the only absolutely essential criterion. In addition, causality is more likely if: the relationship is strong; there is a dose-response relationship; results have been replicated in different settings using different methods; the suggested effects are plausible and agree with accepted understandings of pathology; and finally, alternative hypotheses have been ruled out. These are harder criteria to satisfy than when using randomized trials.

Nevertheless, given the ability of randomized trials to establish causality, there will be a desire to use this approach, although inevitably such studies would have to be over a manageable time period. One approach is to study those who are at a high risk of developing dementia or are displaying early symptoms. There has therefore been an interest in studying those with so called Mild Cognitive Impairment: those whose memory is worse than that expected for their age and education, although as yet it does not interfere significantly with their daily life. Such individuals are at a higher risk of developing dementia and the impact of dietary interventions can be monitored. A criticism of this approach is that these individuals have already minor brain damage and the aim should be to prevent this occurring in the first place.

A second approach is to consider not cognitive decline as such, but rather a biomarker that can be shown to reliably predict cognitive decline. Although the approach has attracted considerable interest, such associations have yet to be established, although there are several approaches that are potentially useful. Most biological theories of aging involve mechanisms that can be modified by diet including oxidative stress, inflammation, homocysteine and advanced glycation end products. As such, indices of these mechanisms could potentially offer markers of the aging process and their response to dietary interventions could be measured. Another approach might be to use brain imaging techniques to measure general brain shrinkage or the volume of areas of the brain known to change in those with dementia.

Should it prove not possible to establish suitable biomarkers, then the change in cognition will by default become the biomarker of interest. To date, many studies have used a particularly crude measure, the Mini-mental state examination,

to measure cognitive decline or dementia. The use of such a brief test, that adds several unrelated aspects of cognition together to produce a single score, has been subject to extensive criticism. An obvious suggestion is that more precise and reliable tests should be used.

A problem in relying on psychological measures is that dementia is not a single disease but a group of symptoms; problems of thinking, memory, and reasoning that reflect a range of diseases. Although Alzheimer's disease accounts for between fifty and seventy percent of all dementias, and vascular dementia accounts for ten to fifteen percent, there are as many as fifty other causes. As these diseases have different aetiologies, nutrition will impact in different ways. It therefore makes little sense to examine the impact of diet on dementia when aspects of diet will influence different types of dementia in different ways. For example because the Wernicke-Korsakoff syndrome responds to thiamine supplementation, and vitamin B12 deficiency responds to supplementation of this vitamin, this does not imply that other forms of dementia would benefit similarly. Psychological measures will need to be interpreted in the light of physiological measures that allow homogeneous groups to be considered.

Assessing Cognitive Development in Infants and Young Children

J Steven Reznick

*University of North Carolina at Chapel Hill
USA*

To assess cognitive development in infants and young children, we must first answer two obvious questions: What should we assess and how should we assess it?

One strategy for conceptualizing and measuring cognitive development in infants and young children is to view cognitive development as a broad and general phenomenon. This strategy, which emerged over a century ago, characterizes cognitive ability as intelligence and measures it on a scale labeled "IQ". Various instruments use infant and child response to specific tasks scored in comparison with group norms, thus leading to a description of a child's performance as compared to age-matched peers. These IQ tests have provided significant prediction of success in school and related outcomes, particularly for children who are represented in the group norms. However, this broad characterization of cognitive development is not oriented towards identifying specific components of cognitive development, measuring individual differences, and assessing cognitive development in children who would not be well represented in the group norms.

An alternative approach to assessing cognitive development in infants and young children is to identify specific aspects of cognition and to develop valid and reliable techniques for measuring these aspects. Considerable progress has been made in recent decades, and our current view of early cognitive development focuses on cognitive abilities such as memory, attention, language, and knowledge. Memory can be defined as the encoding, storage, and retrieval of information. Taxonomies divide memory on the basis of duration of storage (e.g., short term versus long term), type of information stored (e.g., semantic versus episodic), and accessibility to conscious awareness (e.g., explicit versus implicit), to name a few relevant dimensions. Measurement techniques in infants and children include response to novelty, learning tasks, search tasks, etc.

Attention refers to the broad array of processes that direct an organism's sensory focus, and can be subdivided into relevant categories. Endogenous attention refers to the internal, volitional process through which sensory focus is directed toward external stimuli and can be contrasted with related aspects of attention (e.g., maintaining alertness, orienting toward compelling external stimuli). Endogenous attention can be assessed using laboratory tasks in which the infant or child monitors various stimuli. Attention is also manifest in a wide array of behaviors so it is amenable to measurement via parent or care giver observation-based report.

Early language can be divided into production and comprehension. Multi-word utterances lead to characterizations such as mean length of utterance and the presence of various levels of syntax and grammar. Language is relatively obvious and thus can be assessed using parent report and various laboratory procedures. Finally, knowledge refers to the content and organization of mental representations. Aspects of knowledge include understanding of physical phenomena, categorization of stimuli, theory of mind, and problem solving. Inferences about the child's knowledge can be drawn from how the child responds to possible versus impossible physical occurrences, organizes and sorts stimuli, and solves problems.

There may be some questions about influences on cognitive development that could be answered on the basis of a general IQ score, but any sophisticated question would probably be addressed most appropriately with assessment

of specific age-appropriate aspects of cognitive development that are linked to the underlying mechanisms that would mediate the influence. For example, if children are being fed a breakfast that could enhance their attentiveness, their performance on laboratory tests of attention should differ on days when they receive the target breakfast versus a control breakfast. This within-subject design has the advantage of reducing error variance and thus boosting statistical power. If the breakfast intervention is expected to have a broad effect on the child's performance in school, a teacher-report measure of attentiveness would be more pertinent than laboratory tests.

Adapting Cognitive Tests to Asian Children Population

Srinivasan Krishnamachari

*St. John's Medical College & Research Institute
India*

Is a cognitive test applicable outside of the context (developing country) in which it was originally developed (developed country)? In the transformation of instrument from one culture to another, three options are available: adoption, assembly and adaptation (Van de Vijver, 2003). Adoption of instrument is used to compare performance on tests across cultures. Assembly involves constructing a new set of measure, as the existing tests are inapplicable in the target community. Adaptation that has features of both adoption and assembly involves accurate translation of the parts of the instrument that can be applied reliably and validly in the target community and substitution of parts that cannot be translated and applied reliably due to reasons of language, culture, or inadequate psychometric properties. This presentation will highlight adaptation of Kaufman Assessment Battery for Children (KABC-II) for 6-10 year-old Kannada speaking School children of low socio-economic status in Bangalore, India. The presentation will focus on two types of procedures to detect and reduce bias, namely a qualitative judgmental approach that involves piloting test items to check for their cultural appropriateness and application of statistical procedure to assess the quality of adaptation in terms of its reliability and validity.

Van de Vijver FJR (2003) Test adaptation / translation methods. In R.Fernandez-Baleesteros (Ed), Encyclopedia of psychological assessment, Thousand Oaks, CA, Sage Publications, pp 960-963.

Assessing Cognitive Improvement due to Nutritional Influences in Adults

Jeroen Schmitt

*Nestlé Research Centre, Switzerland
Brain Sciences Institute, Swinburne University, Australia*

The notion that cognitive functioning can be influenced through dietary means has gained widespread interest. The assessment of cognitive performance is a key method to scientifically substantiate such nutritional effects on cognition. The presentation will give a general overview of the main concepts, issues and pitfalls of human cognitive research, with a special emphasis on testing cognition in adult subjects. Selection of appropriate performance tests based on various criteria is an important step in designing a sensitive and meaningful experiment. Factors such as aims of a study and the intended use, as well test sensitivity, level of difficulty and feasibility are to be taken into consideration when constructing a test battery. Adequate test administration and planning, taking into account standardization of procedures, managing confounding factors such as subject state and environment, as well as potential learning and practice effects, have an important impact on the quality and validity of the data. Correct interpretation of the findings, in terms of effect specificity, speed-accuracy trade off, time on task and/or test battery and evaluation of the potential role of compensatory effort will lead to an accurate picture of the effects of a particular (nutritional) intervention on cognitive functioning. Some examples will be used to highlight the importance of accurate cognitive testing design, execution and interpretation.

The Australian Imaging, Biomarker & Lifestyle Flagship Study of Ageing: Early Detection and Intervention on Neurodegenerative Disease

Kathryn Ellis

University of Melbourne
Australia

The AIBL study has assembled a large cohort of individuals whose cognitive data, blood samples, imaging results, and lifestyle information is being examined longitudinally at regular 18-month intervals. This is the largest cohort study of its kind in Australia (and one of the largest worldwide). The study has thoroughly assessed individuals with and without Alzheimer's disease (AD), and with varying levels of risk for developing AD. The AIBL cohort has now been reassessed for the first time (18 months after baseline) and 3-year follow-ups are in progress.

Methods. The inception cohort comprised 1112 volunteers aged over 60 years [211 patients with AD (mean age 78.0+/-8.6 years), 133 patients with Mild Cognitive Impairment (MCI; mean age 75.7+/-7.6 years), and 768 healthy volunteers (HV: 70.0+/-7.0 years)]. Neuroimaging was performed in 26% of the cohort, with 177 healthy controls, 57 MCI and 53 mild AD receiving 11C-Pittsburgh Compound B (PiB) scans as a measure of in vivo brain beta-amyloid, and structural magnetic resonance imaging (MRI) scans. Selection of MCI and AD for imaging was on a first come basis. In contrast, HC selection was controlled to ensure that: 1) there was a wide age spread from 60 years through to the very elderly; 2) approximately 50% had subjective memory complaint (SMC); and that 3) approximately 50% were apolipoprotein E (APOE) ϵ 4 carriers. The 18-month follow-up assessments were completed in June 2010. Of the 1112 participants in the inception cohort, nearly 90% (969 participants) were reassessed. The 18-month cohort comprises 969 cases in total; 691 healthy controls (317 non-memory complainers and 374 subjective memory complainers), 81 MCI cases and 197 patients with AD.

Results. At baseline, neuropsychological performance was consistent with clinical classification, with AD cases performing significantly more poorly than MCI or HC. High PiB binding was present in 33% of HC (49% in ApoE ϵ 4 carriers vs 21% in noncarriers) and increased with age, most strongly in ϵ 4 carriers. 18% of HC aged 60-69 had high PiB binding, rising to 65% in those over 80 years. Subjective memory complaint was only associated with elevated PiB binding in ϵ 4 carriers, and there was no correlation between brain beta-amyloid and cognition in HC or MCI at baseline. Examination of exercise data in HC participants revealed that the amount of intense exercise was correlated with better cognitive performance.

Follow-up data showed that AD cases declined by an average of 3.5 points on the MMSE over 18-months. The findings demonstrate a 25% conversion rate from MCI to AD over 18-months in this cohort. Positive amyloid scans at baseline were found to predict cognitive decline and conversion to AD from MCI. Less than 4% of HC progressed to MCI classification at 18 months, and most of these incipient MCI cases were subjective memory complainers at baseline. Almost one-third of healthy controls who did not complain about their memory at baseline exhibited subjective memory concerns at 18 months. However, these participants did not show significant decline in episodic memory or MMSE scores. As expected, there was a higher death rate in the AD group than either the MCI or HC groups. MCI and AD participants were also more likely not to return for follow-up assessment than HC participants.

Conclusion. Cross-sectional analysis of the AIBL dataset has already demonstrated links between cognition, brain beta-amyloid burden, structural brain changes, biomarkers, and lifestyle. The 18 month follow-up data will allow the significance of candidate risk factors associated with cognitive decline and early diagnostic indicators of AD to be examined. 36 month reassessment of the AIBL cohort is currently underway.

THEME 4: EVIDENCE-BASED CLAIMS AND CONSUMER UNDERSTANDING ON COGNITION

CHAIRS

Prof Namsoo Chang
Ewha Womans University, Korea

Prof Andrew Scholey
Brain Science Institute,
Swinburne University, Australia

European Perspectives on Claims Substantiation in the Area of Nutrition and Cognition

Peter Willatts

*University of Dundee
UK*

In December 2006, European Union adopted a new regulation concerning nutrition and health claims made on foods. The aim of this legislation is to protect consumers by ensuring that products put on the market are safe and adequately labeled. Article 13.1 of the regulation refers to 'general function' health claims, which includes psychological and behavioral functions. Article 14 of the regulation refers to claims involving disease risk reduction and child development or health. The European Food and Safety Authority (EFSA) is responsible for verifying the scientific substantiation of submitted claims. This presentation will discuss the methods and procedures which have been developed by EFSA for reviewing claims involving psychological, behavioral and neurological function. Claims submitted under Article 13.1 have a format which specifies the food constituent (e.g. Vitamin B12, Tryptophan), the health relationship that is the subject of the claim (e.g. 'cognitive function', 'attention'), proposed wording for the claim (e.g. 'improves concentration, enhances memory'), and conditions of use (e.g. 'food supplement with 75-225 mg in the daily dose'). The submitted claim also provides a list of scientific articles to support the claim. Different claims involving the same food constituent are evaluated together, and the several sets of articles are combined into a single set for the purpose of evaluation. It is important to understand that only the articles provided by the claimants are considered by the Review Panel. EFSA does not undertake systematic reviews in order to evaluate claims.

We have developed a screening protocol in order to establish whether a claim meets the basic criteria for review. This involves establishing that: the food constituent is adequately characterized; the health relationship is meaningful and can be measured; the target population is identified; and the conditions of use of the food constituent are adequately specified. Only applications that pass the initial screening are reviewed. We have also developed a procedure for evaluating the scientific evidence which involves first identifying the category of the scientific articles (e.g. systematic review or meta-analysis, randomized controlled trial (RCT), observational study, narrative review, textbook, animal study). Highest priority is given to systematic reviews, meta-analyses, and RCTs. Little attention is paid to narrative reviews and textbooks because they do not provide original data. The next step is to determine which articles are pertinent to the claim, and which can be dismissed. Pertinence involves consideration of the food constituent used in a study, the conditions of use, the study endpoints, and the study population. If any of these fails to correspond to the terms of the claim, then the article is rejected. All pertinent articles are thoroughly reviewed, with close attention being paid to the methods, design, statistical analyses and conclusions. A decision is then taken as to whether the article is positive or negative with reference to the claim.

If there is sufficient evidence to support a claim, a literature search is undertaken to determine whether there are other studies not provided by the claimant which provide negative evidence. If additional negative evidence is found, then the claim is rejected. If additional negative evidence is not found, then it is concluded that evidence for a cause and effect relationship has been established and the claim is upheld. Two further steps are then completed. First, the proposed wording provided by the claimant for the health is reviewed. If the wording is inaccurate or misleading, then alternative wording is proposed. Second, recommendations are made for conditions and restrictions of use. Whether a claim receives a positive opinion depends on two things. Firstly, the quality of the scientific evidence provided by the claimant, and secondly, the quality of the application. Many claims have been rejected because, either the scientific evidence was inadequate, or the health relationship was vague or meaningless. There is a huge gulf between what EFSA regards as scientific evidence, and what industry regards as scientific evidence.

Scientific Substantiation in the Area of Nutrition and Cognition – Australia

Richard Head

*CSIRO Preventative Health Flagship
Australia*

Abstract not received at the time of printing.

Health Claim Substantiation in Japan and Researches on Cognitive Functions Toward the FOSHU Approval

Toshio Shimizu

*Nagoya-bunri University
Japan*

In FOSHU (the Foods for Specified Health Uses) approval system of health claims in Japan, the health claim is required to be substantiated by the statistical analysis of human studies using the final product containing characterized effective component, the mechanism defined by animal and in vitro studies, and the safety data including the human study and eating history. The available information on relevant associated researches should be reviewed. Any new scientific evidence used to support the health-related claims must be from published peer-reviewed scientific journals.

The Japanese Ministry defines the allowed health claims in FOSHU as follows:

- 1) Maintain or improve a marker determined by self-diagnosis or health check-up.
- 2) Maintain or improve physiological function and organ function of the human body.
- 3) Causes short-term changes in body condition, but not long-term changes.

The existing FOSHU health claims can be categorized into the eight groups according to the health claims such as gastro-intestinal condition, blood pressure, serum lipid, blood sugar, absorption of mineral, blood fat, tooth health and bone health. The number of products approved by FOSHU has increased to total of approximately 1,000 in September of 2010.

The cognition function claim could belong to the second claim or third claim of above-mentioned health claims defined by Japanese Ministry, but this kind of claim has not been approved as FOSHU yet. The reasons of difficulties are the authorization of measurements by the experts, the consistency of wording of the health claim with the result of the human study, and the scientifically significant differences from placebo. The Japanese researchers now study the field of cognitive related functions such as prevention of memory loss, improvement of sleep quality, and fatigue recovery toward to the FOSHU approval.

Basic concepts of the Codex guidelines for use of nutrition and health claim and the regulations on substantiation of health claims in EU and US are based on the following criteria:

- (a) Health claims should primarily be based on evidence provided by well-designed human intervention studies.
- (b) The totality of the evidence should be identified and reviewed.
- (c) Effective component should be characterized by appropriate methods.

These are similar to the requirements of Japanese FOSHU. The labeling of health claims on foods should be in harmony with international standards. The establishment of the international standards could contribute to the improvement of the quality life of people in aging society.

Claims Substantiation in the Area of Nutrition and Cognition – Southeast Asia Region

Tee E Siong

*TES NutriHealth Strategic Consultancy
Malaysia*

There is considerable interest amongst health professionals and the food industry in making health claims relating nutrients and other food components to improved mental or cognitive performance, learning capability, and brain growth and development. This is evident from several articles as well as advertorials and advertisements on such "function" claims. The nutrients or food components involved include several polyunsaturated fatty acids (especially docosahexaenoic acid – DHA and arachidonic acid - AA), sialic acid, tryptophan, taurine, phospholipids, iron, choline, zinc, "antioxidants", and even proprietary components. These are targeted mainly at children, but also for adults. A survey among seven regulatory authorities in the Southeast Asia region showed that there are currently few officially approved health claims on nutrition and cognition. The survey findings were presented in a seminar and workshop organized by the International Life Sciences Institute SEA Region in September 2010 in Kuala Lumpur. Malaysia has only one approved "function" claim that is related to this subject: "sialic acid is an important component of brain tissue". This claim is only permitted for use in infant formula and follow-up formula. Singapore too has a few function claims for use only foods for infants and young children. These are for example: "choline helps support overall mental functioning", "DHA, AA are important building blocks for development of the brain and eyes in infant" and "taurine helps to support overall mental and physical development".

Nevertheless, most authorities in the region do provide opportunities for the food industry to apply for function claims. There are processes and systems in place to review such applications by relevant experts appointed by the authorities. Information required to be submitted in dossiers include the proposed wordings for the intended claims and the scientific substantiation of the intended claim. Data to support the claim should preferably be from human intervention trials. In the case of specific nutrients or food components that are not in the current permitted lists, applications have first to be submitted for the addition or use of such ingredients. Not many applications on such cognition or mental performance have been submitted to authorities in Malaysia. From the few experiences considered by the committee in the past, several considerations are suggested so as to facilitate evaluation by authorities. The proposed wordings of the intended claims have to be specific, clear and focused. Catchy wordings that attract consumers may be too broad and difficult to measure. The intended claims must be measurable using specific parameters. The methodologies used to provide substantiation must be appropriate for the intended claim. Methodologies for measuring mental and cognitive performance are particularly challenging. These have to be socio-culturally appropriate for the subjects being studied. The proposed claim wordings must be based on and match findings obtainable from the scientific studies.

Industry Perspective of Nutritional Products for Cognitive Function – Omega-3's as a Case Study

Rob Winwood and Jim Astwood

Martek Biosciences

USA

Scientific studies have shown that ARA (arachidonic acid) and DHA (docosahexanoic acid), long chain polyunsaturated fatty acids found in human breast milk, are critical to the development of the central nervous system of the neonate. During the last 15 years, Martek Biosciences has developed pure forms of the LC PUFA's ARA and DHA, developing large scale, commercially viable, fermentation processes using micro-fungi and marine algae respectively, especially for inclusion in infant formula. However, the production of these fatty acids had to be commercially sustainable to ensure regular supply. The production system also had to be reliable and produce ARA and DHA of proven high quality and free from contaminants and taste taints. Over the years, Martek Biosciences, developed a considerable IP portfolio in the production process. However to achieve pan-global commercial success, they needed to ensure that the efficacy of ARA and DHA was fully supported and documented by the scientific community. Further, this body of evidence needed to be interpreted in such a way that it could be presented and accepted by the regulators.

In addition, it is also known that neurogenesis continues throughout life, and that DHA is essential for this process. Cognitive decline and many dementias appear to be associated with reductions of the levels of DHA in neural tissue. Very recent studies indicate that for a least portion of the population, DHA may have a role in delaying the onset of Alzheimer's disease and ameliorate memory loss for everyone. These findings provide potentials for development of DHA products to manage cognitive decline.

Europe has trail-blazed development of centrally-authorized health claims for food ingredients. The process has been much more complex and slower than originally envisaged and will not be complete till around the end of 2011. The whole area of cognition has given considerable problems as there is not scientific consensus on computerised cognitive testing batteries or suitable end-point biochemical biomarkers. The process of submitting a file for a health claim in this area is also complicated. This paper will comment on the experiences of Martek Biosciences with this process in Europe and contrast them with other regions of the world.

Consumer Understanding on Nutrition and Cognition: A Life Course Perspective

Josephine Wills

European Food Information Council

Belgium

Consumer research on perceptions of associations between nutrients in specific foods or in supplements, and brain health, cognition or mental alertness, appears to be limited to a few examples. This talk will examine the available evidence, using examples at different life stages, such as:

- Pregnancy: Folic Acid and neural tube defects
- Infancy: Infant formula claims for brain development
- Childhood: Breakfast and children's learning ability
- Adolescence: Caffeine and mental acuity/alertness
- Old Age: Omega 3 fatty acid and cognitive function

As the European Food Safety Authority (EFSA) continues to review the provided data for health claims linked with brain development, brain health and cognition, we will examine what evidence has been provided to show consumer understanding of those claims.

POSTER
ABSTRACTS



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Poster Group I: Early Nutrition and Cognitive Development

I.01: Effect of In-home Fortification of Complementary Feeding on Intellectual Development of Chinese Children

Chunming CHEN, Yuying WANG, Suying CHANG

ILSI Focal Point in China, China

Objective: To explore the effect of in-home fortified complementary food on intelligence development of children below 24 months.

Methodology: In this intervention trial and follow-up study, 1478 children in China aged 4-12 months were recruited and divided into two different groups. In addition to the usual complementary food, the children were fed with one sachet of fortified food supplement (10g) each day; Formula 1 provides protein and micronutrient (iron, zinc, calcium, vitamin D, vitamin B2 while Formula 2 has the same energy level as Formula 1 (167kj). Besides measurements of physical growth and detection of hemoglobin level, the Development Quotient (DQ) or Intelligence Quotient (IQ) was also assessed.

Results: The DQ of children aged 24 months was 97.2, 95.5 and 93.8 in Formula 1, Formula 2 and control group, respectively; the differences were statistically significant ($p < 0.05$). In the first follow up, the DQ of children in Formula 1, Formula 2 and control groups showed significant differences at 92.7, 90.4, and 88.3, respectively ($p < 0.05$). In the second follow up, the DQ of children in Formula 1, Formula 2 and control group were 96.7, 94.5 and 93.7, respectively, and the differences were statistically significant ($p < 0.05$). Compared with Formula 2 and control group, Full-IQ of children in the Formula 1 was higher by 3.1 and 4.5 points respectively, Verbal IQ was 2.1 and 5 points higher and performance IQ was 2.5 and 3.1 points higher; the differences were all statistically significant.

Conclusions: Fortified complementary food supplement showed persistent effect on the intelligence development of young children, which could persist to 6 years of age; the critical time for anemia correction could be at the age of under 18 months.

Acknowledgement: The follow-up study was supported by ILSI Center for Health Promotion. The guidance and assistance of Dr Betsy Lozoff (University of Michigan) and Dr Li Wang (Peking University) on the planning and method development at the beginning of the follow up study is highly appreciated. We are grateful to all the children and their parents who participated in this study and to the field workers in Gansu for their collaboration.

I.02: Impact of Early Nutrition on Cognitive Function Later at School Age

Tippawan PONGCHAROEN^{1,2}, Pattanee WINICHAGOON¹, Reynaldo MARTORELL^{2,3}

¹ Institute of Nutrition, Mahidol University, Salaya, Nakhon Pathom, Thailand

² Nutrition and Health Sciences Program, Emory University, Atlanta, Georgia, USA

³ Hubert Department of Global Health, Emory University, Atlanta, Georgia, USA

Objectives: To assess the relative influence of growth from birth to late childhood on intelligence at 9 years and to assess complementary feeding practices

Methodology: Weight, length/height, and head circumference (HC) were measured at birth, 4 months, 1 year, and 9 years. Intelligence was assessed at 9 years using Wechsler Intelligence Scale for Children, III (Thai). Multiple Stage Least Squares analysis was used to assess the relative importance of growth at prenatal (size at birth), early infancy (birth to 4 months), late infancy (4 months to 1 year) and late postnatal (1 year to 9 years) on intelligence. Complementary feeding practices were interviewed at 4-6 months.

Results: Growth in weight, length/height, and HC from birth to 4 months was positively associated with intelligence (full scale, verbal, and performance IQ) at 9 years. Effects of size at birth and growth from 4 months to 1 year on intelligence were smaller and inconsistent. Only 40% of children were exclusively breast-fed. Complementary foods, mainly starchy foods, were introduced early.

Conclusions: Growth during the first year, especially from birth to 4 months, is a strong and consistent influence on intelligence at school age in this cohort of children in Thailand. Strategies to provide support for exclusive breast feeding and guidance on appropriate complementary feeding should be emphasized to ensure optimal growth and cognitive development.

Acknowledgement: We appreciate the financial support from Nevin Scrimshaw International Nutrition Foundation and Mahidol University

I.03: Supplementation of Tocotrienol Rich Fraction (TRF) from Palm Oil at Early Life Stage Improves Cognitive Function in Rat Model

Gowri Nagapan, Goh Yong Meng & Kalanithi Nesaretnam

Malaysian Palm Oil Board, Selangor, Malaysia

Objectives: Vitamin E is essential for normal neurological function. It has been demonstrated that vitamin E has a central role in maintaining neurological structure and function. Orally supplemented vitamin E reaches the cerebrospinal fluid and brain. Thus, this study was done to analyze the potential trans-generational effects of tocotrienols, the major vitamin E fraction in palm oil on the promotion and preservation of cognitive and memory functions in rats measured as a function of spatial memory.

Methodology: Adult pregnant female Sprague-Dawley rats were fed with rat chow added with experimental fat supplemented with Tocotrienol Rich Fraction (TRF), Docosahexanoic acid (DHA) and combination of DHA and TRF. The females (F0 generation) were maintained on these diets through the gestation and lactation period. Subsequently, their pups (F1 generation) were weaned with the same diet as their dams for another 8 weeks. The learning and memory behavior was assessed using Morris water maze on F1 generation males after the last feeding trial. The rats were assessed with 6 days acquisition and 6 days reversal trials. All the rats were sacrificed after the last learning trial for laboratory analysis.

Results: Our results showed that TRF and DHA supplementations were both able to reduce the escape latency during acquisition trial compared to the control. However, a more pronounced effect was observed when TRF was supplemented in combination with DHA.

Conclusions: The current study demonstrated that tocotrienol supplementation was able to improve cognitive function in normal rats. The effect was more pronounced when combined with DHA.

Acknowledgement: Malaysian Palm Oil Board; Dr Goh Yong Meng from University Putra Malaysia

Poster Group 2: Impact of Nutritional Intake and Status on Cognitive Function in Children

2.01: The Influence of Household Factors, Nutrition and Health Status on Cognitive Ability of Orang Asli Children

Haslinah ABDULLAH, Zalilah MOHD SHARIFF, Shamsul Bahari SHAMSUDIN, Bahaman ABU SAMAH, Nawalyah ABDUL GHANI, Sarina SARIMAN & Shashikala SIVAPATHY

Teacher Education Institute, Technical Education Campus, Kuala Lumpur, Malaysia

Objectives: To determine the relationship between household factors, children's health and nutritional status and the general cognitive ability of Orang Asli children aged 2.5-8.5 years old.

Methodology: This cross section research surveyed 126 Orang Asli mothers for the household demographics, socio-economic status, food security and children's health status. The Radimer/Cornell Hunger and Food Insecurity instrument was used to determine the level of household food security while three days of 24-hour diet recall were used to determine the quantity and quality of food intake of Orang Asli children. Children were measured for weight and height and the height-for-age, weight-for-age and weight-for-height growth indices were calculated. The cognitive ability of the children was determined using McCarthy Scales of Children's Abilities.

Results: The socio-economic status of the Orang Asli households was low with high percentage of poverty (68.3%) and hard core poverty (28.3%). One third (21.7-26.7%) of the Orang Asli parents had no formal education, majority of them (46.7-50.8%) had education until primary school and smaller percentage (22.6-31.6%) had education up to secondary school and tertiary education. About 88.3% of the Orang Asli households experienced varying levels of household food insecurity. There were 82.4% stunted, 84.9% underweight and 39.4% wasted children. The children had low intake of most food groups such as vegetables, fruits, meat and meat products, as well as milk and milk products. The low intakes could well explain the inadequate intake of energy, vitamin A, vitamin C, niacin and calcium. The children also showed low cognitive ability with more than half (57.8%) having weak and very weak general cognitive scores. The mean scores of verbal and quantitative indices were below the mean scale indices, indicating that their abilities in speech and basic operational mathematics were below the average scores of children with the same chronological age. The mean score of performance-perception was near to mean scale index, indicating that the Orang Asli children had good reasoning. Children with normal growth from mothers with higher education and income had better general cognitive ability compared to children who were stunted ($F=3.93$; $p<0.05$) and underweight ($F=7.23$; $p<0.01$) from mothers with low education ($F=3.83$; $p<0.05$) and no income ($F=2.05$; $p<0.05$). The correlation coefficient indicated that the level of mothers' education ($r=0.220$; $p<0.05$), energy intake ($r=0.192$; $p<0.05$), vitamin A intake ($r=0.204$; $p<0.05$) and weight-for-age ($r=0.215$; $p<0.05$) were related to the cognitive ability of the Orang Asli children. The Multiple Linear Regression results showed that mother's education ($\beta=0.117$; $p<0.05$) and children's height-for-age ($\beta=0.229$; $p<0.05$) are important factors contributing to cognitive ability of the Orang Asli children.

Conclusions: The low socioeconomic status and level of education of the Orang Asli may be the cause of household food insecurity. Nutritional status of Orang Asli children was poor with most of them stunted and underweight. They showed low ability in general cognitive and weak in speech and basic operational mathematics. Mothers' education and children's height-for-age are contributing factors to the low ability of general cognitive of Orang Asli children. Efforts to address cognitive development of Orang Asli children should take into account mothers' education level and the children's health and nutritional status.

Acknowledgement: Assoc Prof Zalilah Mohd Shariff, Head Department of Nutrition and Dietetics, Faculty of Medicine and Health Sciences, UPM.

2.02: Factors Associated With School Performance among Primary School Children

SARINA S¹, Zalilah MS¹, Khor GL¹, Mirnalini K¹ & Rohani A²

¹Department of Nutrition & Dietetics, Faculty of Medicine & Health Sciences, Universiti Putra Malaysia, Malaysia

²Department of Human Growth & Family Studies, Faculty of Human Ecology, Universiti Putra Malaysia, Malaysia

Objectives: This cross-sectional study was conducted to determine factors associated with school performance among primary school children in Selangor, Malaysia.

Methodology: The children were measured for height and weight and their parents were interviewed to assess demographic and socioeconomic information. Dietary intake data of the children was collected through 24-hour diet recall. Final examination results for four subjects (Mathematics, English and Malay Language – comprehension and composition) were obtained from the schools. Data were analyzed using SPSS version 16.

Results: Most of the family (85.2%) had per capita income above the poverty line income of Malaysia. The prevalence of stunting and underweight were 22.3% and 25.1%, respectively, while 8.7% of the children were overweight and obese. Energy intake was low with several nutrients not reaching the recommended intake. Stepwise multiple regression analysis showed that mothers' education, energy intake and expenditure of non-food items explained 27.1% of the variation in school performance among the children ($p < 0.001$).

Conclusions: Socioeconomic, demographic and nutritional factors were associated with school performance of primary school children in Selangor, Malaysia. These findings suggest that efforts to improve academic achievement of children should consider the interaction of various factors.

Acknowledgement: This project was conducted with the financial support of Fundamental Research Grant from Ministry of Higher Education, Malaysia. The authors would like to acknowledge Dr Shamsul Bahari Shamsuddin, teachers and parents for their assistance and contribution to this project.

2.03: Cognitive Performance and Breakfast Consumption: Is It Important for School Children?

Norimah A KARIM, Chong Meei Meei, Ruzita Abd Talib and Mahadir Ahmad

Department of Nutrition and Dietetics, Faculty of Allied Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia

Objectives: To determine the cognitive performance of primary school children after consuming different types of breakfast.

Methodology: Subjects were 160 healthy normal weight (by NCHS) children aged 9 years old. They were allocated into four groups as follows: Group 1 was given breakfast cereals plus milk and a chocolate malt beverage; Group 2 only breakfast cereals plus milk; Group 3 only chocolate malt beverage; No breakfast was given to Group 4. Cognitive performance was assessed using a validated Wechsler Intelligent Scale for Children (WISC-IIIUK). Three subtests were run, which were coding, digit span and arithmetic. All the subtests were conducted after breakfast consumption in Groups 1 through 3.

Results: There was a significant difference in all the subtest scores and cognitive performance between the breakfast groups and the non breakfast group. Majority of the children in the breakfast groups were in the high average score category for coding and in the average category for digit span and arithmetic tests. In contrast, the non breakfast children were mainly in the low average score category in all the subtests. All the subtests were shown to have a significant correlation ($p<0.01$) with mothers' education level and accessibility to mass media at home.

Conclusions: This study demonstrated that skipping breakfast affected the performance of specific cognitive tasks. Subjects in the breakfast groups achieved better results in all the WISC subtests when compared to the non-breakfast group. This study showed the importance of breakfast, irrespective of the types of breakfast consumed in the cognitive performance of schoolchildren.

Acknowledgement: The project was supported by UKM grant. Appreciation to Nestle Products Sdn Bhd for providing the breakfast and all schoolchildren for participating in this study.

2.04: Association between Nutritional Status with Cognitive Ability and Academic Achievement among Primary School Children: A Study in the Rural Area

Zahara ABDUL MANAF & Nurul Fatimah Hanim GHANI

Department of Nutrition and Dietetics, Faculty of Allied Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia

Objectives: To determine the relationship between nutritional status of primary school children with their cognitive ability and academic achievement.

Methodology: A cross sectional study was conducted among 173 (87 boys and 86 girls) primary school children aged 9-11 years in two selected primary schools in rural area of Johor, Southern Malaysia. The ability of cognitive function was measured using the Test of Nonverbal Intelligence-third edition (TONI-3). Academic achievement was assessed based on Malay language and Mathematics examination scores. Weight, height and mid-arm circumference of the subjects were measured using standard method.

Results: It was found that 17.9% of subjects were stunted, 22.6% were underweight, 10.4% were overweight and 2.9% were obese. There was no association found between cognitive test scores with height-for-age, weight-for-age and Body Mass Index. However, a significant positive correlation was observed between height-for-age with Malay language ($r = 0.204$; $p < 0.05$) and Mathematics ($r = 0.120$; $p < 0.05$) examination scores.

Conclusions: Nutritional status among children was associated with academic achievement. Therefore, improving nutritional status is paramount to ensure optimum academic achievement among primary school children.

Acknowledgement: We would like to thank the teachers in the selected schools for their cooperation and most importantly to the children who were selected and participated in this study.

2.05: Iron Deficiency With or Without Anaemia Affects Cognitive Function of Primary School Children

Hamid Jan JAN MOHAMED ¹, Amal K MITRA ², Rohani ABDULLAH ³, Norimah ABDUL KARIM ⁴

¹ Nutrition Programme, School of Health Sciences, Universiti Sains Malaysia, Kelantan, Malaysia

² Department of Community Health Sciences, The University of Southern Mississippi Hattiesburg, Mississippi, USA

³ Department of Human Development and Family Studies, Faculty of Human Ecology Universiti Putra Malaysia, Selangor, Malaysia

⁴ Department of Nutrition and Dietetics, Faculty of Allied Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia

Objectives: To investigate the effect of iron deficiency with or without anaemia on cognitive functions, specifically on short-term memory, attention and visual motor coordination in children.

Methodology: A total of 173 primary school children were enrolled in this cross sectional study. Cognitive functions were assessed using the Wechsler Intelligence Scale for Children. Three sub-tests were selected to assess processing speed (coding test), immediate auditory memory (digit span test) and visual processing and problem solving ability (maze test). Serum ferritin was assessed using chemiluminometric Immunoassay method and haemoglobin was measured using HemoCue BHemoglobin Photometer.

Results: The results showed significant correlation between age and coding test ($r = 0.38$, $p < 0.001$), digit span test ($r = 0.16$, $p = 0.028$), and maze test scores ($r = 0.28$, $p < 0.001$), and the total sub-test scores ($r = 0.43$, $p < 0.001$). After age adjustment of the cognitive function tests, iron deficient children without anaemia scored significantly lower than the healthy children ($p < 0.001$) on coding test, while iron deficient children with anaemia and iron deficient children without anaemia scored significantly lower ($p < 0.001$) than the healthy counterparts on maze test. No significant differences were observed on digit-span score among the groups.

Conclusions: This study confirms the negative effect of both iron deficiency and iron deficiency anaemia on processing speed and visual motor coordination in children

Note: This abstract contains findings from an article published in the Malaysian Journal of Nutrition, 16(2): 261 - 270, 2010. Permission was obtained from the editor to present the findings in this symposium.

2.06: Improvement of Cognitive Performance among School-age Children Before and After School-based Milk Supplementation Program

Bardosono SAPTAWATI

Department of Nutrition, Faculty of Medicine, University of Indonesia, Indonesia

Objectives: To determine whether supplementation of iron-and zinc-fortified milk twice daily for 6 months results in changes in children's cognitive function when compared with supplementation with no fortification.

Methodology: In a randomized controlled trial involving 209 children aged 7-9 years from 5 schools in urban poor area of Jakarta, we compared the efficacy of supplementation of milk powder alone and milk powder fortified with 6.6 mg Fe and 2.4 mg Zn per serving. Supplementation was given twice daily for 7 days a week for 6 months. Here we reported the results of cognitive functional outcome which was assessed using WISC methods for concentration and speed learning process capabilities (coding-test), and concentration and memory capabilities (digit span and visual search tests).

Results: For the cognitive performance, among the coding-, digital span forward-, digital span backward-, and visual search test scores, only changes in coding test scores both after 3 and 6 months among those in the fortified group revealed to be significantly higher than did the controls i.e. 6.70 versus 3.77 after 3 months ($p = 0.025$), and 11.39 versus 6.43 after 6 months ($p = 0.002$).

Conclusions: The beneficial effects on speed learning process over a 3 and/or 6 months period highlight the potential of this iron and zinc-fortified milk powder supplied in a school-based supplementation program.

2.07: Randomized Study on Effect of Iron Supplementation, Nutrition Education or Both on Hemoglobin and Cognition among Malaysian Adolescents

Hafzan Yusoff ¹, Wan Nudri Wan Daud ¹ & Zulkifli Ahmad ²

¹ Department of Community Medicine, School of Medical Sciences, Universiti Sains Malaysia Health Campus, Malaysia

² Office of Deputy Dean of Research and Postgraduate Studies, School of Dental Sciences, Universiti Sains Malaysia Health Campus, Malaysia

Objectives: This community trial assessed the effects of different treatment conditions on hemoglobin and cognitive performance of adolescents in rural Kelantan.

Methodology: Year four adolescents (16 – 17 yr) enrolled at secondary schools in Tanah Merah were screened for anemia ($Hb < 12g/dL$). 371 (43.4%) was found to be anemic, of whom 280 were enrolled in this trial. Participants were randomly assigned by school into; G1: iron-folate (IFA) supplementation; G2: nutrition education; G3: combination; and G4: control. There was a 3 months intervention period, followed by 3 months of withdrawal period. The hemoglobin (Hb) level were tested at baseline, 3 month and 6 month, while Raven's Standard Progressive test was done at baseline and repeated after 6 months.

Results: Based on repeated measures analysis, significant treatment main effect were obtained in Hb status at 3 and 6 months ($F [1, 3] = 66.13, p < 0.05$). There was a substantial improvement in the mean of Hb values in all groups except G4 after 3 month. However, Hb of G1 had plummeted drastically 6 month later. Similar result was found for G4 at 6 month, as it showed a constant decline as time progressed. G2 and G3 showed consistent improvement of Hb all the way through study period. No significant difference in cognitive performance was noted among all 4 groups ($p = 0.901$).

Conclusions: Nutrition education and supplementation significantly improved Hb but not cognitive performance. Longer study period might be required to determine the effect on cognitive performance.

Acknowledgement: We thank the teachers and students of secondary schools in Tanah Merah Kelantan for their participation and USM Short-term Research Grant (304/PPSP/6141611) and USM Academic Staff Training Scheme for the financial support.

2.08: Nutritional Status and Academic Achievement amongst Rural School Children in a Rural District of Kedah

Normah HASHIM, Suhaila ABDUL GHAFFAR

Department of Nutrition and Dietetics, School of Pharmacy and Health Sciences, International Medical University, Kuala Lumpur, Malaysia

Objectives: To evaluate the nutritional status and the academic achievement of children in a rural district in Kedah and to determine the association between socioeconomic status of parents and breakfast habits of primary school children with the academic achievement of children.

Methodology: A total of 35 boys and 46 girls from three primary schools in a rural district of Kedah participated in the study. Nutritional indicators used were weight for age, height for age and weight for height. Socioeconomic data such as occupation, income, educational level of parents, breakfast pattern and food frequency intake were collected through questionnaires. Academic achievement was monitored based on the average score of the final examination for major subjects i.e. Bahasa Melayu, English, and Mathematics.

Results: The results showed that 13.4%, 14.4%, 9.8%, and 13.4% of the children were underweight, overweight, stunted and wasted, respectively. The mean score for academic achievement was 61.45%. The study found that there was no correlation between nutritional status and academic achievement (AA). However, the number of years of education of the fathers was significantly correlated with AA of the children ($r=0.262, p<0.019$). T test revealed that there was no difference in AA between children who normally ate breakfast and those who did not eat breakfast. However, there was a significant difference ($t = - 3.015, p = 0.003$) when the AA was compared between gender with the mean result for girls was 66.45 (s.d. 16.55) whilst for boys was 54.88 (s.d. 17.82)

Conclusions: This study revealed that nutritional status was not correlated with AA. However, the number of years of education of the fathers was significantly correlated with AA of the children.

Acknowledgement: We appreciate the kind cooperation of the schools' principals in this study

2.09: Association between Dietary Intake and Cognitive Function of Elementary School-Children in Iodine Deficiency Disorders Area

Winda IRWANTI¹, Toto SUDARGO¹, Leny LATIFAH²

¹ Public Health Postgraduate Program in Health and Nutrition Interest, Faculty of Medicine, Gadjah Mada University, Yogyakarta, Indonesia

² Research and Development Center of Iodine Deficiency Disorder, Borobudur, Magelang, Central Java, Indonesia

Objectives: To assess the association between dietary intake of seven nutrients (energy, protein, iodine, vitamin C, Fe, Zn, Se) and cognitive function of school-children who live in Iodine Deficiency Disorders (IDD) endemic area.

Methodology: This is a cross sectional study. Subjects were 69 school-children from 3 elementary schools in Kismantoro district, Wonogiri, Central Java. IDD status of subjects was examined by palpation methods. Dietary intake of seven nutrients was assessed by 3 days of 24 hours food recall method. Cognitive function was evaluated with WISC-R method by psychologists from Psychology Unit of Gadjah Mada University to obtain an IQ (Intelligence Quotient) score. The association of nutrient intake and cognitive function was analyzed by bivariate and multivariate analyses.

Results: Using bivariate analysis, intake of energy, protein, iodine, zinc had negative significant association with IQ score test of children ($p<0.05$). Meanwhile, vitamin C, Fe and Se had no significant association with IQ score test ($p>0.05$). Using multivariate analysis, dietary intake of energy, protein, iodine, vitamin C, Fe, and selenium influenced 5.7% of IQ score of school-children. Thus, 94,3% of IQ score was affected by other factors which were not evaluated in this research such as other nutrients, goitrogenic substances, parents education, parents attention, childhood education and nurture, culture and socioeconomic factors. Another reason was that the 24-hour food recall method only evaluated recent dietary intake, while IQ is an accumulation of long term process, even during the growth in womb.

Conclusions: Dietary intake of energy, protein, iodine, vitamin C, zinc, Fe and Se had no positive association with cognitive function of elementary school-children who lived in IDD endemic area. Evaluation of long term food intake might be able to better predict the IQ scores.

Poster Group 3: Nutrition and Cognitive Function in Adults and Elderly

3.01: Nutrients from Fruits and Vegetables Are Beneficial for Cognitive Function among Elderly Chinese in Singapore

Woon-Puay KOH, N Venketasubramaniam RAMANI, Suresh SAHADEVAN

Department of Epidemiology and Public Health, National University of Singapore, Singapore
Department of General Medicine, Tan Tock Seng Hospital, Singapore

Objectives: There are limited studies in Asian populations on the association between diet and cognitive function. In this study, we investigated this association among elderly Chinese in Singapore.

Methodology: This study involved 1,009 Chinese aged 50 years and above, who participated in a prospective population-based cohort known as The Singapore Chinese Health Study (SCHS), as well as a population-based cross-sectional study on prevalence of stroke, Parkinson's disease, epilepsy and dementia in Singapore (SPEEDS). All participants answered a validated interviewer-administered semi-quantitative food frequency questionnaire during their recruitment into SCHS between 1993 and 1998 to assess dietary intakes and lifestyle factors. Cognitive function was examined by a validated 10-item cognitive function test known as Abbreviated Mental Test (AMT) during their participation in the SPEEDS study between 2001 and 2003. Logistic regression models were used to study the association between diet and risk of impaired cognitive function.

Results: Among 1,009 subjects, 68 subjects were classified as being cognitively impaired. After adjusting for factors such as age, gender, education, smoking, physical activity and medical histories including diabetes and stroke, we found a dose-dependent association between increased intake of fruits and vegetables and reduced risk of cognitive impairment. Compared to the lowest quartile, the highest quartile intake of vegetables was associated with 62% reduction in risk [p for trend=0.007]. For the intake of fruits, relative to quartile 1, quartile 4 intake was associated with 72% reduction in risk (p for trend=0.003). Nutrients found in vegetables and fruits such as carotenoids, vitamins B and C, were accordingly associated with reduced risks of cognitive impairment.

Conclusions: Our study shows that Asian diets rich in vegetables and fruits are also associated with better cognitive function in the elderly, and provides strong reason for promoting the intake of these foods in the population.

3.02: Tree Nuts Are a Good Source of Nutrients Associated with Cognitive Performance

Bradley W BOLLING ¹, C-Y Oliver CHEN ², Jeffrey B BLUMBERG ²

¹ University of Connecticut, Department of Nutritional Sciences, Storrs, CT, USA

² Jean Mayer USDA Human Nutrition Research Center on Aging, Tufts University, Boston, MA, USA

Objectives: To demonstrate that research on the effect of tree nuts on cognition is warranted

Methodology: Reports of neuroprotection by dietary components were examined and synthesized in the context of tree nut nutrients and phytochemicals.

Results: Specific nutrients and phytochemicals have been associated with neuroprotective actions, improved cognitive performance, and/or reduced risk of age-related dementias, including vitamin E, amino acids, phytosterols, unsaturated fats, and polyphenols. Though a good source of many of these compounds, little research on tree nuts has been directed to cognitive outcomes. In vitro and in animal models, α -tocopherol reduces inflammation and oxidative stress in neurons. Some observational studies and clinical trials suggest

that α -tocopherol can reduce the risk or progression of Alzheimer's disease. Similarly, consumption of mono- and polyunsaturated fats, particularly n-3 fatty acids, affect neuronal membrane fluidity and inflammation and are associated with a lower risk for depression and age-related dementia. In vitro experiments show that polyphenols, including flavonoids and proanthocyanins, improve synaptic plasticity and stimulate neurogenesis. Small, short-term interventions with polyphenol-rich foods or extracts reveal improved cognitive function among elderly subjects. Arginine improves verbal memory in older adults. Interestingly, senescent rats fed a walnut diet showed a reversal of age-related declines in working memory and psychomotor performance. Thus, direct studies of the effect of tree nuts on cognition are warranted, with special attention to the potential for synergistic interactions between their neuroactive constituents.

Conclusions: Evidence obtained from in vitro, animal model, and human studies suggests that several nutrients and phytochemicals common to tree nuts have neuroprotective actions and may promote cognitive performance, particularly on functions associated with age-related declines. Thus, while research on the effect of tree nuts on cognition has been limited to date, these results warrant new investigations in this area.

Acknowledgement: Support for this work was provided by the Almond Board of California.

3.03: Beneficial Effects of Docosahexaenoic Acid (DHA) Omega-3 on Cognition and Age-related Cognitive Decline

James D ASTWOOD, Karin YURKO-MAURO, Deanna MCCARTHY, Alan S RYAN, Norman SALEM, Edward B NELSON, and Rob WINWOOD

Martek Biosciences, Columbia, Maryland, USA

Objectives: Decreases in plasma DHA are associated with cognitive decline in healthy elderly and Alzheimer's patients. Preclinical studies have shown that DHA supplementation restores DHA brain levels, enhances learning and memory tasked in aged animals, and reduces beta amyloid, plaques and tau in transgenic models of Alzheimer's disease. The objective of this study was to determine the effects of DHA supplementation on cognitive functions in healthy older adults with age-related cognitive decline.

Methodology: A randomized, double-blind, placebo-controlled clinical study with 485 healthy volunteer subjects, aged > 55, was conducted with 900 mg/day of DHA vs. placebo for 24 weeks. Subject criteria included a score of >26 on the Mini-Mental State Examination and a Logical Memory baseline score (Wechsler Memory Scale III) at ≥ 1 standard deviation below younger adults. Outcomes in visuospatial learning and episodic memory were assessed using the CANTAB Paired-Associate Learning test.

Results: Significantly fewer PAL six-pattern errors were observed in subjects receiving DHA vs placebo at 24 weeks. Plasma DHA levels doubled in the treatment group and correlated with improved PAL scores.

Conclusions: Supplementation with 900 mg/day of DHA for 24 weeks improved learning and memory function in age-related cognitive decline.

Acknowledgement: We thank the 19 US clinical sites and numerous investigators who contributed in this study.

3.04: Nutritional Status and Its Association with Cognitive and Functional Status among Older Adults 60 Years and Above in a Government Health Clinic

Zaitun YASSIN and SOR Yun Chen

Department of Nutrition & Dietetics, Faculty of Medicine & Health Sciences, Universiti Putra Malaysia, Malaysia

Objectives: A cross-sectional study was carried out to determine the relationship between nutritional status and cognitive and functional status among older adults 60 years and above in a government health clinic.

Methodology: A total of 107 elderly consisting of 60 males and 47 females aged 60 to 86 years old were recruited from a health clinic using purposive sampling. Data on personal background and general health characteristics were collected by face-to-face interview. Weight, height, waist, hip, calf and thigh circumferences, body fat mass, body fat percentage and handgrip strength were measured using standard procedures and appropriate equipments. Cognitive function test (Hodkinson's Abbreviated Mental Test), Elderly Mobility Scale (EMS), General Health Questionnaire (GHQ) and manual dexterity were observed and measured using appropriate instruments. The data was analyzed using SPSS 14.0.

Results: Based on the body mass index (BMI), 23.4% of the elderly were overweight and 8.4% were obese. About 17% were classified as "probable cases" (score: 0-4) and 13.1% as "borderline cases" (score: 5-6) of cognitive decline. The results showed significant differences in the cognitive function score, EMS score, GHQ score, handgrip strength, weight, and body fat percentage ($p < 0.05$) between the male and female subjects. There was a significant correlation between BMI and age ($r = -0.193$, $p < 0.05$), but not with scores of cognitive test, GHQ, EMS, and handgrip strength. On the other hand, cognitive scores were significantly correlated with GHQ scores ($r = -0.451$, $p < 0.01$), EMS scores ($r = 0.441$, $p < 0.01$), handgrip strength ($r = 0.568$, $p < 0.01$), and weight ($r = 0.409$, $p < 0.01$). Significant correlations were also observed between age and cognitive scores ($r = -0.278$, $p < 0.01$), EMS scores ($r = -0.485$, $p < 0.01$), weight ($r = -0.287$, $p < 0.01$), waist circumference ($r = -0.230$, $p < 0.05$), and handgrip strength ($r = -0.268$, $p < 0.01$). X²-test did not show any association between BMI and cognitive status ($p > 0.05$).

Conclusions: Nutritional status was not associated with cognitive status but a number of health-related and functional indicators were correlated with cognitive scores. Therefore, appropriate interventions need to be carried out to address the age-related consequences of cognitive decline among the elderly.

Poster Group 4: Nutrition and Cognitive Function in Adults and Elderly

4.01: Assessing the Impact of Nutrition on Children's Cognition

David BENTON¹, Elizabeth ISAACS², John OATES³

On behalf of the ILSI EUROPE Nutrition and Mental Performance Taskforce

¹ University of Swansea, Swansea, United Kingdom

² University College London, Institute of Child Health, London, United Kingdom

³ The Open University, Milton Keynes, United Kingdom

Objectives: Nutrition may affect cognition in children, both in terms of the influence of early diet on subsequent development and in the short-term for example by the patterning of meals. Appropriate methodologies and psychological measures need to be used to assess these effects.

Results: We present general guidelines for choosing tests suitable to assess the impact of nutrition on cognitive abilities of children at various ages, organized by cognitive domain. We illustrate how such tests may be used by presenting an overview of how deficiencies in both micro- and macro-nutrients have been demonstrated to impact on brain and behavior in children. The diet of the mother during pregnancy and the diet of the infant in the perinatal period can both have long-term consequences. A deficiency of various micro-nutrients in developing countries has been found to have long-term implications for cognitive development. Vitamin A plays a critical role in visual perception and a deficiency is the leading cause of childhood blindness. A lack of iodine during a critical period in brain development is associated with reduced intellectual ability. Iron shortage is a widespread problem in the developing world and in industrialized countries: iron deficiency in early life can adversely effect brain development. In industrialized countries, the role of folate in preventing neural tube defects is well established and in a few individuals impaired cognitive functioning is associated with a lack of vitamin B12. There is increasing evidence that the missing of breakfast has negative consequences and a working hypothesis is that meals of a low glycaemic load are beneficial.

Conclusions: The understanding of the aspect of cognition being assessed, the age of the child, and the likely impact of the nutrients will determine the selection of the tests to assess the impact of nutrition on cognitive abilities in children.

4.02: The Measurement of Diet-induced Changes in Cognition: Methodological Aspects

David BENTON¹, Wolfgang KALLUS², Jeroen SCHMITT³

On behalf of the ILSI Europe Nutrition and Mental performance Taskforce

¹ University of Swansea, United Kingdom

² Karl-Franzens Universität Graz, Austria

³ Nestlé Research Center, Switzerland & Brain Sciences Institute, Australia

The possibility that cognitive functioning can be influenced by diet is attracting increasing attention as the evidence grows that diet can be influential throughout the entire life. An ILSI Europe expert group (EG) has been established to explore the current methods used to assess cognitive abilities, considering the scientific substantiation of nutritional effects on cognition.

The EG produced an introductory overview on the methodological aspects of assessing nutritional enhancement of mental performance through behavioral assessment. The main domains of cognitive functioning, the series of processes they involved, as well as the influences of individual states (e.g., level of arousal, mood or motivation), have to be carefully considered when designing a study, selecting a cognitive test or interpreting results.

The EG published two reviews dedicated to the impairments of memory and of attention and psychomotor functions in elderly. Theoretical conceptions of these functions, their changes during aging, related tests and methodological approaches were investigated. Changes due to selected nutritional variables were discussed (influence of caffeine, ginseng, glucose on attention and psychomotor performance; phosphatidylserine and vitamin E on memory). With age the episodic memory declines but memory is not a unitary phenomenon and should be monitored using a range of tests that reflect theoretical conceptions of the topic. Attention and psychomotor functions can be divided in sub-functions differentially affected with age. To assess nutrition effects, the experimentally oriented functional microanalysis of changes is complementary to the performance profile.

Behavioral assessments can be a sensitive and valid method to investigate the effects of nutrition on brain function, if applied appropriately. Control for potentially confounding factors is essential, as is the selection of a tests and the condition under which they are administered. The study design should be tailored to meet the study aims, product characteristics and target population

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Last but not least, we thank the delegates who have traveled from near and far to participate in this Symposium. We thank you for the support in making this event a success.

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