**SCIENTIFIC & EVIDENCE BASE for SKIN-TO-SKIN CONTACT**

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**Speaker Disclosure**

Under ACCME guidelines:

a) I am the South African distributor of MIRIS: Human Milk Analyzer
b) My wife and I are owners and directors of NINO Academy (Tendotouch Pty Ltd) produce educational & promotional goods and materials related to the talk content.

"Cells which FIRE TOGETHER, WIRE TOGETHER, and those which don't, won't."

Carla Shatz

Prof Hugo Lagercrantz

**RELATIVE BRAIN ACTIVITY**

NEW SYNAPSE FORMATION

METABOLIC ACTIVITY peaks 3 years

**NEUROGENESIS**

**MIGRATION**

**Arborisation**

**SYNAPTOMESIS**

**Myelination**

**COMPETITIVE ELIMINATION**

Programmed cell death

**NEURONAL PLASTICITY**

**MIGRATION**

**Arborisation**

**SYNAPTOMESIS**

**Myelination**

**COMPETITIVE ELIMINATION**

Programmed cell death
The HARD DISK

**Computer has 500 GB**
= 500,000,000,000 b

**Brain connections**
= 500,000,000,000,000,000

50 billion neurons, 50,000 synapses, 2000 neuron networks

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**SECOND COMMANDMENT OF NEUROSCIENCE**

**USE IT, OR LOSE IT**

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**SYNAPSE DEVELOPMENT**

At birth, the human being has more synapses in its brain than at any other stage of life.

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**SENSORY STIMULUS**

- Synapse store chemical signal
- Chemical signal stronger
- Threshold ➔ Exempt from elimination (synapse stabilised)

**PATHWAY**

(Rima Shore 1997)
fetal REM sleep (or active sleep) seems to be particularly important to the developing organism...

...spontaneous synchronous firing

Marks et al. 1995

**BRAIN WIRING**

- REM
- NR1
- NR2
- NR3
- SWS

**ACQUISITION**
- poly-sensory input
- short-term memory
- stored cortex

**CONSOLIDATION**
- transfer information
- SWS -> amygdala / hippocampus

**MEMORY**
- REM stage 4
- NR4
- NR5
- NR6
- REM stage 3

Primary function of sleep pertains to consolidation of memory

This article follows the hypothesis that a primary function of sleep pertains to the consolidation of memory. In recent years, this view has received substantial support from a rapidly growing number of experiments performed in various species and at different levels of behavioral, cellular, and molecular analysis.

**EARLY DEVELOPMENT**

Gestational age
20w. all structures completed

parallel development of structure & function

(Hugo Lagercrantz 2004)

Brain growth depends on experiences!!

**NEURO PHYSIOLOGY**

**NEURO DEVELOPMENT**

**NEURO BEHAVIOUR**

PATHWAYS
→ CIRCUITS
→ NETWORKS

Brain growth depends on experiences!!

Primary function of sleep pertains to consolidation of memory
When does the infant become conscious?

The "Stress" of being born

You can never reach the same high levels of catecholamine levels during your whole life as at birth

Reduced catecholamine surge after C-section

Elective C-section

Vaginal delivery

The infant brain is not blank!

Resting activity - "stream of consciousness"

The newborn brain consumes 50% of all the blood glucose - In the adult 20%

Awake at birth

Noradrenergic neurons from LOCUS COERULEUS

Scientific American 1986

Scientific American Mind 2009
At birth, the brain has two critical sensory needs: smell and contact. The newborn brain skin-to-skin contact fires and wires the amygdala-prefronto-orbital cortical pathway (PFOC). The amygdala: emotional processing unit. Prefrontal cortex: executive function. Social and emotional intelligence.
In humans, oxytocin increases gaze to the eye region of human faces and enhances interpersonal trust and the ability to infer the emotions of others from facial cues.
The BOND is made up of the sensory inputs from the parent to the infant

**Through “hidden maternal regulators”...**

- warmth \(\rightarrow\) activity level
- milk \(\rightarrow\) heart rate

"physiological set points"

- internal working models
- scripts - templates

A mother precisely controls every element of her infant’s physiology, from its heart rate to its release of hormones from its appetite to the intensity of its activity.

(Gallagher 1992)

It is a serious mistake to assume that the principles derived from careful animal studies do not apply to human infants. The risk of suppression or disruption of needed neural processes...

is very significant and potentially lasts a lifetime.
SENSORY STIMULATION
EMOTIONAL EXCHANGES
AUTONOMIC BODY CONTROL
WELL-BEING
HEALTH

The First Idea

"It is necessary for a child to be engaged in a series of affective (emotional) interactions that give rise to the development of motor sensory and social capacities, which, when combined with symbol formation, lead to language.

Greenspan & Shanker 2006, p39

The First Idea

"The symbolic use of language, in turn, creates the foundation for more advanced social and intellectual capacities, including higher and higher levels of reflective thinking.

Greenspan & Shanker 2006, p39

ATTACHMENT - REGULATION

The objective is to achieve the ability to establish an efficiently regulated right brain:

‘STABILITY THROUGH CHANGE

The Foundation for INFANT MENTAL HEALTH

Schore 2001a

RESILIENCE (= STRESS RESISTANCE)

“capacity to maintain healthy emotional functioning in the aftermath of stressful experiences”

DUAL CODING REGULATION - ATTACHMENT
Neuronal Plasticity
“the first three years are decisive”

The cortex retains some plasticity throughout life ...

But limbic system and the midbrain are fixed after the age of three years.

Neuronal Plasticity
“the first three years are decisive”

→ platform for subsequent development of higher cognitive functions.

MOTHERBOARD

Motherboard is the hardware platform to build the computer.

The limbic brain is the “platform for higher cognitive functions.”

“The brain is designed to be sculpted into its final configuration by the effects of early experiences.”

These experiences are embedded in the attachment relationship.

Stanford Report, July 12, 2006
Forget the latest toys: All kids really need is love.

Authors say public policy should focus on helping children have good experiences in their earliest years.

Knudsen et al., 2006

“The brain is designed to be sculpted into its final configuration by the effects of early experiences.”

These experiences are embedded in the attachment relationship.
MOTHER is the KEY for NEURODEVELOPMENT

All mammals have set sequence of behaviours at birth ............

....... All with a single purpose: to BREASTFEED

After birth, events are determined ...

... by the neonate stimulating the mother!

(Rosenblatt 1994)

Breast-feeding is “established through a set of mutual, complex sensory stimulations in mother and child.”

(Kjellmer & Winberg 1994)

HABITAT DETERMINES BEHAVIOUR

BEHAVIOUR ENSURES BIOLOGICAL NEEDS

Warming, feeding and protection behaviours are intricately, inseparably linked to the right place.

(Alberts 1994)

= NUTRITION PROGRAMME
Through “hidden maternal regulators”...

- warmth $\rightarrow$ activity level
- milk $\rightarrow$ heart rate

“physiological set points”
- internal working models
- scripts - templates

A mother precisely controls every element of her infant’s physiology, from its heart rate to its release of hormones from its appetite to the intensity of its activity.

(Gallagher 1992)

In all mammals .......

..... the newborn is responsible for initiating breastfeeding, not the mother!!

EXCEPT IN HUMAN ????

Sequence human newborn breast-feeding

Pre-requisite = habitat
- hand to mouth
- tongue moves
- mouth moves
- eye focuses nipple
- crawls to nipple
- latches to nipple
- suckles

(Widstrom et al 1994)

Newborn behaviour to locate the breast when skin-to-skin: a possible method for enabling early self-regulation

There are “needed neural processes”!

Table 1: Definition of phases/behaviours identified

<table>
<thead>
<tr>
<th>Phases</th>
<th>Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth cry</td>
<td>Intense crying just after birth</td>
</tr>
<tr>
<td>Relaxation</td>
<td>Infants resting/recovering; No activity of mouth, head, arms, legs or body</td>
</tr>
<tr>
<td>Awakening</td>
<td>Infants begins to show signs of activity; Small thresh of head, up, down, turn side-to-side; Small movements of limbs and shoulders</td>
</tr>
<tr>
<td>Active</td>
<td>Adults move limbs and head, is more determined in movements; Rooting activity, “pushing” with limbs without shifting body</td>
</tr>
<tr>
<td>Crawling</td>
<td>“Pushing” which results in shifting body</td>
</tr>
<tr>
<td>Reaching</td>
<td>Infant rests, with some activity, such as mouth activity, sucks on hand</td>
</tr>
<tr>
<td>Familiarisation</td>
<td>Infant has reached areola/nipple, positioned to brush and lick areola/nipple</td>
</tr>
<tr>
<td>Suckling</td>
<td>Infant has taken nipple in mouth and continues sucking</td>
</tr>
<tr>
<td>Sleeping</td>
<td>The baby has closed its eyes</td>
</tr>
</tbody>
</table>

There are “needed neural processes”!
Activation of Olfactory Cortex in Newborn Infants After Odor Stimulation: A Functional Near-Infrared Spectroscopy Study

SMELL: vanilla / colostrum / water (control)
read NIRS activity FRONTAL LOBE

- Those babies showing the greatest increase in \([\text{Hb O}_2]\) were between 6 and 24 h old at testing.
- In the 14 babies older than 24 h there was no significant difference between the changes in \([\text{Hb O}_2]\) during control and colostrum exposure.

"The newborn may appear helpless, but displays an impressive and purposeful motor activity which, without maternal assistance, brings the baby to the nipple." (Michelson et al 1996)

"The newborn may appear helpless, but raises its own temperature, has a higher blood glucose, metabolic adaptation faster." (Widstrom 1987)

**METABOLIC ADAPTATION**

<table>
<thead>
<tr>
<th>SSC started in the first 20 minutes after birth</th>
<th>SSC</th>
<th>Cot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood glucose (1 hr)</td>
<td>3.17</td>
<td>2.56</td>
</tr>
<tr>
<td>Base excess drop</td>
<td>3.4</td>
<td>1.8</td>
</tr>
</tbody>
</table>

(Christenson 1992)
Warming, feeding and protection behaviours are intricately, inseparably linked to the right place.

(Alberts 1994)

Through “hidden maternal regulators” ...

a mother precisely controls every element of her infant’s physiology, from its heart rate to its release of hormones from its appetite to the intensity of its activity.

(Gallagher 1992)

The mother and infant at birth are ready to develop optimal attachment relationships and to work together toward organised cognitive, social and emotional development.

Joy Browne 2004

... the newborn child is a small human being, with all its senses developed, open and receptive.

(John Lind, 1979)

Psalm 22 v 9

“I learnt trust on my mother’s breasts”

Neural circuitry of bonding

Eyes say “contact”

Visual cortex says “open eyes”

PFOC says “approach”

Amygdala says “safe”

SSC says “mother”

THE NEUROSCIENCE OF BIRTH AND BREASTFEEDING

EPIGENETICS, NEUROSCIENCE, EVOLUTIONARY BIOLOGY,
Scientific American, December 2011

**Genome** - genes of species

**Genotype** - genes in specimen

**Phenotype** - specimen resulting from gene - environment interaction

**EPIGENES** ... controls on the DNA/gene “switches in the mind”

\[ G \times E \]

“For species such as primates, the mother **IS** the environment.”


Nothing an infant can or cannot do makes sense, except in light of mother's body.
“except in the light of mother’s body.”

Highly conserved

Neuro-endocrine behavior

Estrogen peaks
Progesterone falls
Pup stimulation
Rich environment

Increased spines (dendrification)
New circuits = enhanced learning

Amygdala
Less fear / anxiety

Hippocampus
Better learning / memory

Hypothalamus
Better stress tolerance

Maternal neurobehaviour
Maternal neurobehaviour

- Enhanced foraging
- Stress responsiveness
- Enhanced problem solving
- More emotional resilience

Enhanced foraging

Time to find a baited food well:
- Non-mother: 130 sec
- Mother mouse: 40 sec

A maze with food

At end:
- Mother mouse learns her way through ONE DAY
- Non-mother: ONE WEEK

Enhanced problem solving

MEMORY permanently improved

Same MAZE, TWO YEARS LATER:
- Mother mouse REMEMBERS TWICE AS FAST

Stress responsiveness

“Open Arm” - exposed and scary for mouse.
“Closed arm” - secluded and safer, less anxiety.

Mother mouse: 30-40%
Non-mother: 5-10%

More emotional resilience
LESS ANXIETY

PROLACTIN rises
OXYTOCIN rises
LACTATION
OXYTOCIN
MEMORY permanently improved

Opioids
Glucocorticoids
Norepinephrine
Vasopressin
BDNF (=Brain Derived Neurotropic Factor)
(fathers specially)

PROLACTIN rises
OXYTOCIN rises
LACTATION
OXYTOCIN
MEMORY permanently improved

Opioids
Glucocorticoids
Norepinephrine
Vasopressin
BDNF (=Brain Derived Neurotropic Factor)
(fathers specially)
Breastfeeding mothers have the HIGHEST VAGAL TONE → Stress Resistance. LOWER systolic blood pressure → Stress tolerance.

The mother and infant at birth are ready to develop optimal attachment relationships and to work together toward organised cognitive, social and emotional development.

Joy Browne 2004

The mother and infant at birth are ready to develop optimal attachment relationships and to work together toward organised cognitive, social and emotional development.

Joy Browne 2004

Centrally released oxytocin coordinates the onset of maternal nurturing behavior at parturition and plays a role in mother-infant bonding.

Ross 2009
In the FIRST HOUR .......
..... the newborn
ELICITS CARE GIVING
INSTINCTUAL
BEHAVIOUR FROM
THE MOTHER!!

With permission from Kerstin Uvnäs Moberg
Brain stem and limbic system structures related to threat and safety

In the FIRST HOUR .......
..... the newborn
ELICITS CARE GIVING
INSTINCTUAL
BEHAVIOUR FROM
THE MOTHER!!

Measure of a "good mammal mother":
FEROCITY OF DEFENCE OF YOUNG.

Sodersjukhuset, Stockholm
Randomisation to new and old unit

Personal testimony of a mother at international KMC meeting

"The instinct of a mother to hold and care for her baby is primordial and primitive, and an overwhelmingly powerful feeling."

Jane Davis, Bogota, Dec 1998
"The newborn may appear helpless, but skin-to-skin contact stimulates prolactin, ensures nutrition; oxytocin, ensures protection; and cholecystokinin, ensures wellbeing bonding."

The first hours after birth are a CRITICAL PERIOD. Mutual psycho-neuro-physiological caregivers are needed neural processes.

Critical period concept: "Windows of opportunity in early life when a child’s brain is exquisitely primed to receive sensory input in order to develop more advanced neural systems." a mother’s brain … SENSITIZATION.
The Relation of Early Mother-Infant Skin-to-Skin Contact to Later Maternal Sensitivity in South African Mothers of Low Birth Weight Infants

Ann E. Bigelow, et al

From Bergman et al 2004 RCT
SSC time first 24 hr correlated with SSC time first month.

The effect of mother-infant skin-to-skin contact on infants' response to the Still Face Task from newborn to three months of age

Ann E. Bigelow, Michelle Power

Department of Psychology, U of Western Ontario, Canada

Skin-to-skin contact accelerated infants' social expectations for their mothers' behavior and enhanced infants' awareness of themselves as active agents in social interactions.

Infants with skin-to-skin contact began responding to changes in their mothers' behavior with their affect at 1 month; infants without skin-to-skin contact did so at 2 months.

At 3 months, infants with skin-to-skin contact increased their non-distress vocalizations during the still face phase, suggesting social bidding to their mothers.
Effect of Mother/Infant Skin-to-Skin Contact on Postpartum Depressive Symptoms and Maternal Physiological Stress

Conclusion:
Mother/infant SSC benefits mothers by reducing their depressive symptoms and physiological stress in the postpartum period.


EPDS (depression) score DECREASED significantly for first two visits.


BONDING (Bergman mini-model)

Birth experience:
Sensations → hormonal changes →
neural circuits →
LIMBIC PLATFORM

Early life experience:
Neural circuits →
emotional & social intelligence →
CORTICO-LIMBIC CIRCUITRY →
ATTACHMENT

MATERNAL SENSITIVITY

SENSORY STIMULATION
SKIN-TO-SKIN CONTACT
EMOTIONAL EXCHANGES
Mutual OXYTOCIN

CRITICAL PERIOD
PATHWAY FIRING

EMOTIONAL INTELLIGENCE
ATTACHMENT

SOCIAL INTELLIGENCE

BIDIRECTIONAL !!

Affect regulation

“Human brains are RELATIONAL”

... co-creating touch
... signature unique to caregiver

PRATHIBA REEBYE

BONDING Sensitization

Secure attachment
Attuned parenting
Positive Stress
- Moderate, short-lived.
- An important and necessary aspect of healthy development occurs in the context of stable and supportive relationships.

Tolerable Stress
- Stress responses that could disrupt brain architecture, but are buffered by supportive relationships that facilitate adaptive coping.

Toxic Stress
- Strong and prolonged activation of the body’s stress management systems in the absence of the buffering protection of adult support.

“absence of the buffering protection of adult support”

Toxic Stress
- Disrupts brain architecture...
  ... increasing the risk of stress-related physical and mental illness.

Slide by: Jack P. Shonkoff, M.D.
... anxious parenting mediated by stress-related mechanisms and greater neural disorganization.

Well-adapted parenting ... reward-related motivational mechanisms, temporal organization, and affiliation hormones.

Can this be influenced??
Reduced catecholamine surge after C-section

Can this be influenced??
Oxytocin surge absent in Caesarean

Can this be influenced??
Vaginal birth → unique pattern
  → sensory processing, empathy, arousal, motivation, reward and habit-regulation circuits ... MORE SENSITIVE

Can this be influenced??

Maternal brain response to own baby-cry is affected by cesarean section delivery

Brain differences between VD & CSD mothers ...
may contribute to mental health risks & RESILIENCY in the mother-infant dyad.
Affective communication

- Mirroring
- Attunement
- Reciprocity
- Rupture / repair
- Containment

Reflective function
Mind-mindedness
Mentalisation

Attunement
Synchronous
Sensitive

Non-contingent

Intrusive
Insensitive

Multiple environmental factors

The Neuroscience of Birth & Breastfeeding

- The DNA
- Epigenetics
- Neurodevelopment
- Evolutionary biology

Environment

Adaptation
Experience
Reproductive fitness

Birth

Bonding
Parental sensitization
Toxic stress
Insensitive parenting
Disordered attachment

Beyond

Breastfeeding
Feed & sleep cycling
Secure attachment
Attuned parenting

Psychobiological Roots of Early Attachment

Attachment
Protest
Detachment
Mary Ainsworth (1913 – 1999)

... provide scientific evidence for Bowlby’s theories.

Strange Situation Test:
- secure attachment
- insecure ambivalent (anxious)
- insecure avoidant

Strange Situation Test:
- secure attachment
- insecure ambivalent (anxious)
- insecure avoidant

MICHAEL MEANEY

Maternal care as a model for experience-dependent chromatin plasticity? 

In response to stress, CRF ... and vasopressin are released ... anterior pituitary ... synthesis release ACTH ... glucocorticoids ->

Unsafe environment activates HPA axis (autonomic nervous system, ANS).

Early stress alters gene expression, with health impact across lifespan.

Earliest care at birth matters

Same gene -> switched

Earliest care at birth matters

Same gene -> switched
BONDING components

**Social**

**Emotional**

**Physical**

**ANS**

---

BONDING consequence

**Child:** Insecure attachment

**Emotional ANS**

**Social**

**Physical**

**CORTISOL**

**Adult:** Higher CORTISOL and lower immunity (CD4 cells)

---

Maternal separation produces lasting changes in cortisol and behavior in rhesus monkeys

Plasma CORTISOL response to STRESS (2y)

**CORTISOL**

**Locomotion** passive active

**Stereotypicity** neurotic relaxed

**Sitting together** reclusive social

---

Primate separation studies

Primate Early Life Stress Leads to Long-Term Mild Hippocampal Decreases in Corticosteroid Receptor Expression

**CORTISOL**

**Depression** Low gene expression, small hippocampal volume

**Suicides** Low gene expression, small hippocampal volume

**Frontal lobe** reduced expression

Maternal Separation Paradigm

Early Deprivation (ED) vs control (CON)

ED n 11 Mat 30-120 min daily → 48w

CON n 4 Mat → → → → 48w

---

Repeated short separations:

Low gene expression

Smaller hippocampal volume

Adults with depression, suicides:

Low gene expression

Small hippocampal volume

Reduced expression frontal lobe

---

Jaremka 2013
Adults with depression, suicides:
LOW gene expression
smaller hippocampal volume
reduced expression frontal lobe.

These findings translate previous results from rats / monkeys to humans.
The Neuroscience of Birth & Breastfeeding

RESILIENCE

"capacity to maintain healthy emotional functioning in the aftermath of stressful experiences"

BRUCE McEWEN  allostatics

ALLOSTASIS

ANY STRESS: Psychological, Neurological, Endocrine, Immune

STRESS  ➔  RESPONSE  ➔  ALLOSTATIC STATE  ➔  HEALTH

elevated activity of mediators, with return to baseline and no impact on health.

ALLOSTASIS

ANY STRESS: Psychological, Neurological, Endocrine, Immune

STRESS  ➔  RESPONSE  ➔  ALLOSTATIC STATE ➔  ALLOSTATIC LOAD ➔  ALLOSTATIC OVERLOAD ➔  DISEASE

the point at which chronic load results in actual disease or abnormal conditions.

Spectrum of health:

WELL-BEING ➔ SUSCEPTIBILITY ➔ MORBIDITY ➔ MORTALITY
"buffering protection of adult support"

"needed neural processes"

"except in the light of mother’s body."

"IT MATTERS HOW WE ARE BORN"

"DYAD are a single psychoneurobiological organism"

"IT MATTERS HOW WE ARE BORN"

"buffering protection of adult support"

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