









Growing up with GUSTO



### Yap-Seng CHONG

Associate Professor, Dept of Obstetrics & Gynaecology, NUHS

Executive Director, Singapore Institute for Clinical Sciences, A\*STAR

24 February 2016

Research

**Clinical Care** 

Education

Developmental Origins : Singapore

De¥OS

## Translational and Clinical Research Flagship Programme \$25 million over 5 years, awarded end 2008;

renewed end 2013



**Developmental Origins : Singapore** 

### **Developmental Pathways to Non-Communicable Diseases**

- To study how pregnancy and early childhood conditions (development) influence the tendency of individuals to develop non-communicable diseases (obesity, diabetes, neurodevelopmental disorders) later on in life.
- To study how **ethnicity** influences the tendency of individuals to develop NCDs.
- Main aim is to find ways to prevent these chronic diseases rather than just treating them or preventing their complications.

# Windows of opportunity to promote health



M. A. Hanson, and P. D. Gluckman Physiol Rev 2014;94:1027-1076

If you mess up your children, nothing else you do really matters.

> Jacqueline Kennedy Onassis, 1929-1994



## How does early life affect long term health?

Pregnancy Early childhood

First 1000 days

# How the pregnancy period affects the baby's future development



#### From Gluckman et al, Am J Hum Biol 2007; 19: 1-19

## Development from a phenotypic perspective



## Great Ice Storm of 1998



The North American Ice Storm of 1998 was a massive combination of five smaller successive ice storms, which combined to strike a narrow swath of land in eastern Canada and northeastern USA in January 1998.

## January 1998

Loyola High School Gym Shelter Closes it doors Jan 16th 1998 after serving Notre Dame De Grace area of Montreal for 9 days

DUTEAU DASS TANCE

OJ DINADA

Montreal Ice Storm Loyola Gym/shelter Kitchen ©Patrick McDonne

INSURANCE

OF CANADA

BUREAN



Some of the volunteers and Emergency staff have time to talk Overview of the Shelter Dinning Room



One of the many volunteers helps the refugees Montreal DownTown never closes during the Storm











## Long term effects of antenatal maternal stress on their children

- The Great Ice Storm of 1998 caused extensive infrastructural damage to parts of Atlantic Canada and northeastern USA and left millions of people without electricity for weeks.
- Studies of pregnant women exposed to this natural disaster later found that their young children's neurodevelopment were negatively affected, reflected by lower general intellectual and language abilities.



The effects of prenatal maternal stress on children's cognitive development: Project Ice Storm

SUZANNE KING<sup>1,2</sup> & DAVID P. LAPLANTE<sup>2</sup>

<sup>1</sup>Department of Psychiatry, McGill University, Québec, Canada, and <sup>2</sup>Douglas Hospital Research Centre, Verdun, Québec, Canada

Taylor & Francis Taylor & Francis Group	Psychiatry Research 219 (2014) 353-360				
		Contents lists available at ScienceDirect	2		
	5-2-61	Psychiatry Research	Psychiatry Research		
	ELSEVIER	journal homepage: www.elsevier.com/locate/psychres			

Prenatal maternal stress predicts autism traits in 6<sup>1</sup>/<sub>2</sub> year-old children: Project Ice Storm

CrossMark

Deborah J. Walder<sup>a</sup>, David P. Laplante<sup>b</sup>, Alexandra Sousa-Pires<sup>b</sup>, Franz Veru<sup>b,c</sup>, Alain Brunet<sup>b,c</sup>, Suzanne King<sup>b,c,\*</sup>

<sup>a</sup> Department of Psychology, Brooklyn College and The Graduate Center of The City University of New York, 2900 Bedford Avenue, Brooklyn, NY 11210, USA <sup>b</sup> Psychosocial Research Division, Douglas Mental Health University Institute, 6875 LaSalle Boulevard, Verdun, Quebec, Canada H4H 1R3 <sup>c</sup> Department of Psychiatry, McGill University, 1033 Pine Avenue West, Montreal, Quebec, Canada H3A 1A1

"Truly World-class & Best-in-class" Tachi Yamada, A\*STAR Board Meeting, June 2014.

"A study with great national impact - to prevent and manage diseases like diabetes and obesity." *Minister Heng Swee Keat,* MOE FY2015 Committee of Supply Debate-Speech, 6 Mar 2015.





**GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES** 

- Launched in 2009
- 1247 mother-child pairs
- 3 Asian ethnic groups
- Closest longitudinal follow-up ever
- Deepest phenotyping & biosampling



IN UTERO



BIRTH



**INFANCY & CHILDHOOD** 



#### 1.5.

#### 26-28wk clinic visit

#### **Blood taking**

Oral Glucose Tolerance Test Biochemical markers (CRH, CRH binding protein, cortisol,leptin, alpha-feto protein etc)

#### Collection of hair sample

Non-mydriatic retinal photograph & autorefraction Anthropometry (Ht, Wt, Skinfold thickness, MAC) Pulse wave velocity (BP)

#### Questionnaires

Life style, family background and breastfeeding Food diary (24 hour recall and 2 days food diary)

#### Self administered questionnaires

STAI, EPDS, BDI-II, LYDON & Question on domestic helper Pittsburgh Sleep Quality Index (PSQI)





## Deep phenotyping of mothers in mid-pregnancy











### 24/7 on-call team





## Collection of specimens at delivery

### Umbilical cord & placenta







Store all Zip-lock bags in -80°C



Store all Zip-lock bags in -80°C







### Maternal, Paternal, Cord blood, etc

## Interrogating the BioSamples Devos

Umbilical cord and placenta



Maternal and fetal blood

Longitudinal buccal swabs



Cord derived MSCs

Longitudinal microbiota sampling



Blood chemistry

Including micronutrients, metabolomics

**Genotyping** Omniexpress+ exome arrays SNP and CNV

Methylome assessment Infinium 450K arrays RRBS Methyl-capture-seq

**Chromatin and histone assessment** TaCH / DNAase protection Native ChIP-seq Mnase-seq

## Transcriptome assessment

Infinium HT12 v4 arrays RNAseq miRNAseq

**Microbiome assessment** 16S RNA sequencing Metagenomics

## Day 1 – Body Composition



Skinfold measurement

Bioelectrical impedance



Air displacement plethysmography



# In GUSTO, we measured neonatal brain function right after birth



### EEG on Day 1 of life

### MRI on Day 7 of life



Reconsent



# Now used for sick infants



Skinfold & Anthropometry

BIA



**386 MRIs** done without sedation

For a subset, MRI is repeated at: Week 6 Month 6





Preparation



## **MR Imaging**



### Whole Body Study: Head & Chest, Abdomen & Lower Limbs







FRACTIONAL ANISOTROPY: INTEGRITY OF AXONS, IMPORTANT IN MEDIATING NEUROLOGICAL FUNCTIONS



## Security Clinic Visits at 6, 18, 24, and 36 months: Neurodevelopmental and other detailed assessments







**4 Years** 

### **School Readiness Test**



Peabody Picture Vocabulary Test	Lollipop Test	Number Knowledge Test	Visually Cued Recall Test	Random Object Span Test	Comprehensive Test of Phonological Processing- 2
This is a test of receptive vocabulary which assesses the child's vocabulary acquisition.	This test assesses the child's ability to identify colours, shapes, numbers and letters.	This test assesses the child's intuitive knowledge of numbers.	This test evaluates the child's working memory through visual images and verbal information.	This test assesses the child's visual working memory.	This test evaluates the child's <b>phonological</b> <b>processing</b> as a prerequisite to reading fluency.



This test measures the child's **number sense** and approximate number system (ANS) which underlies the ability to produce abstract number representation.

This checklist measures the child's **behavioural and socio-emotional functioning** as reported by parents.

These tasks carried out during the **48 Months Home Visit** help to assess the child's 'school readiness' in Singapore.



### **MRI:** SAFARI ADVENTURE!





### SIEMENS MAGNETOM Skyra syngo MR D13



## 4.5 Years

## MRI Abdominal Compartment at 4.5 years













now one of the top centres for early childhood imaging research

### **BOD POD:** Spaceship adventure!

### Quantitative Magnetic Resonance Technology QMR: *Fun with sea animals!*





Visit	Status	Visit completed	<b>BOD POD performed</b>	QMR performed (KKH)
Year 5	Ongoing	647	329	193
Year 6	Just started	29	5	21

## Translational impact Turning research into action



## **Importance of Early Mental Health**

#### Short-Term Memory, Working Memory, and Executive Functioning in Preschoolers: Longitudinal Predictors of Mathematical Achievement at Age 7 Years

#### Rebecca Bull

School of Psychology, University of Aberdeen, Aberdeen, United Kingdom

#### Kimberly Andrews Espy and Sandra A. Wiebe

Office of Research & Department of Psychology, University of Nebraska-Lincoln

#### Correlations between Predictor Variables and PIPS Mathematics and Reading Scores

	PIPS Correlations Mathematics			PIPS Correlations Reading		
Predictor	Wavel	Wave 2	Wave 3	Wave1	Wave 2	Wave 3
Short-term memory:						
Consi Span Forward	.40**** (104)	.36 (101)	.13 (82)	0.19 (104)	0.27*** (101)	0.28 (83)
Digit Span Forward	.36**** (104)	.32 **** (101)	.12 (82)	0.32**** (104)	0.35**** (101)	0.25**(83)
Working memory:						
Consi Span Backward	.34 *** (78)	.36 **** (75)	.39***(58)	0.37 (78)	0.55 **** (75)	0.27**(58)
Digit Span Backward	.52 (84)	.37 **** (81)	.32*** (62)	0.45**** (84)	0.39 **** (81)	0.23 (63)
Executive functioning:						
Shape School Inhibit (Efficiency)	.42**** (104)	.43 **** (101)	.23 ** (82)	0.40**** (104)	0.46 (101)	0.21*(83)
Shape School Switch (Efficiency)	.38***** (104)	.31*** (101)	.29****(82)	0.45**** (104)	0.33**** (101)	0.29***(83)
Tower of London	.46**** (104)	.30 (101)	.26** (82)	0.41**** (104)	0.35 (101)	0.17 (83)

Number of observations included in each correlation are provided in parentheses





### **For Education**



**For Financial Responsibility and** Criminality

## Our neonatal MRIs have yielded much new information

Citation: Transl Psychiatry (2015) 5, #66.8: doi:10.1038/to.2015.133

OPEN

Citation: Transi Psychiatry (2013) 3, e306; doi:10.1038/tp.2013.79 © 2013 Macmillan Publishers Limited All rights reserved 1365-7852/13

where nature combin

#### ORIGINAL ARTICLE

Maternal anxiety and infants' hippocampal development: timing

www.nature.com/tr

matters A Olu<sup>1,2,2</sup>, A Rifkin-Grabo

Citation: Transl Psychiatry (2015) 5, e508; doi:10.1038/tp.2015.3

Exposure to maternal ORIGINAL ARTICLE

OPEN

years after birth, the t antonatal and postnata Prenatal maternal depression alters amygdala functional regulation. A total of at 6 months of age. M connectivity in 6-month-old infants months after delivery. at birth. However, chili A Qiu<sup>1,2</sup>, TT Anh<sup>1</sup>, Y Li<sup>1</sup>, H Chen<sup>3</sup>, A Rifkin Grabol<sup>2</sup>, BFP E right hippocampus ow MJ Meaney2A staistically stronger wi maternal anxiety and r Prenatal maternal depression is associated with alterat anxiety and the left hip for the influence of prenatal maternal depression on distinct responses to p association between prenatal maternal depressive syn influence of the expos establish the neural functional basis for the transgene anxiety, but enhanced development. Twenty-four infants were included in thi state functional MRI (fMRI) at 6 months of age. Mater delivery using the Edinburgh Postnatal Depression Sca Translational Psychiatry and to examine the associations between prenatal m Keywords: antenatal : results showed that at 6 months of age, the amygdala i egulation, sensory and perceptual, and emotional me symptoms, infants born to mothers with higher prenat

the arrivodala with the left temporal cortex and insult

major depressive disorder. Our study provides novel of amygdala's functional connectivity in early postnatal lif

of phenotypes associated with maternal mood are an

Translational Psychlatry (2015) 5, e508; doi:10.1038/tp.

entromedial prefrontal cortices, which are largely con-

#### INTROD UCTIO N

Anxiety has a familial con parents show a signifi problems.<sup>23</sup> Although th vulnerability is transmitte maternal emotional well ( ess and the resulting ne affect fetal physiology, inhibition in the first two postnatal mood<sup>6</sup> and INTRODUCTION behavioral and emotional Exposure to prenatal maternal depression increases the density in childhood.6 bility for depression in the offspring<sup>1,2</sup> and associates density in childhood<sup>\*</sup> Billy for depression in the offspring<sup>\*\*</sup> and zacotases bandgeneational trans formas in naurobehavioal<sup>\*</sup> cognitive<sup>\*\*</sup> and sock-ar vulnerability for arketryn Diffscher transmort of ethichte transmort of subandtim offster on ps subandtim offster on ps

provide any device on prime provide any second seco confer resistance to stress depression and the amygdala's microstructure of infant Confer resistance to sures appression and the employees interval appression. Parker<sup>16</sup> propose a stress in analog sudy proformed shortly after birth.<sup>18</sup> But there that exposure to mild stri lack of inowledge on whether the amyodia functions of are also influenced by prenatal insternal depression. The secondark is a law thain mobion closely associat

The amygdala is a key brain region closely associat Department of like engineering, I stress reactivity and vulnerability for depressive dit for Clinical Sciences, the Agent Structural magnetic resonance imaging (MRI) studies Generations, Yoon Loo Lin Scho

Generation, Yong Loo Lin Schr Vernen's and Chiefen's Hoopb Wornen's and Chiefen's Hoopb Wornen's and Chiefen's Hoopb Part Regeneration of Schemer 1 (Streppen Sprapen Not Worker) and Chiefen's Hoopb Sendi Bregeneration of Schemer Sendi Bregeneration of Schemer 1 (Streppen Notice) (Streppen Notice) Bregeneration of Schemer 1 (Streppen Notice) (Streppen Notice) (Streppen Notice) Bregeneration of Schemer 1 (Streppen Notice) (Streppen Notice) (Streppen Notice) Bregeneration of Schemer 1 (Streppen Notice) (Streppen Notice) Bregeneration (Streppen Notice) (Streppen Notice) (Streppen Notice) Schemer 1 (Streppen Notice) (Streppen Notice) (Streppen Notice) Bregeneration (Streppen Notice) (Streppen Notice) Free Management (Streppen Notice) (Streppen Notice) Free Management (Streppen Notice) (Streppen Notice) (Streppen Notice) Free Management (Streppen Notice) (Streppen Notice)

Grnait: blequijn uuvduug Received 7 July 2014; revixed 25 November 2014; accepted 19 December

OPEN

ORIGINAL ARTICLE

Maternal sensitivity, infant limbic structure volume and functional connectivity: a preliminary study

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www.nature.com/b

A Rifkin-Graboi<sup>1</sup>, L Kong<sup>2</sup>, LW Sim<sup>1</sup>, S Sanmugam<sup>1</sup>, BPP Broei PD Gluckman<sup>4,9</sup>, W Fortier<sup>10</sup>, D Referson<sup>11</sup>, MJ Meaney<sup>1,10,11</sup> ARCHIVAL REPORT

#### Prenatal Maternal Depression Associates with understrood Stuties with nonharman models suggest water Microsstructure of Right Amygdala in Neonates antologyaphy and emotional regulation. In some research

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Angi Qiu, Ph.D.

Ta Anh Tuan, M.S.

Mei Lyn Ong, Ph.D.

work suggests early-postnatal social adversity accelerates the at Birth explored whether maternal sensitivity predicts human limbi

sample of human infants. When infants were 6 months of at Anne Rifikin-Graboi, Jordan Bai, Helen Chen session and the infants underwent neuroimaging at the sai Mya Thway Tint, Birit Leutscher-Broekman, session and the marks since with management of a monstrain Marielle V. Fortier, Michael J. Meaney, and bilateral hippocampal volume at six months, with the major

Similar indirect, but not significant results. Moreover, functional statements in adversal control levels associated and connectivity between the hippocampus and areas implementation in the offering. However, because affecting the and connectivity between the hippocampus and areas imp Sensitivity additionally predicted indirect associations bet w maternal influences is undear. This study aimed to exam Our volumetric results are consistent with research indicatin and neonatal anygdala volume and microstructure and t and in combination with our functional results, if replicated i for affective disorders during prenatal development maternal care influence neuroanatomical trajectories impo Methods: Our study recruited Asian mothers at 10 to 13

Translational Psychiatry (2015) 5, e668; doi:10.1038/tp.2015. using the Edinburgh Postnatal Depression Scale. Studura with 157 nonsedated, 6- to 14-day-old newborns and the values of the amygdala.

The quality of parental care influences socio-emotional a and birth weight, we bound significantly lower fractional are cognitive development,<sup>14</sup> as well as mental health,<sup>1</sup> althou in the regram you's and birth weight, we bound significantly lower fractional are cognitive development,<sup>14</sup> as well as mental health,<sup>14</sup> althou in the regram you's an other works of the other social and an and and weight the development. It is not understood in correct, there is no social emotional is not understood. The correct, there is no social emotion.

well-documented effects of more extreme forms of childho Conclusions: The results reveal a significant relation bet advenity, such as abuse and neglect, upon brain developms right anygdala, a brain region dosely associated with s and function.<sup>67</sup> In addition, the influence of variations in parent suggest the prenatal transmission of vulnerability for d care that lie within the normal range upon neuronal developms depression should begin early in pregnancy

and behavior has been extensively studied in rodents,<sup>8</sup> w

similar neurodevelopmental findings in nonhuman primates.<sup>9</sup>
Nevertheless, studies of human child development do reveal t Key Words: Affective disorders, anyodab, antenatal dep particular importance of variation in 'maternal sensitivity' diffusion tensor imaging, magnetic resonance imaging, n developmental outcomes.<sup>10,19</sup> Maternal sensitivity refers to tim brain and accurate responsivity to situationally dependent infa

signals, and is obtain for the management of inflat distribution in the person has a strong familial component. CMM the analysis confirm that maternal is analysis confirm that maternal is analysis confirm that maternal is analysis. depression relative to the normal population (1-3 wise, the offspring of depressed mothers show increase

dence for the intermediate phenotypes that associat Integrative Neuroscience Program, Singapore Institute for Clinical Sciences, Singal youh grability for depression (4,5), including alterations i <sup>1</sup> Vargatte Neurositere Regres, Fongones Institute & Dial Liferones, Char, vulnerability for depression (45,1), including alterators in Neurosit Neurosity of Traignon, Singenes, Paragenese and Paralian Incorpology (47), These defices appent to reflect the trans-formation of Neurosity and Singenes, Singenes, Singenese Teams and Annual International Incolectual differences in vulnerability institution with Singenes, Singenes, Singenes, Singenese Cardinal Content of Annual Annual International Internation Internation Internati

un unwerzeg, wondeal, Quebec, Canada, Convepondence: Dr A Rifkin-Grabol, lecular Medicine 30 Medical Drive, Singapore 117099, Singapore or Accodum glowning Drive 1, Block EA HOI-12, Singapore 117576, Singapore. E-mail: anne\_riffeingsicca+toradusg or biequignusadusg Received 21 January 2015; e-viced 2 July 2015; accepted 22 July 2015

Research Center (JB, AQ, National University of Singapore Dep of Diagnostic and Interventional Imaging (HC, MVP), KK Wom Children's Hospital; and Department of Obstatrics & Gynaecolo BL-B, Y-SC), Yong Loo Lin School of Medicine, National Univ Singapore, National University Health System, Singapore, Si and Douglas Mental Health University Institute (NUM), McGill U

Montreal, Canada. Address correspondence to Angi Qiu, PhD, National Unive Singapore, Department of Bioengineering and Clinical arch Center, 9 Engineering Drive 1, Bock EA 403-12, Si 76. Singapore: E-mail: blegadhus.edu.sg 117576 G Received Mar 22, 2013; revised May 26, 2013; accepted Jun 13, 1

0006-3223/\$36.00 http://dx.doi.org/10.1016/i.bioosych.2013.06.019 Article

Marielle V. Fortier, M.D.

Michael I. Meaney, Ph.D.

Joanna Dawn Holbrook, Ph.J

COMT Haplotypes Modulate Associations of Antenatal Maternal Anxiety and Neonatal Cortical Morphology

#### PLOS ONE

#### RESEARCH ARTICLE

Gestational Age and Neonatal Brain Microstructure in Term Born Infants: A Birth Cohort Study

Birit F. P. Broekman<sup>1,3</sup>, Changqing Wang<sup>2</sup>, Yue Li<sup>2</sup>, Anne Ritkin-Grabol<sup>3</sup>, Seang Mei Saw<sup>4</sup>, Yap-Seng Chong<sup>2</sup>, Kenneth Kwek<sup>6</sup>, Peter D. Gluckman<sup>3,7</sup>, Marielle V. Fortier<sup>2</sup>, Michael J. Meaney<sup>3,9</sup>, Angi Qiu<sup>22,104</sup>, for the GUSTO Study Group

Ter the Use 11 of SUBJ Sectory Genotics Colometer of Physician Medicine, Yong Loc Lis School of Matchine, National University of Singpoons, National University Heads Bysicians, Biogenes, Biogenes, B. Speatment of Research at Research Sectors, Schoolege, Steffenstein, Biogenes, Margones, A. San Merei, Matchine M. School of Phata School Sectors, Schoolege, Steffenstein, Biogenes, Margones, A. San Merei, Machanal Chine, Steffenstein, Balter National University of Biogenes, Biogenes, Biogenes, Alasse Merei, Matchina of Matchine, Steffenstein, National University of Biogenes, Biogenes, Margones, Alasse Merei, Matchine of Matchines, Steffenstein, Biogenes, T. Jageine statilas, National Y and Validade, Astalander, Han Zhander, Matchine of Dispatistics Biogeness, T. Jageine statilas, Validated, Astalande, Haio Zhander, Haio Zhander, Matchiner, Matchines, Stepartment of Dispatistics Biogeness, T. Jageine statilas, Validated, Astalande, Haio Zhander, Haio Zhander, Haio Zhander, Matchiner, Matching, Matchiner, Matching, Matchines, Biogeness, T. Jageine statilas, University of Auditated, Astalander, Haio Zhander, Haio Zhander, Matchines, Matchines, Matchines, Matchines, Biogeness, T. Jageine Statility, Matchines, Matchingeness, Matchiness, Matchiness, Matchiness, Matchi Psychiatry and Neurology & Neurosurgery, McGill University, Montreal, Canada, 10. Clinical Imaging Research Centre, National University of Singapore, Singapore, Singapore

#### \*bisce@nus.edu.so

thership of the GUSTO Study Group is provided in the Acknowledgme

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Published: December 23, 20%

Abstract

Objective: Understanding healthy brain development in utero is crucial in order to

December 2014 The State of the State St However, in most studies neuroimaging was done after a significant postnatal period, and in those studies that performed neuroimaging on fetuses, the quality of data has been affected due to complications of scanning during pregnancy. To understand healthy brain development between 37-41 weeks of gestational age University of Strapport, and biogenerating who is lose a whiter of the GUERD sectors our study assessed the *in utero* growth of the brain in healthy term both babies with cours budy assessed the *in utero* growth of the brain in healthy term both babies with DTI scanning soon after birth.

Methods: A cohort of 93 infants recruited from maternity hospitals in Singapore underwent diffusion tensor imaging between 5 to 17 days after birth. We did a cross-sectional examination of while matter microstructure of the brain among healthy term infants as a function of gestational age via voxel-based analysis on fractional anisotropy. 430), The

Results: Greater gestational age at birth in term infants was associated with large fractional anisotropy values in early developing brain regions, when corrected for Computing Interests: The actives have declared age at scan. Specifically, It was associated with a cluster located at the corpus their computing interest with.

PLOS ONE | DOI:10.1371/gamal.pone.0115229 Determber 23, 2014

1/17

Kenneth Kwek, M.D. Seang-Mei Saw, Ph.D Yap-Seng Chong, M.D.

> of affected parents show an increased risk for emotional the precise mechanism through which vulnerability is

Anxiety has a strong familial component (1). Children Vulnerabi parents may mpared with the normal population (2). While (9). The cat

transmitted remains undear, there is evidence that ante natal maternal emotional well-being associates with alterations in the uterine environment (3) and in fetal physiolog (4). Antenatal maternal anxiety and the accompanying alterations in the uterine environment also predict an in-creased risk for childhood behavioral and emotional oblems (3), decreased gray matter density of prefrontal nd sensory cortices in childhood (5, 6), and alterations performance on prefrontal dependent tasks (5). Imnortantly, the associations of antenatal maternal anxiety with childhood emotional function (7) and early brain growth, particularly in structures that are implicated in the regulation of emotional states (8), are independent of postnatal maternal anxiety. These findings appear to reflect a prenatal, transgenerational trans of individual differences in vulnerability for emotional

#### Objective: Evolute to antenatal mat Yue Li. B.S. anolety and complex genetic variations shape fetal brain development. In parti the catechol-O-methyltranslense(CDMI) Helen Chen, M.D. located on chromosome 22g 11.2 regi catecholamine signaling in the prefe cortex and is implicated in anxiety, pair stress responsivity. This study evan whether individual single-nucleotide morphisms (SNPA of the COMF gene their haplotypes moderate the assor between antenatal maternal anxiet

COMTvaria with anxiety, single-nude (x 4680) lead methionine allde is sugg higher COM sumably lea enhanced d dated with a

Anne Rifkin-Graboi, Ph.D. Birit F.P. Broekman, M.D.

Peter D. Gluckman, Ph.D.

in utero cortical development. GOPENACCESS Method: A total of 146 meonates Clastion: Broelman BFP, Wang C, Li Y, Rikin-Gaboi A, Saw SM, et al. (2014) Gestational Age genotyped and underwent MRI sh after birth. Neonatal cortical morph-was characterized using cortical thick and Neonabl Bain Microstructure in Term Born Infants: A Birth Cohert Study. PLoS ONE 9(12): e115229. doi:10.1371/journal.pone.0115229 Antenatal maternal anxiety was ass using the State-Trait Andery Invento week 26 of pregnancy. Editor: Nouchine Hadjikhani, Harvard Medical School, United States of America Received: May 4, 2014

and superior

cated on ch the brain be in the prefit adulthood ( particularly and is asso anatomy an Funding: This study is supported by National Medical Research Council (NMRC; NMRCIT OR 004-NLE:2008, NMRC/CERC/003/2013), the of Singapore (NUSYIA FY10 P07), the National University of Singapore MOE AcRF Ter 1, and Singapore Ministry of Education Academic Singapon Ministry of Education Academic Research Fund Ter 2 (MOE2012-172-4130). The funding agencies did net jety any role in study design, data milicelion and analysis, decision to publish, or preparation of the manuscript.

## We are examining the influence of unique **Singaporean factors on infant functioning**

Cultural Differences in Mirror Self-Recognition in 18

month-old Singaporean Toddlers

Jun Pei Lim<sup>1,2</sup>, Lidia Suárez<sup>2</sup>, Litwee Sim<sup>1</sup>, Birit F. P. Bro Kwek<sup>5</sup>, Peter Gluckman<sup>1,6</sup>, Seang-Mei Saw<sup>1,7</sup>, Michae <sup>1</sup>Singapore Institute for Clinical Sciences, Agency for Science, Tech University, 3Department of Psychological Medicine, Yong Loo Lin Scho National University Health System, 4Department of Obstetrics & Gynaec University of Singapore, National University Health System, 5KK Wor University of Auckland, 7Saw Swee Hock School of Public H Singapore

> 8Departments of Psychiatry and Neurology and Neurosurgery anne rifkin@sics.a-star.edu

Abstract--- Western societies put emphasis on the development of the individua in relation to social groups. In Western populations roughly 60% of 18-month themselves reflected in a mirror. Self-referential behavior has been used as a The aim of the current study was to investigate possible cultural difference themselves in a mirror. The current study involved 329 18-months-old Southe in a larger prospective mother-offspring birth cohort study GUSTO. In co toddlers showed mirror self-recognition behavior. However, rates significantly showing more self-referential behavior than Singaporean Malay and Chiu differences in self-referential behavior and expression of self-recognition. We similarly across different cultures but that other variables, such as parenting st

#### Keywords-cultural differences; mirror self-recognition; toddlers

#### INTRODUCTION

A child's ability to show self-recognition is often viewed as a part of a larger suit language, symbolic play, planning, and object permanence. These abilities collect such as autobiographical memory and self-evaluation [1]. Self-recognition has also relations, social cognition, maturational, and affective growth [2]. Studies have f under-developed sense of self, which is crucial for development of empathy [1,3,4]. Self-recognition in toddlers is most frequently measured via the Rouge Mark ta mark on an individual's face so that the mark cannot be seen directly. This is follow of the toddler towards his or her own reflection is observed [6]. Toddlers aged betweet the rouge mark placed on his/her nose when placed in front of the mirror, showing recognition concept [1,7]. For example, Amsterdam (1972) observed a sample of and found that 42% showed self-recognition behavior. Nielson and Dissanayake ( mirror self recognition (MSR) in a sample made of Australian-Caucasian toddlers. 67% of observed 18 months-old White toddlers exhibited MSR behavior.

Nevertheless, variations in the onset of MSR and expressivity of self-referential b



#### CHILD DEVELOPMENT

Comparis

inhibitory

in infancy

unclear. İ

informatio

ciency in a monolines

early to en

Child Development, xxxx 2014, Volume 00, Number 0, Pages 1-9

Back to Basics: A Bilingual Advantage in Infant Visual Habituation

Leher Singh and Charlene S. L. Pu National University of Singapore	Aishah A. Rahman, and Shami Singapore Institut	AJČN. First published ahead of print Deceml	ber 10, 2014 as doi: 10.3945/ajcn.114.095414.	
Pratibha Agarwal KK Womm's and Children's Hospital	Jiang Camegie Ma			
Chong Yap Seng National University Hospital	Michael Singapore Institut and McG	Infant feeding effects on early neur in Asian children <sup>1-4</sup>	ocognitive development	
Anne Rifkin-Graboi Singapore Institute for Clinical Sciences	On behalf of the G	Shirong Cai, Wei Wei Pang, Yen Ling Low, Lii Wee Sim, Suet Chian Sam, Michaela Bianka Brantnaegor, Eric Qinlong Doris Fok. Biris FP Binekman, Lehor Singh, Jenny Bichmond, Pratibha Agarwal, Angi Qiu, Saang Mei San, Fabia Kath M Godfrey, Peter D Glacionan, Yap-Song Chong, Michael J Meanoy, Michael S Kramer, and Anne Rigkin-Gra behalf of the GUSTO Saudy Group		
mparisons of cognitive processing in morolinguals inhory control. Recent studies have demonstrated infinecy. Havevers, the domain specificity and zeo clear. In the present study, 114 morolingual and iomation processing—visual hubituation—at 6 mor yr in stimulas encoding as well as in improved noinguals. Findings neveal a generalized cognitive ly to emerge, and not specific to language.	and bilinguals have revealed advartages associated with e profite infant bilingual advi- tilingual infants were compare the of age. Bilingual infants + surgatiton memory for facilit + advantage in bilingual infan	A ISTRACT Background: Resattlending has been shown to enhance global mea- tures of intelligence in children. However, few indicis have enamined anotations between breattlending and specific cospitive tail; perfor- mance in the first 2 of 10th, perturbutly in an Asian population. Objective: We assessed associations between early siftant feeding and detailed measures of cospitive cleaderspannets the first 2 y of life in healthy Asian children horn at term. Doiging: In a proportive cohort study, neurocognitive testing was performed in 40b healthy children toged 6, 118, and 24 no) from uncomplicator proparations (i.e., performance), and et- ennory ( <i>Edversion indicision</i> , relational bailing, hebitantion) and di- tention table (studi expectation, and integrits) tables and that and basily Solate O tables and Todikal Development. This Ha fails on	INTRODUCTION Although Insuffeeding is generally though to positively finance copality development, mean over 30 y (1) has yis due reparterish. Some studies reported flat threas the funge performance on global inseaues of intelligence (2-5), whi others found small or no effects (6-8). Studies that come exclusively and partially invested instan are likely to atte- effects when a sering the infrare of the attered sign on equi- (9). Variation in formula comparison (10) and detay differe $^{-1}$ trunch. Dipatments of Obstaries and Opscology (2). Whe $^{-1}$ trunch. Dipatments of Obstaries and Opscology (2), We (2), and MSG) and hysioniged Mathematical (0) and linomicial ling and Clinical hange Research Control (A), and its loss frace	

The CUSID Research term includes Dennis Reg. Artit Sissen. Cal Shirong, Helen Chan, Jeny Chan, Ylong Huak Chan, Come Is Chee, Audrey Chia, Chiang Wen Chin, Amutha Chinnaduni, Ching Chai, Kair, Mary Chong, Chong Shang Chee, Chua Me Chim, Wayne Cutfield, Mary Daniel, Ding Chun Ming, Keith Goditey, Anne Pergueon-Smith, Eric Andrew Rokekten, Markdie Fottier, Dorts Folk, Anne Goh, Daniel Goh, Joshua J Gooley, Han Wee Meng, Mark Hanson, Mikael Hartman, Mikhael Hay-mann, Stephen Hau Chin-Ying, Hazel Inskip, Jeevesh Kapur, Lee Bee Wah, Lee Yung Seng, B. F. P. Leutscher-Breekman, Lim Sok Bee, Loh Seong Feel, Low Yen Ling, Ilana Maglati, Susan Morton, Erichamoorthy N., Cheryl Ngo, Pang Wei Wei, Prathiba Agawal, Qiu Angi, Quah Boon Long, Victor S. Rajadarai, Jen Rohmond, Anne Rifidn-Grabol, Allan Sheppand, Lynette Pei-Chil Shek, Borys Shuter, Leher Singh, So Wing Chee, Soh Shu IL, Su Lin Lin, Tan Kok Hian, Teoh Onn Hoe, Terry Yoke Yin Tong Mya Thway Tint, Hugo Van Bever, Rob van Dam, Sudhaka Venkatesh, Helena Marteke Verkooljen, Inez By Wong, P. C. Wong, Fabian Yap, and George S. H. Yeo.

This meanth was conducted under the auspices of a Transla tional Clinical Research Flagship program grant from the Singapore National Medical Research Coundl, which supports the CRETO Cohort. SICS Investigators are supported in part through Agency for Science Technology and Research (A\*STAR) funding. We would like to thank the participants and their families for their involvement in this meanch.

Consepondence on certing this article should be addressed to Leber Singh, Department of Bychology, National University of Singapon, 9 Arts Link, Singapone 11750. Hactronic mail may be sent to paylemaseduag.

Infants raised in a biling impress in their ability guages with remarkab ease. Nevertheless, the upon a bilingual infar infants must differential sounds from each lang correspondences, and es of two systems that o Mastering independent hetween languages ha sharpen an important bilinguals known as exe In a substantial body for abilities to manage

attention have been ev (e.g., Bialystok, 1999; Bi Bialystok & Martin, 20 bilingual advantage. Reses

© 2014 The Authors Keywords Asian, breastfeeding, cognition, infant, memory, toddler, Child Development @ 2014 Society All rights researed 0009-3920/2014 DOI: 10.1111/adev.12271

atention, mutrition, electrophysiology, eyetracking

Am J Cân Natr doi: 10.3945/ajcn.114.095414. Printed in USA: © 2014 American Society for Nutritio

(BSID-III). Children were stratified into 3 groups (low, intermediate,

Results: After potential confounding variables were controlled for,

significant associations and dose-response relations were observed for

4 of the 15 tests. Higher breastleeding exposure was associated with

better memory at 6 mo, demonstrated by greater preferential looking

toward correctly matched items during early portions of a relational

for the first two 1000-ms time hins, respectively). No effects of

breastfeeding were observed at 18 mo. At 24 mo, breastfed children

were more likely to display sequential memory during a deferred imitation memory task (P-trend = 0.048), and toddlers with more

exposure to breastlending scored higher in receptive language

(+0.93 (0.23, 1.63) and +1.08 (0.10, 2.07) for intermediate- and high

breastleeding groups, respectively, compared with the low-breastleeding

group], as well as expressive language [+0.58 (-0.06, 1.23) and

+1.22 (0.32, 2.12) for intermediate- and high-breastleeding groups,

Conclusions: Our findings suggest small but significant benefits of

breatfeeding for some aspects of memory and language development

in the first 2 y of life, with significant improvements in only 4 of 15

indicators. Whether the implicated processes confer developmental

advantages is unknown and represents an important area for future

research. This trial was registered at www.clinicaltrials.gov as

NCT01174875. Am J Clin Nutr doi: 10.3945/ajen.114.095414.

respectively] assessed via the BSID-III.

mory task (i.e., relational binding task: P-trend = 0.015 and 0.050

and high) on the basis of breastfeeding duration and exclusivity.

ided nces reas bine unte ition nors

DF ing and Clinical Imaging Research Cantre (AQ); and the Saw Swee Hock School of Public Health (SMS), National University of Singapore, National University Health System, Singapore, the Abbott Nutriti arch and Development Asia-Pacific Center, Singapore (YLL); the Singapore Institute for Clinical Sciences, Agency for Science and Technology Research (A\*STAR), Singapore (LWS, SCS, MBB, EQW, AQ, BHPB, PDQ, Y-SC. MJM, and AR-O; the School of Psychology, University of New South Wales, Sydney, Australia (JR); the Departments of Neonatology (PA) and Pediatrics (PV), Kandang Kerhau Women's and Chiklren's Horpital, Singa pore, the Medical Research Council Lifecourse Epidemiology Unit and Na ional Institute for Health Rosearch Southampton Biomodical Research Centre, University of Southampton and University Hospital Southampton National Health Service Foundation Tract, Southampton, UK (RMO); Lig size Institute, University of Auckland, Auckland, New Zedard (FDG): and the Departments of Epidemiology, Biostatistics, and Occupational Health (MSK), Poliatrics (MSK), and Psychiatry and Neurology and Neurosurger MIM), McGill University, Montreal, Canada.

<sup>2</sup> Supported by the Translational Clinical Research (TCR) Flucship Pro gam on Developmental Pathways to Metabolic Disease finded by the Na-tional Research Foundation and administered by the National Multical Research Council (NMRC), Singapore (NMRC//CR/004-NUS/2008). This work was also supported by the Singapore Institute for Clinical Sciences (A\*STAR) and Abbott Nutrition Research and Development Asia-Pacifi

3 Sumiemental Methods are available from the "Sumiemental data" link in the online posting of the article and from the same link in the online table of contents at http://aion nutrition.org.

<sup>4</sup>Addresscorrespondence to A Rifkin-Graboi, Singapore Institute for Clinical Sciences, Americy for Science and Technology Research (A\*STAR). Brenner Center for Molecular Medicine, 30 Medical Drive, Singapor 117609. E-mail: anne\_r#kin@sics.a-stazodu.sg. Received July 22, 2014, Accented for sublication November 17, 2014

doi: 10.3945/ajm 114095414

1 of 11



Effect of GDM on conditional difference in EP max amplitude towards oddball and standard stimuli, stratified by hemispheres.



	Adjusted mean condition difference*† (95% CI)			
6 months (n=104 control, 25 GDM)		p value		
Left Hemisphere (µV)	-0.76 (-1.49 to -0.04)	0.039		
Right Hemisphere (μV)	-0.02 (-0.80 to 0.77)	0.964		
Maternal alucemia levels influence				

## infant neural activity predicting vulnerability for attentional difficulties such as ADHD

EPmax amplitude condition	Fasting PG		2 hours PG	
difference‡ in left hemisphere (μV)				
	Adjusted <sup><math>\dagger</math></sup> $\beta$	(95% CI)	Adjusted <sup>+</sup> $\beta$	(95% CI)
6 months	-0.04 (-0.78 to 0	.70)	-0.19 (-0.42 to	0.04)
18 months	-0.36 (-1.04 to 0	.31)	-0.27 (-0.49 to	-0.06)

<sup>+</sup>Adjusted for maternal age, maternal education, sex and gestational age of child, ethnic group, 26 weeks STAI-state, maternal pre-pregnancy BMI and gestational weight gain at 26 weeks gestation. <sup>‡</sup> Condition difference= oddball - standard

## Maternal Stress and Brain Development of the Newborn





## Maternal anxiety and depression

	During pregnancy	Postpartum
Singapore	<ul> <li>12.2% with depression</li> <li>11% with major depression and 7% with minor depression in high-risk group</li> <li>12.5% with anxiety disorder in high-risk group</li> </ul>	7% with depression
GUSTO cohort study	<ul> <li>12% with depression</li> <li>12% with high anxiety symptoms</li> <li>21% with high anxiety personality traits</li> </ul>	<ul> <li>11% with depression</li> <li>13% with high anxiety symptoms</li> <li>20% with high anxiety personality traits</li> </ul>

At least 1 in 9 women in Singapore experience anxiety and/or depression during and after pregnancy.
Anxiety rates in Singapore are higher than what was

reported by other groups (roughly double).

Depression is *the leading cause of disability worldwide* and a major contributor to the global burden of disease (WHO: http://www.who.int/mediacentre/factsheets/fs369/en/)

## Neurodevelopment

## Maternal depression during pregnancy affects the brain of the newborn

(less ordered neural pathways in a brain region closely associated with **vulnerability for mood anxiety disorders**).

Suggest the transmission of vulnerability for depression from mother to child.



### **Biological Psychiatry**

Available online 19 August 2013

In Press, Corrected Proof - Note to users



#### Archival Report

### Prenatal Maternal Depression Associates with Microstructure of Right Amygdala in Neonates at Birth

Anne Rifkin-Graboi<sup>ª</sup>, Jordan Bai<sup>c</sup>, Helen Chen<sup>c</sup>, Waseem Bak'r Hameed<sup>ª</sup>, Lit Wee Sim<sup>ª</sup>, Mya Thway Tint<sup>d</sup>, Birit Leutscher-Broekman<sup>a, d</sup>, Yap-Seng Chong<sup>d</sup>, Peter D. Gluckman<sup>ª</sup>, Marielle V. Fortier<sup>c</sup>, Michael J. Meaney<sup>a, e</sup>, Anqi Qiu<sup>a, b,</sup>



Figure 1: The red contour indicates the <u>amygdala</u> on diffusion tensor imaging and T2-weighted magnetic resonance imaging.

## Catechol-O-methyltransferase (COMT) Haplotypes Modulate Associations of Antenatal Maternal Anxiety and Neonatal Cortical Morphology



Antenatal **maternal anxiety** affects the prefrontal and parietal **cortical thicknesses** of neonatal brains (involved in **executive functioning & sensory processing**).

## This association is modulated by the babies' COMT SNPs

(val158met, rs737865, and rs165599).

#### COMT Haplotypes Modulate Associations of Antenatal Maternal Anxiety and Neonatal Cortical Morphology

Anqi Qiu, Ph.D., Ta Anh Tuan, M.S., Mei Lyn Ong, Ph.D., Yue Li, B.S., Helen Chen, M.D., Anne Rifkin-Graboi, Ph.D., Birit F.P. Broekman, M.D., Kenneth Kwek, M.D., Seang-Mei Saw, Ph.D., Yap-Seng Chong, M.D., Peter D. Gluckman, Ph.D. Marielle V. Fortier, M.D., Joanna Dawn Holbrook, Ph.D., Michael J. Meaney, Ph.D.

C→ This article is discussed in an Editorial by Dr. Hudziak (p. 111)

Am J Psychiatry 172:2, February 2015

# Recognition of GUSTO's value

- An editorial in the February 2015 issue of the prestigious *American Journal of Psychiatry* lauded the study, remarking that "the GUSTO design is unique in that it (doing MRI at 1 week of life) removes the biggest scientific obstacle that faces most birth cohort studies that aim to examine antenatal factors."
- Deputy Prime Minister Teo Chee Hean, in his speech at the 30<sup>th</sup> anniversary of Institute of Molecular & Cell Biology on 8 May 2015, described GUSTO as "a national birth cohort study of Singaporean mothers and babies on how environmental factors affect the development of diseases in later years.
- For example, the research findings showed how a mother's anxiety from pregnancy could affect her child intellectually and emotionally from birth."

FEBRUARY 2015 | VOLUME 172 | NUMBER

## The American Journal of **Psychiatry**



reatment of Psychosis and Mania in the Postpartum Period

Uncovering the Hidden Risk Architecture of the Schizophrenias: irmation in Three Independent Genome-Wide Association Studies

Paraprofessional-Delivered Home-Visiting Intervention for American Indian Teen Mothers and Children: 3-Year Outcomes From a Randomized Controlled Trial

COMT Haplotypes Modulate Associations of Antenatal Maternal Anxiety and Neonatal Cortical Morphology

> Official Journal of the American Psychiatric Association ajp.psychiatryonline.org



Mr Teo Chee Hean Deputy Prime Minister

## FINDINGS

- •More than 1 in 9 Singaporean women suffer from anxiety and depression during and/or after pregnancy.
- Findings from GUSTO show that poor maternal mental health may be associated with increased neurodevelopmental disorders in the offspring including anxiety, depressive or disruptive behavior disorders, even in sub-clinical ranges of maternal anxiety and depression.

### **RECOMMENDATIONS TO MOH, 3 SEP 2015**

- 1. Integrate **screening** for anxiety and depression into routine prenatal and postnatal care across all government and private maternity hospitals.
- 2. Provide professional emotional health **support** for women during pregnancy and continuity of care services from hospital to home.
- 3. Identify risk factors and **social determinants** for perinatal anxiety and depression and provide targeted help for high-risk groups.



### Maternal Emotional Well-being:

Screening and Management may benefit Singapore's future generations.

Prepared by:

3 September 2015

Dr Cai Shirong, NUHS; Prof Michael Meaney, SICS & McGill University; Dr Anne Rifkin-Graboi, SICS; Dr Birit Leutscher-Broekman, NUHS & SICS, Dr Qiu Anqi, NUS; Dr Soh Shu E, SICS; Prof Kenneth Kwek, KK Women's & Children's Hospital; and A/Prof Chong Yap Seng, NUHS & SICS





## Special Communication | USPSTF RECOMMENDATION STATEMENT Screening for Depression in Adults US Preventive Services Task Force Recommendation Statement

Albert L. Siu, MD, MSPH; and the US Preventive Services Task Force (USPSTF)

**DESCRIPTION** Update of the 2009 US Preventive Services Task Force (USPSTF) recommendation on screening for depression in adults.

**METHODS** The USPSTF reviewed the evidence on the benefits and harms of screening for depression in adult populations, including older adults and pregnant and postpartum women; the accuracy of depression screening instruments; and the benefits and harms of depression treatment in these populations.

**POPULATION** This recommendation applies to adults 18 years and older.

**RECOMMENDATION** The USPSTF recommends screening for depression in the general adult population, including pregnant and postpartum women. Screening should be implemented with adequate systems in place to ensure accurate diagnosis, effective treatment, and appropriate follow-up. (B recommendation)

Editorial pages 349 and 351

- Author Audio and Video Interviews and JAMA Report Video at jama.com
- Related article page 388 and JAMA Patient Page page 428
- CME Quiz at jamanetworkcme.com and CME Questions page 411
  - Related articles at jamapsychiatry.com, jamainternalmedicine.com, and jamaneurology.com

Author Affiliations: Author affiliations are listed at the end of this article.

Authors/Group Information: The USPSTF members are listed at the end of this article.

Corresponding Author: Albert L. Siu, MD, MSPH (albert.siu@mssm.edu).

## True Translation: GUSTO findings inspire cartoon

thesundaytimes home

May 4, 2014 the sunday times

## Anxious mums = smaller babies

Study finds that the mental state of pregnant women can affect their infants' brain development

#### Feng Zengkun

Singaporean women who feel stressed, depressed or anxious while pregnant may give birth to children who are more easily distracted and have poorer memory, according to the preliminary findings of a landmark study.

The mental distress may even cause the babies to be born physically shorter, which is an issue as Asian children tend to have higher IQs when they are born longer, heavier or with larger head circumferences.

Scientists from the Agency for Science, Technology and Research's Singapore Institute for Clinical Studies (Sics) said more research is needed, but the findings suggest that looking after expectant women is critical to ensuring their children get the best start in life. "To really help our children grow, we need to take care of soon-to-be mothers and their families early, even before any difficulties arise," said principal investigator Anne Rifkin-Grabol.

![](_page_36_Picture_8.jpeg)

![](_page_37_Figure_0.jpeg)

![](_page_38_Picture_0.jpeg)

Singapore PREconception Study of long-Term maternal and child Outcomes

![](_page_38_Figure_2.jpeg)

# Preconception influences on maternal and offspring outcomes

- Unprecedented opportunity to study how a woman's health, nutritional and emotional state *before* pregnancy can influence:
  - Their pregnancy outcome
  - Their child's health and development
  - Their own health after pregnancy
- Help us develop guidelines for all reproductive-age women:
  - to give their **babies** the **best start to life**
  - improve the nation's health
- Launched Q2 2015, with over 300 prepregnant women enrolled, 50 pregnancies, and 4 deliveries so far.

![](_page_38_Picture_12.jpeg)

![](_page_38_Picture_14.jpeg)

![](_page_38_Picture_15.jpeg)

![](_page_38_Picture_16.jpeg)

## EpiGen GLOBAL RESEARCH NETWORK

CHF 22m deal signed Oct 2014

![](_page_39_Figure_2.jpeg)

# **Nipper**

Nutritional Intervention Preconception and During Pregnancy to Maintain Healthy GlucosE Metabolism & OffspRing Health

- High rate of micronutrient deficiency in GUSTO mothers with Gestational Diabetes.
  - Randomised controlled trial of a pre-pregnancy nutritional drink:
    - Healthier blood glucose levels in mothers
    - Healthier babies
    - Better long term health for mothers

## Validate findings across 3 populations:

- Auckland, Singapore, Southampton (EpiGen)
- Launched August 2015: 144 subjects randomised, with 13 pregnancies so far.

![](_page_39_Picture_13.jpeg)

Taken orally, twice a day

![](_page_39_Picture_16.jpeg)

Directions for use:

Empty content of the sachets in a small glass (200 mL) of water at room temperature

Stir well with a spoon and consume immediately

![](_page_39_Picture_20.jpeg)

The NiPPeR nutritional drink is designed to assist in maintaining healthy glucose levels in the body and to provide standard vitamins and minerals recommended for pregnancy. In the clinical study,

50% of the participants will receive a control drink, which only includes standard vitamins and minerals recommended for pregnancy

14.17.NRC

# **Rising obesity** among young set to worsen diabetes rate

### The Straits Times, February 22, 2016

Experts warn that 34% of those aged 24 to 35 this year may become diabetic by age 65

#### Salma Khalik

Senior Health Correspondent

Rising obesity in children and young adults will push up the rate of diabetes in Singapore – already among the highest in the developed world – going by recent studies. for some children, there is a cycle of weight gain during long holidays followed by weight loss during term time as a result of physical activities and weight-management programmes in school.

Stallholders in school canteens have been encouraged to use healthier ingredients, and drinks

## Key Area Going Forward: Early detection & prevention of Diabetes

![](_page_41_Picture_1.jpeg)

GUSTO revealed alarming rates of missed GDM and subsequent development of T2D

![](_page_41_Picture_3.jpeg)

Singapore PReconception Study of long-Term maternal and child Outcomes

S-PRESTO designed to study factors leading to development of GDM and subsequent T2D

![](_page_41_Picture_6.jpeg)

Nutritional Intervention Preconception and During Pregnancy to Maintain Healthy GlucosE Metabolism & OffspRing Health

NIPPER designed to prevent GDM and subsequent T2D with pre-pregnancy nutritional supplementation

### **Deep Phenotyping**

### Longitudinal cohorts throughout the Life Course

![](_page_41_Figure_11.jpeg)

### Achievements to date

Metabolic TCR Flagship Programme, NUS Medicine Singapore Institute for Clinical Sciences, A\*STAR, Singapore Centre for Nutritional Sciences, Metabolic Diseases, and Human Development (SiNMeD) and KK Women's & Children's Hospital

![](_page_42_Figure_2.jpeg)

## We are doing all this to benefit Singaporeans and to Change Tomorrow's Health, Today...

![](_page_43_Picture_1.jpeg)

![](_page_44_Picture_0.jpeg)

![](_page_44_Picture_1.jpeg)

![](_page_44_Picture_2.jpeg)

![](_page_44_Picture_3.jpeg)

![](_page_44_Picture_4.jpeg)

**CHONG** Yap Seng LEE Yung Seng **QIU** Angi Kenneth KWEK **Bryan Emmett OGDEN** Joanna D. HOLBROOK Fabian YAP Peter GLUCKMAN Marielle FORTIER LING Lieng Hsi Jeyakumar HENRY Mary CHONG **Rob Martinus VAN DAM** LEK Ngee **CHEUNG** Yin Bun Michael MEANEY Birit Broekman Anne Rifkin-Graboi Leher SINGH Joshua GOOLEY Helen CHEN Prathiba AGARWAL **CHONG Shang Chee** TAI E Shyong TAN Kok Hian George YEO SH Jerry CHAN Kok Yen Citra MATTAR

Victor Samuel RAJADURAI KKH Anne Ferguson-Smith Cambridge

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Walter STÜNKEL Neeria KARNANI SAW Seang Mei Lynette SHEK SEMC, Duke-NUS Stephen HSU **CHAN** Yiong Huak Jonathan CHOO T.L. **QUEK Swee Chve** Robert GRIGNANI Sendhil VELAN Philip LEE Teck Hock Jeevesh KAPUR Micheal LIM C.M. HAN Wee Meng Keith GODFREY Mark HANSON Wayne CUTFIELD John WONG **Daniel FUNG Michael CHEE Eric FINKELSTEIN Cornelia CHEE** Iliana MAGIATI **Daniel GOH** Mahesh RAMAMURTHY Mary DANIEL LIM Sok Bee Anne GOH **Oon Hoe** 

Pauline TAY STRAUGHAN NUS

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Elizabeth SPELKE YONG Eu Leona Arijit BISWAS **TAN Heng Hao** Shephali TAGORE **Bernard CHERN** SU Lin Lin Melvin LEOW HUANG Zhongwei Claudia CHI LI Jun **Philip BAKER** Paul ROBSON NG Huck Hui Southampton, UK HAN Weiping Mark VICKERS **DING Chun Ming TAN Chuen Seng CHNG Chai Kiat** Cheryl NGO LEE Bee Wah Hugo van BEVER QUAH Boon Long Tony PLEASANTS Sheila BARTON Allan SHEPPARD Karen LILLYCROP Laurent FAY Thomas BECK James KAPUT Irma SILVA-ZOLEZZI

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