

OSLO, NORWAY

SEPTEMBER 28, 2014

**THE MOST IMPORTANT YEARS OF LIFE:  
OUR BEGINNINGS**

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- Leckman and March, Developmental neuroscience comes of age, *J. Child Psychology and Psychiatry*, 2011: Describe “the phenomenal progress of the past three decades in the developmental neurosciences.”
- “Over the past decade it has... become abundantly clear that... the dyadic relations between child and caregivers within the first years of life can have direct and enduring effects on the child’s brain development and behavior.”

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- “The enduring impact of early maternal care and the role of epigenetic modifications of the genome during critical periods in early brain development in health and disease is likely to be one of the most important discoveries in all of science that have major implications for our field”
- Brain development not just genetically encoded; needs epigenetic social experiences. Not one or other but gene-environment interactions, mother nature and mother nurture combine to shape human nature.
- Here briefly review my ongoing work (1994-2014) in developmental neuroscience and attachment theory.

BRAIN OF BABY SHAPED BY BRAIN OF MOTHER. EMOTIONAL BRAIN. REGULATOR OF EMOS. SKIEN UBEVISST

- Schore (1994): integrates developmental psychology and developmental neuroscience and interpersonal neurobiological model of attachment.
- Schore (1996): “The self-organization of the developing brain occurs in the context of a relationship with another self, another brain.”
- J. Schore & A. Schore (2008): “We suggest that in line with Bowlby’s fundamental goal of the integration of psychological and biological models of human development, the current clinical and experimental focus on how affective bodily-based processes are nonconsciously interactively regulated... has shifted attachment theory to a regulation theory.”

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- Schore (2012): “Attachment theory, first created by... John Bowlby over 50 years ago, is now revitalized, particularly by its deep connections with neuroscience. At this point in time, we have in attachment theory a coherent theory of development that is grounded in both psychological science and neuroscience, and thereby is on a much firmer ground than it used to be.”
- Schore (1994-2014): modern attachment theory describes how social-emotional attachment experiences shape developing brain, specifically early developing “social,” emotional” right brain.

- In following Part 1 briefly discuss recent research on how optimal attachment experiences facilitate experience-dependent maturation of developing “emotional” right brain, core of the self, and thereby emotional well-being in later stages of life.
- Part II discuss recent neuroimaging of mother’s love for infant, which directly influences the development of the baby’s developing right brain, and thereby shapes capacity for later adult forms of mutual love.



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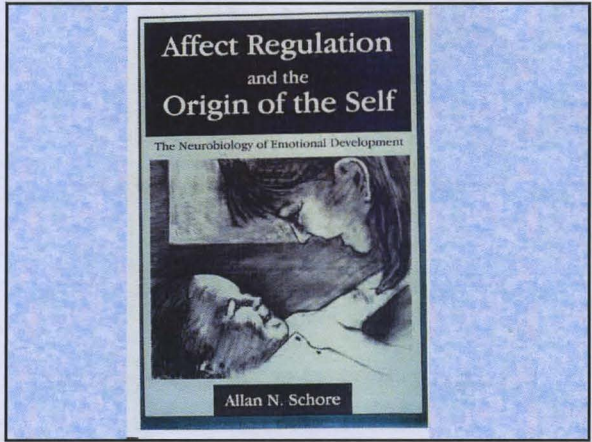
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PART I:  
THE RELATIONAL ORIGINS OF  
EMOTIONAL WELL-BEING

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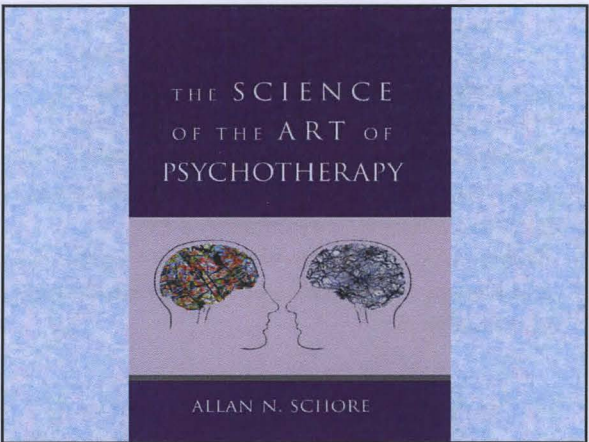
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- Schore (*Affect Regulation and the Origin of the Self*, 1994) on developmental origins of emotional well-being:
- "The understanding of early development is one of the fundamental objectives of science. The beginnings of living systems set the stage for every aspect of an organism's internal and external functioning throughout the lifespan."
- "Events that occur during infancy, especially transactions with the social environment, are indelibly imprinted into the structures that are maturing in the first years of life."

- "The child's first relationship, the one with the mother, acts as a template, as it permanently molds the individual's capacities to enter into all later emotional relationships."
- "These early experiences shape the development of a unique personality, its adaptive capacities as well as its vulnerabilities to and resistances against particular forms of future pathologies. Indeed, they profoundly influence the emergent organization of an integrated system that is both stable and adaptable, and thereby the formation of the self."

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- Schore (*Science of the Art of Psychotherapy*, 2012):
- "There is now agreement... that the essential task of the 1st year of human life is the co-creation of a secure attachment bond of emotional communication between the infant and his/her primary caregiver."
- The baby communicates its burgeoning positive emotional states (e.g., joy, excitement) and negative emotional states (e.g., fear, anger) to the caregiver so that she can then regulate them.
- The attachment relationship shapes the ability of the baby to communicate with not just the mother, but ultimately with other human beings."

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MOTHER DOES NOT CREATE THE BOND. CHILD + MOTHER.

+ JOY, EXCITEMENT, INTEREST  
÷ FEAR, ANGER, LOSS



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- Walker-Andrews & Bahrick (*Infancy*, 2001):
  - "From birth, an infant is plunged into a world of other human beings in which conversation, gestures, and faces are omnipresent during the infant's waking hours. Moreover, these harbingers of social information are dynamic, multimodal, and reciprocal."
  - Paradigm shift in conception of infancy. From beginning, infant relating to social environment. Emotional and social, not just cognitive development.
  - Sentient being, capable of perception, sensation and feeling. Emerging subjectivity (developing mind) created in an intersubjective context.

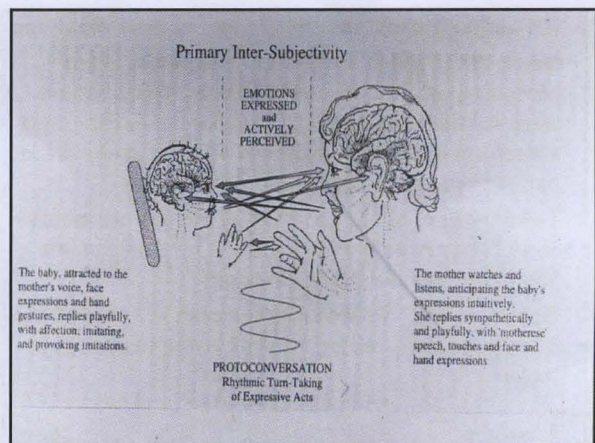
CAPABILITIES FORMED BY RELATION

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- Tirassa (2006): "The infant's subjective perspective of herself as immersed in an all-social world... against which she can interact with her caregivers, communicating with them, trying to make sense of what they do and their attempts to communicate with her, acquiring the first elements of the cultural environment in which she happens to live."
  - Infants don't use verbal language, but with others who intuitively understand nonverbal communications.
  - In order to process these dyadic communications, infant seeks proximity to mother, who must be subjectively perceived as predictable, consistent, and emotionally available.

FOR VIS CARINET, CONSISTENT EMOTION AVAILABLE

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- Bowlby (1969): mother-infant attachment communications are "accompanied by the strongest of feelings and emotions, and occur within a context of facial expression, posture, tone of voice..."
  - Bowlby (1991): "Emotion is nonverbal communication of basic but very powerful attitudes in mind and potential action."
  - Schore (1994): in episodes of right brain-to-right brain visual-facial, tactile-gestural, and auditory-prosodic affective transactions, sensitive psychobiologically attuned primary caregiver is receptive to infant's bodily-based nonverbal attachment communications.

MOTHER NON COMMUNICATION PH



MATERNAL INTUITION

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- Attachment emotional communications between infant's right brain and mother's right brain.
  - Infant: "The right hemisphere can be considered dominant in infancy, for the type of visual and acoustic communication which is relevant for the prelinguistic child." (Brown and Jaffe, *Neuropsychologia*, 1975).
  - Adult: "The neural substrates of the perception of voices, faces, gestures, smells, and pheromones, as evidenced by modern neuroimaging techniques, are characterized by a general right-hemispheric functional asymmetry" (Brancucci et al., *Proc. Royal Soc. London B*, 2009).

- 17
- RH visual-facial attachment communications
  - Grossmann et al. (2007): 4-month-old infants presented with images of a female face gazing directly ahead show enhanced gamma electrical activity over right prefrontal areas.
  - Nakato et al. (2009): near-infrared spectroscopy research reveals 5-month-olds' RH responds to images of adult female faces.
  - Tzourio-Mazoyer et al. (2002): PET study of 2-month-old infant looking at image of a woman's face; activation of infant's RH.

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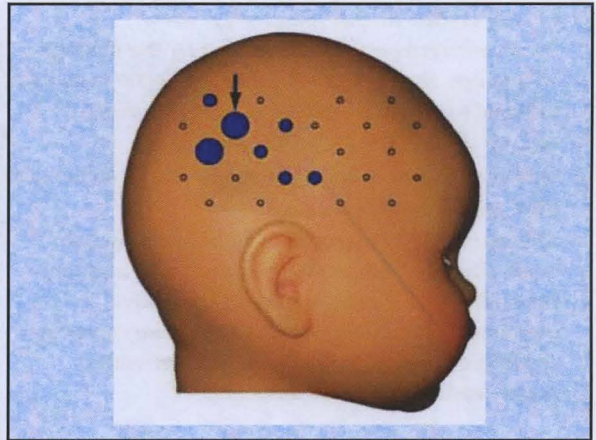




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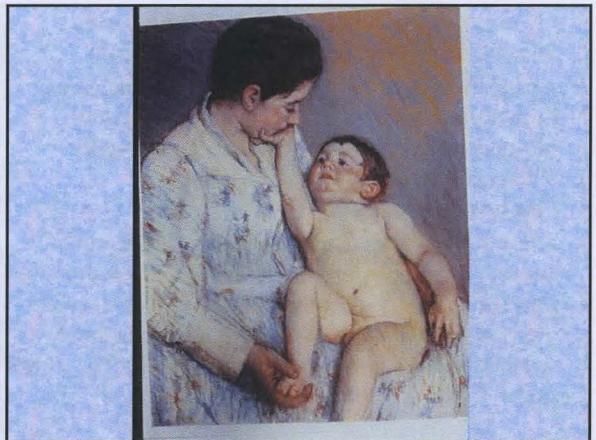
- **RH auditory-prosodic attachment communications**
- Mento et al. (2010): EEG study of **auditory pitch** processing in preterm infants born at 30 gestational weeks: "These findings suggest that the **earlier right structural maturation in foetal epochs** seems to be paralleled by a right functional development."
- Telkemeyer et al. (2009): NIRS of **2-6 day neonates** show "responses to slow **acoustic** modulations are lateralized to the **right hemisphere**."
- Homae (2006): "**Prosodic** processing in **3-month-old infants** is subserved by the **right temporoparietal region**."



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- **RH tactile-gestural attachment communications**
- Nagy (*Infant Child Develop.*, 2006): study human neonates in their first 3-96 hours of life, and find a "lateralized system for neonatal imitation."
- "The **early advantage of the right hemisphere** (Chiron et al., 1997; Schore, 2000; Trevarthen, 2001) in the **first few months** of life may affect the lateralized appearance of the first imitative gestures."
- Sieratzki & Woll (*Behav. Brain Sci.*, 2005) on touch and RH: "The **emotional impact of touch**, the most basic and reciprocal mode of interaction is also **more direct and immediate** if an infant is held to the **left side of the body**."



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- **RH tactile-gestural attachment communications**
- "Along the right hemisphere affect-communication vector, left-sided cradling facilitates the flow of auditory and visual communication between mother and infant and channels somato-affective feedback and infant sound to the mother's right hemisphere, which in turn tunes the melody of the mother's voice - the lullaby will not sound the same, and will not feel the same with the baby on the other side."
- "The role of the right hemisphere is crucial in relation to the most precious needs of mothers and infants."

SPRENET TREMMER KOMMUN MENS  
MORGENS GEMOENELLA HANNE

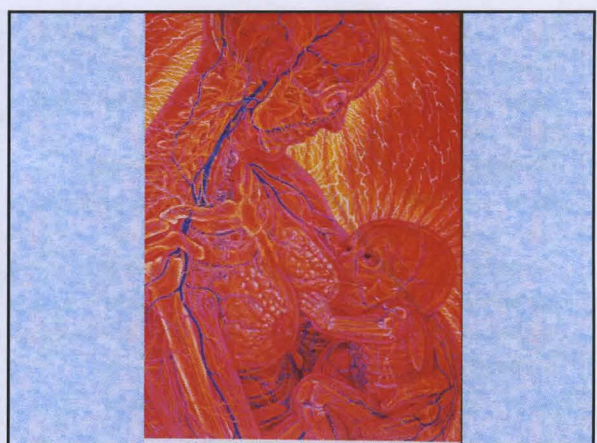
- **RH tactile-gestural attachment communications**
- Montirosso, Borgatti, & Tronick (2010): observe **left-sided regulatory gestures when infant stressed.**
- "Infants cope with the emotional distress caused by unresponsive mothers through self-regulation behaviors associated with a greater **activation of the right hemisphere... during a stressful condition there is a state-dependent activation of the right hemisphere.**"
- "The right hemisphere is more involved in the social and biological functions regarding infant caregiver emotional bonding (Schoore, 2005; Siegel, 1999)."

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- Mother not only receives infant's right brain emotional communications, but then interactively regulates them.
- **Attachment = interactive regulation of emotion.**
- **Baby becomes securely attached to psychobiologically attuned caregiver who minimizes negative affect (e.g., fear, in soothing) and maximizes positive affect (e.g., joy, in play).**
- "It is the **emotional availability of the caregiver in intimacy** which seems to be the most central growth-promoting feature of the early rearing experience."
- Winnicott (1986): "The main thing is a communication between the baby and the mother in terms of the anatomy and physiology of live bodies."

SPREBAMET HAR VANSKER MENS A  
REGULERE NEGATIV GEMOENELER  
- UPREGULERING AV JOY -  
(MODREGULERING AV NEGATIVE GEMOENELER)



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ATTACHMENT REGULERE FYSIOLOGI

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- Basch (1976): "the language of mother and infant consist of signals produced by the **autonomic, involuntary nervous system in both parties.**"
- Schoore (1994): ANS develops pre- and postnatally, and is imprinted by attachment relationship.
- RH deeply connected into **sympathetic energy-expending and parasympathetic energy-conserving** components of ANS that generate somatic aspects of emotions.
- McGilchrist (2009): "The right hemisphere, is...more closely in touch with emotion and the body."

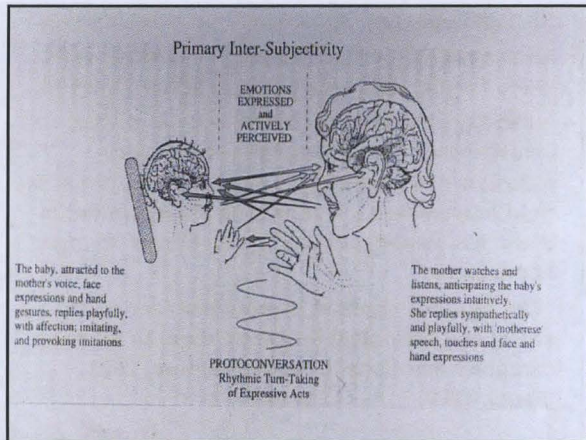
- Ovtcharoff & Braun (Neuroscience, 2001):
- "The dyadic interaction between the newborn and the mother...serves as a **regulator** of the developing individual's internal **homeostasis.** The regulatory function of the newborn-mother interaction may be an essential promoter to ensure the normal development and maintenance of synaptic connections during the establishment of functional brain circuits."
- Lagercrantz & Ringstedt (2001): prenatal and postnatal periods rate of synaptogenesis estimated at **40,000 new synapses every second.**

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- Schore (1994): right brain-to-right brain **attachment experiences impact experience-dependent maturation of infant's developing right brain.**
- Chiron et al. (*Brain*, 1997): **"The right brain hemisphere is dominant in human infants."**
- Allman et al. (*Trends in Cognitive Sciences*, 2005): "The strong and consistent predominance for the right hemisphere emerges postnatally."
- Howard & Reggia (*Brain and Cognition*, 2007): **"Earlier maturation of the right hemisphere is supported by both anatomical and imaging evidence."**

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- Lenzi et al. (*Cerebral Cortex*, 2009): fMRI study of mother-infant emotional communication offer data "supporting the theory that **the right hemisphere is more involved than the left hemisphere in emotional processing and thus, mothering.**"
- Minagawa-Kawai (*Cerebral Cortex*, 2009): near-infrared spectroscopy study of infant-mother attachment at 12 months, **"our results are in agreement with that of Schore (2000) who addressed the importance of the right hemisphere in the attachment system."**

- Ratnarajah, ... Meaney, & Qiu. (*NeuroImage*, 2013):
- Report human neonatal brain, at 5 to 17 days, presents "two topologically well-organized hemispheres with distinct and lateralized functions."
- **[I]n early life the right cerebral hemisphere could be better able to process...emotion (Schore, 2000; Wada and Davis, 1977).** This idea appears consistent with our findings of rightward asymmetry in the ...limbic structures... **These neural substrates function as hubs in the right hemisphere for emotion processes and mother and child interaction."**

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- Schore & McIntosh (2011): "Studies now show that **one parent is the primary organizer of the infant's stress states, and in nuclear setups, this is usually the mother.**"
- Gunnar (2000): **maternal care within attachment relationship shapes infant's stress regulating hypothalamic-pituitary-adrenocortical (HPA) axis.**
- Wittling (1997): **RH regulates HPA; control of vital functions supporting survival enabling organism to cope with stresses / challenges.**

- Schore (1994): **subsequent to child's attachment to mother in 1st year, forms another to father in 2<sup>nd</sup>**
- Herzog (2001): "The biorhythmicity of man with infant and woman with infant" affords infant to have **"interactive, state-sharing, and state-attuning experiences with two different kinds of caregivers."**
- Schore (2003): **father later critically involved in male and female toddler's aggression regulation [vs. earlier mother and fear regulation]**
- Braun's laboratory in Germany (2006): **paternal care affects synapse formation of the developing brain.**

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MADRE/FEDRE EN ULKE  
ANSOROSPENSOMAN. BARNET  
TRANGEN BEGGE.  
DISORDEN = DISREGULATION OF  
EMOTION

MOR : NEUREGULERT DEMPER ANGST  
FAR : APPREGULERTEN REG. AGGRESSION



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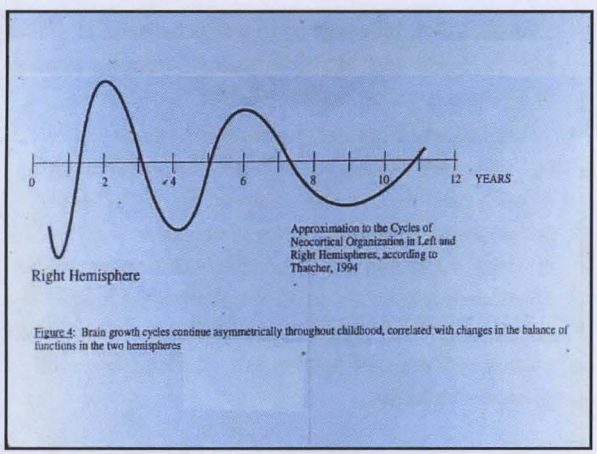
- Abraham et al., **Father's brain is sensitive to child care experiences**. PNAS, 2014.
- Study parental brain response to infant stimuli using fMRI, oxytocin and parent behavior. Measure **"primary caregiving" mothers and "secondary caregiving fathers."**
- Describe a "parenting caregiving" expressed in two different brain systems: "subcortical-paralimbic structures implicated in emotional processing and cortical areas involved in social understanding. **Mothers showed greater activation in the emotional processing network and fathers in the social cognitive circuits.**"

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- "[P]rimary caregiving **mothers** showed higher **subcortical** activation and secondary-caregiving **fathers** exhibited greater activation in **cortical** socio-cognitive circuits."
- "The **phylogenetically ancient role of maternal care, which has remained relatively uniform across time and culture, appears to be underpinned by evolutionarily ancient structures**, whereas... **paternal care**... appears to be underpinned by **later-developing** prefrontal temporo-parietal circuits supporting social understanding."

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- Schore (1994): **attachment source of right brain functions of emotional well-being over life span.**
- Sullivan & Dufresne (2006): **"right hemispheric specialization in regulating stress - and emotion-related processes."**
- Decety & Chaminade (2003): **"Mental states that are in essence private to the self may be shared between individuals... self-awareness, empathy, identification with others, and more generally intersubjective processes, are largely dependent upon...right hemisphere resources, which are the first to develop."**

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- Schutz (2005): "The right hemisphere operates a distributed network for rapid responding to **danger** and other urgent problems. **It preferentially processes environmental challenge, stress and pain** and manages **self-protective responses such as avoidance and escape.**"
- Hecht (2014): "[T]he **right hemisphere** has a relative advantage over the left hemisphere mediating **social intelligence - identifying social stimuli, understanding the intentions of other people, awareness of the dynamics in social relationships, and successful handling of social interactions.**"

MB!

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- Schore (2012) models of psychopathogenesis: "Essentially, **interpersonal neurobiology explains how early social-emotional experience indelibly influences later experience—by impacting and altering the developing brain**... The emotional relational environment provided by the primary caregiver shapes, **for better or worse**, the experience-dependent maturation of the brain systems involved in attachment functions that are accessed throughout the life span."
- Best current description of path of neurodevelopment is that it is **"malleable"** (not "resilient").

ALLE SIND ER NICKE RESILIENTE



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- Henry (1993): "The vital task of establishing a personally relevant universe and the **solace** derived from it depend on right hemispheric functioning. If this function is indeed **lost in the insecurely attached**, much has been lost."
- Helmeke et al. (2001): "**Positive** (formation of emotional attachment) **or negative** (e.g., maternal separation or loss) emotional experience may carve a permanent trace into a still developing neuronal network of immature synaptic connections, and thereby can **extend or limit** the functional capacity of the brain during later stages of life."

- Knickmeyer et al. (*J. Neuroscience*, 2008): "The large increase in total brain volume in the first year of life suggests that this is a **critical period in which disruption of developmental processes**, as the result of innate genetic abnormalities or as a consequence of environmental insults, may have **long-lasting or permanent effects** on brain structure and function."
- "**Although the first year of life may be a period of developmental vulnerability, it may also be a period in which therapeutic interventions would have the greatest positive affect.**"

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- Schore (2012): "In human infancy, right brain functions are dominant and need to be allowed to fully mature. Throughout life, the right, and not left brain, is centrally involved in critical **survival functions**: the allocation of **attention**, the capacity to experience **positive and negative emotions**, the **regulation of stress**, the ability to **empathically and intuitively** read the emotional states of other human beings, and indeed, **morality**."
- Meares (2012): **RH "background state of well-being."**
- **Infants-toddlers have unique social emotional needs. Critical role of infant mental health to later emotional well-being.**

- **Schore, 2001**, Introduction to a special issue of *Infant Mental Health Journal*, "Contributions from the decade of the brain to Infant Mental Health":
- "The **earliest stages of humanhood** are critical because they contain within them the **representation of our possible futures** – they model the potential developmental extension of our individual and collective identities...When and where shall we place our current resources so as to optimize the future of human societies?...**How much should we value the very beginnings of human life, in tangible social program dollars.**"

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RAPPORT

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- **UNICEF report, "Child Well-Being in Rich Countries, 2013: (Norway 2/29; US 26/29)**
- "It is perhaps no longer necessary to argue the case for the **importance of the early years**. Advances in both **neuroscience** and social science have repeatedly confirmed that it is at this time that **genetic potential interacts** in infinitely complex ways **with early experience** to construct the neural pathways and connections that quickly become both the foundations and the scaffolding for all later development."
- "**It is therefore at this time that the child's wellbeing, health and development are most in need of society's concern and protection.**"

- **Science**, July 20, 2014: **Editorial, "A focus on child development,"** K.L. Silver & P.A. Singer (Canada).
- Speak to role of the policy goals of the United Nations.
- "**Investing in child development is the foundation for improved health, economic, and social outcomes.** Not getting the early years 'right' is linked to violent behavior, depression, higher rates of noncommunicable disease, and lower wages, and it negatively affects a nation's gross domestic product."
- Emphasis on child development "would put the **focus** where it belongs: **on the end beneficiary, the child,** and her or his potential for development."

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PERSONLIGT BET SKOPNEN I LIVMOREN



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- Refer to "the fundamental importance of early child development to **overall sustainable development**."
- "Recent **advances in neuroscience** indicate the importance of **healthy brain development in the early years to human capital formation**...A society only reaps the full benefits of a child's survival if that child becomes a productive individual as an adult."
- "An increase in thriving children over the next 15 years would lay a stronger foundation for **healthy, prosperous, and peaceful societies**."
- "**Healthy brain development**" = enduring effects of secure attachment, optimal right brain development and **relational origins of emotional well-being**."

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SEPTEMBER 28, 2014

PART II:  
MOTHER'S LOVE DEVELOPS  
BABY'S RIGHT BRAIN

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- Toronto (*Psychoanal. Psychol.*, 2001) describes **critical nature of the nonverbal experiences of early stage of human development**:
- "The period when individuals experience life totally, globally, **outside the bounds that language places on them** is important not only to the understanding of deficits, developmental arrests, and pathology, it is also a vital and abundant source of creativity, artistry, religion, intuition, and **love**."

- Shorter Oxford English Dictionary defines love as "a state or feeling," "**deep affection, strong emotional attachment**." Raises matter of relationship of love to attachment, especially in light of transformational impact of interpersonal neurobiology on attachment theory.
- Though love mostly thought to be sole province of arts, poets and writers, from beginning of modern biology and psychology, science continues to explore this essential aspect of the human condition.

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HALL ——— jkkc movements

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• Darwin, *Expression of Emotions in Man and Animals* (1872): "The emotion of love, for instance that of a mother for her infant, **is one of the strongest of which the mind is capable**...No doubt, as affection is a pleasurable sensation, it generally causes a gentle smile and some brightening of the eyes. A **strong desire** to touch the beloved is commonly felt."

- Psychoanalysis, the "science of the unconscious mind" has a long history of interest in love.
- Schore (2003): "Although for much of his career [Freud] seemed ambivalent about the role of maternal influences in earliest development, in his very last work he stated, in a definitive fashion, that the **mother-infant relationship** "is unique, without parallel, established unalterably for a whole lifetime as the **first and strongest love-object** and the prototype of all later love relations" (Freud, 1940/1964)."
- In last century more so than any of Freud's disciples, Donald Winnicott studied deeper origins of love.

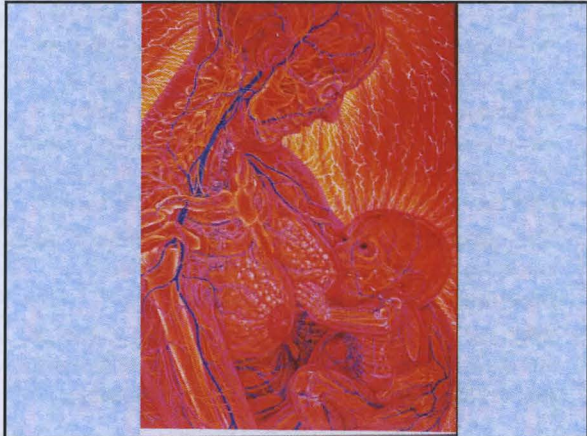
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- Winnicott (1975): "The early management of an infant is a matter **beyond conscious thought and deliberate intention**. It is something that becomes possible only through **love**..."
- "[The **good enough mother**] by **expressing love** in terms of physical management and in giving physical satisfactions...enables the infant psyche to begin in the infant body...The main thing is a communication between the baby and the mother in terms of the anatomy and physiology of live bodies."
- Alex Grey, caption: "The bonding of mother and child is a miraculous outpouring of **unobstructed love** channeled through the mortal coil."

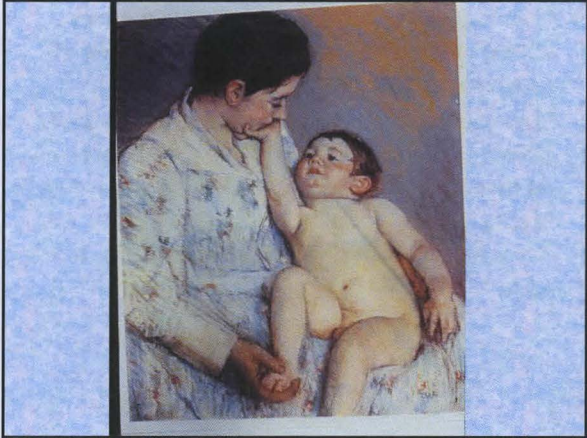
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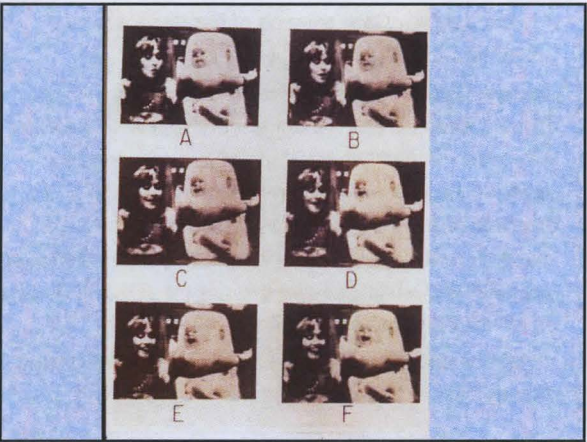
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- Winnicott (1963): describes two forms of love in developing infant.
- "**Quiet love**," seen in moments when the mother holds and handles the infant [= **calming, soothing, comfort**; low arousal, mutually decelerating, parasympathetic-dominant energy-conserving].
- "**Excited love**," seen in moments of thrilling excitement and contains an energetic potential [**joy and excitement**; high arousal, mutually accelerating, sympathetic-dominant energy expending].



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- Bowlby, J. (1953). *Child Care and the Growth of Love*. London: Pelican.
- Ainsworth, M.D.S. (1967). *Infancy in Uganda: Infant Care and the Growth of Love*.
- Bowlby (1969): mammalian attachment = evolutionary mechanism.
- Bowlby (1979): "Many of the most **intense emotions** arise during the formation, the maintenance, the disruption, and the renewal of attachment relationships. **The formation of a bond is described as falling in love**, maintaining a bond as loving someone, and losing a partner as grieving over someone."

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VICA GUEST  
MAJAA PZ RYK

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- Fromm, E., *The Art of Loving*, 1956:
- **Love = "the experience of union with another being," "becoming one with another."**
- Harlow, The nature of love. *Amer. Psychologist*, 1958: "Love is a wondrous state, deep, tender, and rewarding. Because of its intimate and personal nature it is regarded by some as an improper topic for experimental research... Psychologists, at least psychologists who write textbooks, not only show no interest in the origin and development of love or affection, but they seem to be unaware of its very existence."

- Harlow (1958): "We know little about the fundamental variables underlying the formation of affectional responses and little about the **mechanisms through which the love of the infant for the mother develops into the multifaceted response patterns characterizing love or affection in the adult.**"
- This knowledge was not available to science until 1990's. In that decade emotion finally became a investigated by both researchers and clinicians. This period also began to forge links between brain and emotion. In this period 3 neuroscientists started to forge **links between love and specifically right brain.**

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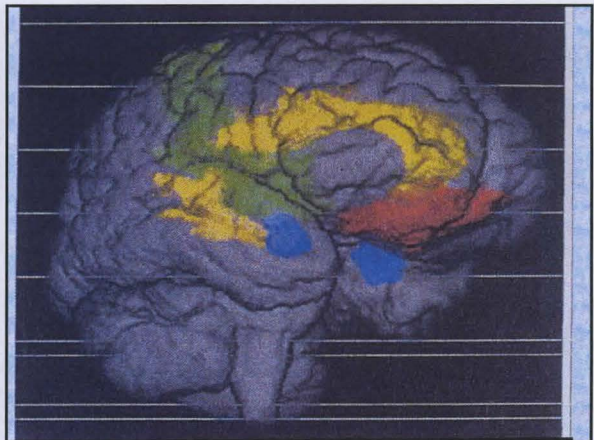
- Paul MacLean (*Zygon*, 1996): "For the mother the experience during pregnancy of the formless life within, could become after birth a sense of exteriorization and extension of the **self that physiologically derives to a large extent from the right hemisphere.**"
- *The Triune Brain* (1990): in mammalian attachment transactions, infant's **thalamocingulate limbic system** expresses emotional signals processed in loving mother's right brain.

- Rhawn Joseph (*The Right Brain and the Unconscious*, 1992): "**The infant and child must experience love and nurturance, or the limbic nuclei will not develop normally.**"
- "The **right amygdala** appears to be more greatly affected by early rearing experiences."
- (1990): Two right lateralized components of the limbic system, **amygdala and anterior cingulate** "are primary in regard to the development and maintenance of **long-lasting social and emotional attachments**... it is presumably the interaction of these limbic nuclei (coupled with the neocortex) that give rise to attachment and bonding behavior."

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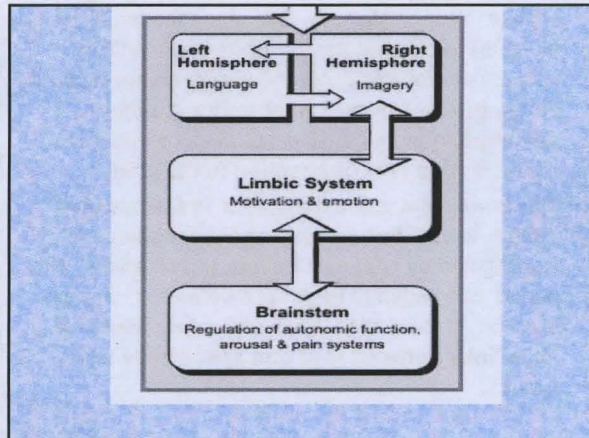
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- Schore (2000): right orbitofrontal cortex attachment control system (love = strong emotional attachment).
- Schore (2003): "The **infant's right brain is tuned to dynamically self-organize upon perceiving certain patterns of facially expressed exteroceptive information, namely the visual and auditory stimuli emanating from the **smiling and laughing joyful face of a loving mother.****"
- Maternal love activates right limbic emotional circuits. Over first year regulatory systems appear in sequence: **amygdala** (blue), **insula**, **cingulate** (yellow), **orbitofrontal cortex** (red), all connecting into subcortical arousal and motivational systems.



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- Following lecture on mother-infant mutual love, **strong emotional attachment:**
  - Neuroimaging research of maternal love (begins 2004)
  - Initial emergence of mutual love at 2-3 months.
  - Mother-infant relational origins of adult mutual love.
  - Thesis: **all later forms of mutual love arise from early affective experiences of mother-infant mutual love.** All share common right lateralized circuits that generate extremes of arousal, "**deep affection, strong emotional attachment.**" Intense nonverbal embodied expressions of human heart are generated by subcortical limbic-autonomic areas of right brain

- 20
- **Neuroimaging Research of Maternal Love**
  - Growing number of studies on structural and functional development of infant brain. Much of this **infant brain imaging** focuses on infant's right brain perceptual processing of maternal visual facial, auditory prosodic, and tactile gestural communications. Many of these studies utilize videos or auditory recordings of mother.
  - In parallel, recent surge in **parental brain imaging**, such as studies of functional neuroanatomy of mothering now connecting to the neurobiology of the maternal brain and the neuropsychology of parenting. Many of these involve mother responding to her own infant's vs. an unfamiliar infant.

- 21
- Bartels & Zeki, **The neural correlates of maternal and romantic love.** *NeuroImage*, 2004.
  - "The tender intimacy and selflessness of a mother's love for her infant occupies a unique and exalted position in human conduct...it provides one of the most powerful motivations for human action, and has been celebrated throughout the ages—in literature, art and music—as one of the most beautiful and inspiring manifestations of human behavior."
  - Refer to "**the long-lasting and pervasive influence of maternal love (or its absence) on the development and future mental constitution of a child.**"

- 22
- Functional magnetic resonance imaging (fMRI) study of mother's viewing picture of own child's face (early as 9 months).
  - "**Extraordinary affect state**" of maternal love triggers activation in mother's lateral OFC, medial insula, anterior cingulate, fusiform cortex.
  - Maternal love activates mother's lateral **OFC**, associated with "pleasant visual, tactile and olfactory stimuli."
  - Maternal love activates **insula**, area involved in "gut feelings" of emotive states, and in "limbic touch" that evokes pleasant feelings of touch and "caress-like, skin-to-skin contact between individuals."

- 23
- Maternal love activates **anterior cingulate** "suggesting a potential link to the mother's feelings of empathy and urge to care for her infant."
  - Maternal love activates **ventral tegmental dopamine neurons** associated with "**highly rewarding experiences.**"
  - Maternal love activates midbrain **periaqueductal gray**, involved in "endogenous **pain suppression** during experience of intense emotional experience such as childbirth." [PAG also reduces fearfulness and increases maternal protective aggression]
  - Maternal love also deactivates certain brain regions. Affected "the right hemisphere substantially more."



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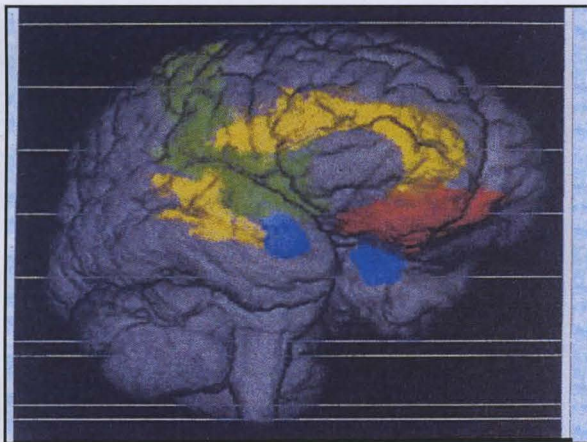
- **Deactivations** in two areas: "middle prefrontal, inferior parietal and middle temporal cortices mainly in the right hemisphere, as well as the posterior cingulate cortex play predominantly a role in cognition."
- "The second set of areas deactivated here (amygdala, temporal poles, parietotemporal junction and mesial prefrontal cortex) has...been **associated to negative emotions and to social, moral and 'theory of mind' tasks.**"
- [Note deactivation of mentalizing in loving moment.]
- **Maternal love deactivates negative emotion.** "The amygdala is reliably activated in neuroimaging studies involving negative emotions, **aggression and fear.**"

★

- Nitschke et al., **Orbitofrontal cortex tracks positive mood in mother's viewing pictures of their newborn infants**, *NeuroImage*, 2004.
- "Positive affect elicited in a mother toward her newborn infant may be one of the most **powerful** and evolutionarily preserved forms of positive affect in the emotional landscape of human behavior."
- "One form of positive emotion...is the affect that arises in a mother's relationship with her infant. Whereas **reward** paradigms capitalize on approach tendencies and pursuit of an appetitive goal, the form of positive emotion in **maternal attachment is better characterized by warmth, nurturance, joy, and fulfillment.**"

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- Mother in fMRI scanner while viewing **photos of mother's own 3 to 5 month old infants.**
- "Most mothers report **extremely strong** pleasant emotions when interacting with or thinking about their infants." While observing picture of her smiling infant (never before seen photo), **mother's describes her subjectivity as "loving" and "motherly."**
- "MR signal change in the OFC appears to linearly **track the intensity of positive emotions** that may underlie maternal attachment... The present study extends this work by highlighting the role of the **OFC** in the representation of attachment-related positive affect (Bowlby, 1982)."

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- Ranote et al., **The neural basis of maternal responsiveness to infants: an fMRI study.** *NeuroReport*, 2004:
- Mother looking at videos of own **4-8 month-old infant**; activation of right anterior inferior temporal cortex and right occipital gyrus, "consistent with previous findings reporting **right sided effects of...face processing.**"
- Mother's viewing of own infant activates amygdala. "The **amygdala** is commonly associated with the processing of **fearful** and unpleasant emotional stimuli, but has **also** been shown to play a part in processing of **happy** expressions of facial emotion."

- Noriuchi et al., **The functional neuroanatomy of maternal love: mother's response to infant's attachment behaviors**, *Biological Psychiatry*, 2008:
- "Maternal love is one of the most **powerful** motivations for the maternal behaviors of mothers to care for and protect their infants. Bowlby (1953) described that a **mother's love in infancy and childhood is as important for mental health as are vitamins and proteins for physical health.**"
- "The amount of love with which a mother interacts with her infant is highly influential on the stability of the mother-infant relationship and the quality of the mother-infant attachment..."

28

AMYGDALA PROSESEREN  
SPEKKE EMOSJONEN +/-



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- “The infant plays an important part in mother-infant attachment because the infant’s behavior has a powerful effect on the mother’s emotions. Therefore, **strong maternal attachment**, which is expressed in the mother as **affectionate behavior, vigilance, and protectiveness**, would be induced by the infant’s attachment behaviors.”
- Mothers’ of 16 month infants shown **two videos**. “In the first situation, the **infant** was smiling at his/her own mother while **playing with his/her mother**, and in the second situation, the **infant** was asking for his/her mother while being **separated from his/her mother**.”
- [Mother’s joyful in former, anxious in latter.]

- “In the separation situation, the mother left the room, and the infant who was left alone was unduly distressed (I.e., the infant was crying and/or calling for his/her mother).”
- “While **mothers** may feel **joyful** by watching video clips of their own infant in the **first situation**, they may feel **anxious and protective** when shown video clips of their own infant in the **second situation**.”
- Posit, “invariant maternal love would exist in the mother herself, regardless of how she responded to her own infant in any situation.” [secure?]

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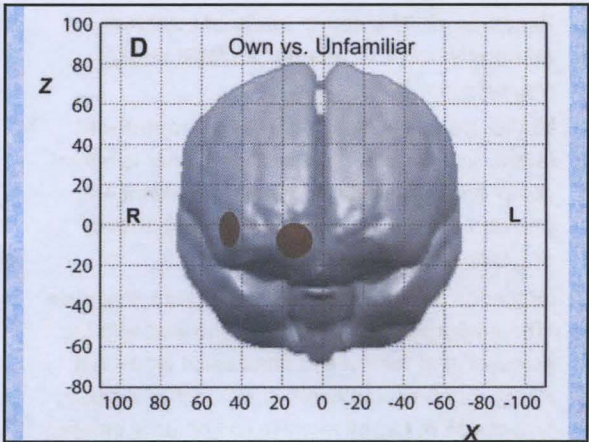
- Maternal love activates mother’s periaqueductal grey, insula, and anterior cingulate, “involved in **maternal response to infant’s pain of separation**.”
- “**Positive emotions such as love and motherly feeling coexisted with negative ones such as anxious feeling and worry in the mother herself**. In this complicated situation, the **mother’s emotional responses to her own infant might be appropriately regulated by monitoring her own emotional states** and by inhibiting her excessive negative affects so as not to show negative expressions to her infant who is in distress.”
- [secure more so than insecure mother?]

- Maternal love activates right inferior frontal gyrus, associated with recognizing infant’s facial expressions.
- “In the present study, **the infant’s attachment behaviors in the video stimuli were thought to touch its mother’s heart, in which she felt her own infant’s dynamic facial expressions and actions realistically**.”
- “[T]hese feelings representing **maternal love** were elicited by viewing their own infant, **regardless of the situation**, and the activity in the **right OFC** was associated with this.”
- “The **OFC** is known to play an important role in the reward system; it receives ascending **dopamine** projections from the ventral tegmental area.”

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33

- Minagawa-Kawai et al. Prefrontal activation associated with social attachment: Facial-emotion recognition in mothers and infants, *Cerebral Cortex*, 2009.
- NIRS of 12 month **infants looking at video of their smiling mother, and mothers’ looking at video of infant while playing**. Mothers watched movie alone, rated their emotional mood from 0-6 “(6 = most loving).” “We captured neural responses from the prefrontal area that were specific to looking at their own-mother’s smiling expression in 12-month-old infants and vice versa in the mothers.”
- **Mothers looking at infant show activation in right OFC; infants looking at mother also right OFC.**



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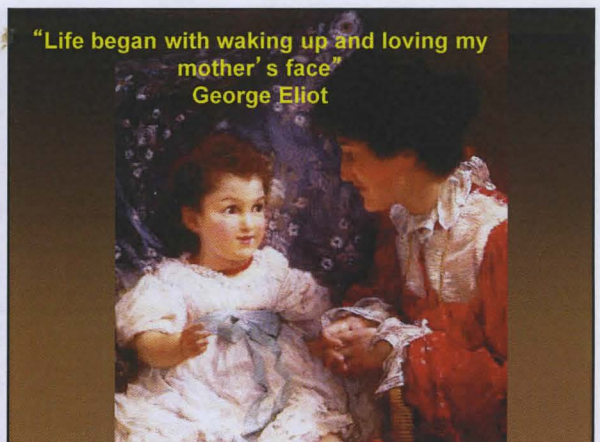
- 35
- **Brain response of mother** in "most loving state": "It may be that if a mother shows higher frontal activation in response to her infant, then her **infant could also show larger activations as a result of his/her mother's stronger affection** probably observed in their daily life."
  - **Brain response of infant**: "the neural correlates for facial-emotion processing, particularly positive emotional processing, are **stronger for their own mother**... The infants' prefrontal activation around the anterior OFC is specific to viewing their mothers' smile."
  - [mutual love = "strong emotional attachment"]

- 36
- "Our results are in agreement with those of Schore (1999, 2000) who addressed the importance of the **right hemisphere in the attachment system**."
  - Right lateral OFC functions "develops within the social world between caretakers and infants as one form of attachment. This type of emotional regulation is also a fundamental social skill to extend infants' social involvement **beyond kinship and friendship, including love, in the general social world**."

- 37
- **Initial emergence of mutual love at 2-3 months**
  - Johnson et al., *Developmental Psychopathology*, 2005: the social brain network is partially active starting from at least 3 months of age
  - Developmental psychoanalysis and developmental psychology describe import of 2-3 month transition (e.g. Rene Spitz).
  - **Stern (1975): describes transition from an early forming "emergent self" at birth into a "core self" at 2-3 months.** "When this perspective forms, the subjective social world is altered and interpersonal experience operates in a different domain, a domain of core-relatedness."

- 38
- "At the age of two to three months, infants begin to give the impression of being quite different persons. **When engaged in social interaction, they appear to be more wholly integrated.** It is if their actions, plans, affects, perceptions, and cognitions can now all be brought into play and focused, for a while, on an interpersonal situation."
  - "At this stage infant participates in shared "observable interactive events" involved in "bridging the infant's subjective world and the mother's subjective world."
  - "There are many ways with being with an other can be experienced... such as **merging, fusion... symbiotic states**..."

- 39
- **Primordial expression of mutual love first appears at 2-3 months**, onset of critical period of "core self."
  - Recall earliest studies of maternal love with 3 month old babies (Nitschke). **Mother and infant now share moments of up-regulated intense positive arousal and down-regulated intense negative arousal.**
  - **Loving mother now interactively regulates both states of parasympathetic "quiet love" and sympathetic "excited love,"** allowing infant to integrate these embodied affective states. **Face-to-face experiences of right brain state-sharing of mutual mother-infant love** structuralize Stern's "core self."



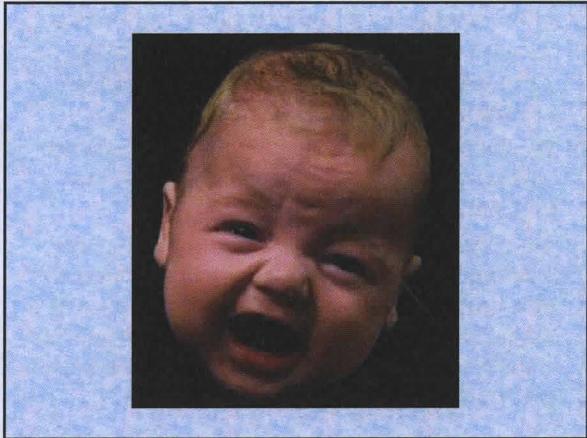


- 41
- Chong, Werker, Russell, & Carroll, **Three facial expressions mothers direct to their infants**, *Infant and Child Development*, 2003.
  - Building on Stern's (1974) home observations of maternal expressions used with 3-4 month "core self" infants, they identify **three types of infant-directed facial expressions in English and Chinese speaking mothers** interacting with their 4-7 month infants.
  - Videotape analysis reveals 3 "**dramatic, unique, and easily identifiable facial expressions** parents were using with their infants but not with other adults."
  - **Earliest expression of "the faces of maternal love."**

- 42
- **Expression A**, "fish mouth face": puckered lips and lips slightly apart. "Worried" (lips rounded and pursed, but eyebrows more furrowed, forehead wrinkled, and chin down). This maternal expression "unambiguously conveyed **love and concern** of adult viewers."
  - "Common words generated in response to this expression type: nurturance, **calming**, 'don't cry', compassion, reassurance, **soothing, comforting, help, affection, caring, love, and protection.**"
  - Maternal regulation of infant from a state of distress into calm state = "**quiet love.**" Down regulation of sympathetic hyperarousal of a negative state (cry, protest anger, fear); shift to parasympathetic comfort.



FISH-MOUTH



- 45
- **Expression B**, Stern's "mock surprise", "**Wow!**"
  - Exaggerated facial expression in which "the eyebrows go way up, the eyes open very wide, the mouth opens and purses and usually emits a long 'Oooooo', and the head comes up and forward sometimes to within inches of the baby's face."
  - "Mothers reported a cluster of **Surprise, Excitement, and Interest**... [T]his expression conveys that **sense of wonder and engagement parents feel at their infant's accomplishments**. We would suggest using the term **WOW** to label Expression B, to capture that sense of amazement and pride that this expression type communicates."





- 47
- Regulated **noradrenergic** "excited love."
  - This form of maternal love expressed in her high arousal attention = interest (=wonder) in her infant's burgeoning accomplishments (high "maternal attention").
  - Mother inches from baby's face. Transitional space of "intimate edge." Heightened interest in the most intimate details of her love object. Mother modeling ability to tolerate extreme closeness = intimacy.
  - These experiences of early mutual love shape right brain capacity for later excitement and interest in love object; **heightened excited anticipation of seeing (or imagining) face of loved object.**

- 48
- **Expression C, "Joy,"** an "unmistakable look of love in the eyes."
  - Characterized by a smile (lip corner pull), cheek raise, and a slightly open mouth (as evident by either lips part or jaw drop).
  - "We chose the term JOY rather than HAPPY." [intensity dimension]
  - Associated with "a desire to touch." (recall Darwin, love = "a strong desire to touch the beloved").
  - Semantic response: joyful, **love and warmth**; adoration, praise, admiration.



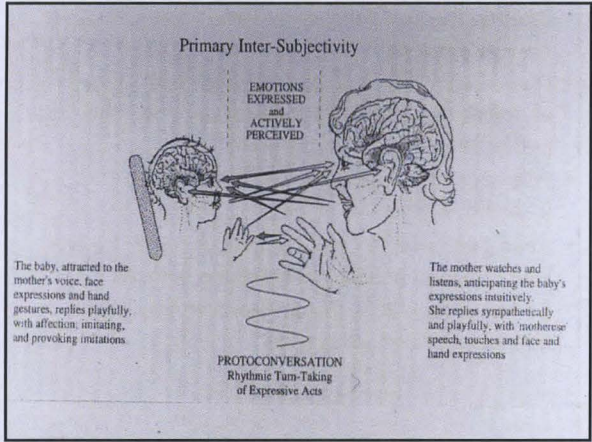
- 50
- Regulated **dopaminergic** "excited love." **Mutually accelerating dopaminergic arousal generates joy in both.** Activation of mother's ventral tegmental dopamine neurons.
  - Schore (1994): "The unconditionally rewarding and exciting properties of the mother's gaze... activate ventral tegmental dopaminergic elation and dopaminergic arousal."
  - Minagawa-Kawai (2009): mother's right lateral OFC activated watching her own infant's positive state.

- 51
- Relational experience of the emergence of mutual love at 2-3 months induces neuroplastic **changes not only in the infant's brain, but in mother's brain.**
  - Kim et al. **The plasticity of human maternal brain:** Longitudinal changes in brain anatomy during early postpartum period. *Behavioral Neuroscience*, 2010.
  - Longitudinal study of mother's brain at two time points: 2-4 weeks postpartum and 3-4 months postpartum [critical period of onset of mutual love, 2-3 months].
  - Report from 2-4 weeks to 3-4 months **increased gray matter in mother's brain**, including **right** insula, hypothalamus, anterior cingulate, and amygdala.

- 52
- "The **structural changes in the midbrain** region including the hypothalamus, substantia nigra, globus pallidus, and amygdala over time were **predicted by a mother's positive perception of her baby at the first month postpartum.** Thus, the mother's positive feelings for her baby may facilitate the increased levels of gray matter."
  - [mutual love increases limbic system gray matter on both sides of any loving dyad, parent-infant, adult romantic, intimate friendships, etc.]



53



- **Mother-Infant Origins of Adult Mutual Love**
- Ammaniti & Gallese, *The Birth of Intersubjectivity. Psychodynamics, Neurobiology, and the Self*, 2013
- "As Daniel Stern (1993) has written, expressions of love begin early in an astonishing way. **Mother and child behavior overlaps with the behavior of two lovers.** For example, mother and child look at each other without speaking, hold a physical closeness with **faces and bodies** in constant contact, display alterations in **vocal expressions** or synchrony of movements, and perform particular **gestures** like kissing each other, hugging, touching, and taking the face or the hands of the other."

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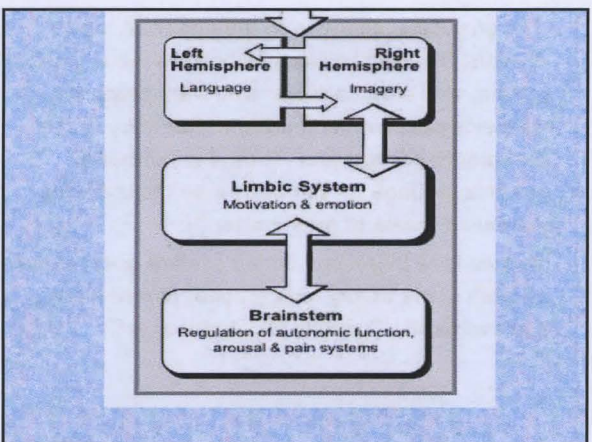
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- "When parents speak to their child, or lovers talk with one another... they emphasize the **musicality of the words** instead of the meaning, they use baby talk, and they express a wide range of nonverbal vocalizations... **Facial expressions** assume a special register also, altering and emphasizing the facial mimic. **There is also a choreography in the movements of mother and baby, like those of two lovers; they move in synchrony, getting closer and more distant on the basis of a common rhythm.**"
- [= right brain-to-right brain]

- Co-creation of **mother-infant mutual love**, a bond of "deep affection, strong emotional attachment" represents the expression of an **instinctual evolutionary mechanism** that is continually activated over the stages of human infancy.
- Both low arousal parasympathetic "**quiet**" and high arousal sympathetic "**excited**" love imprint developing subcortical-cortical emotional circuits in critical periods of right brain development, and thereby allow "the emotional brain" to develop to more complexity and "higher forms" of mutual love.

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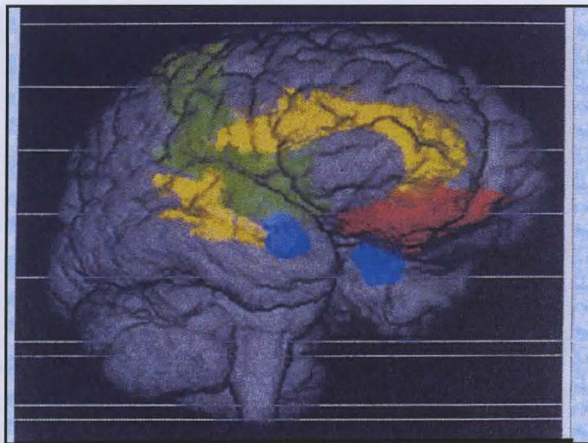


- Primordial experiences of mutual love, "the experience of union with another being" facilitate an increased connectivity of the early maturing "lower" subcortical (right amygdala) and the "higher" cortical (right anterior cingulate and orbitofrontal) levels of right hemisphere.
- Schore (2003): "The right lateralized self system represents a nested system, with an outer later-developing **orbitofrontal**-limbic regulated core, an inner earlier developing **cingulate**-limbic regulating core, and an earliest evolving **amygdala**-limbic regulated core that lies deepest within, like nested Russian dolls."

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- In first 2 years, mother-infant love epigenetically shapes developing right brain capacity to empathically share an interactively regulated state of heightened arousal, **love**, an intensely embodied attachment bond of emotional communication with early on **mother**, but **later**, another subjective self, **father**.
- Mother-infant love is developmental source of all later forms of "excited love" (**exhilaration of romantic infatuation**) and "quiet love" (**tender intimacy**).
- **Researchers now emphasizing common neurobiological mechanisms in all forms of mutual love.**

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- Bartels & Zeki, The neural correlates of **maternal and romantic love**, *NeuroImage*, 2004:
- "Maternal and romantic love share a common and crucial evolutionary purpose, namely the **maintenance and perpetuation of the species**. Both ensure the formation of firm bonds between individuals, by making this behavior a rewarding experience. They therefore share a **similar evolutionary origin and serve a similar biological function.**"

- Swain (*Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 2011): "With the idea that **parental love may make use of the same reward and emotion circuits as romantic love**...these studies suggest that **romantic love** uses **subcortical** motivation and **reward systems** to focus thoughts and behaviors on a specific individual, while **limbic cortical** regions process individual emotional factors."

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- Stern (1985) on the sense of early evolving "core self" expressing "**excited love**" at **later stages of life**:
- "The sense of being with an other with whom we are interacting can be one of the **most forceful experiences** of social life...Falling in love provides a normal example. Lovers are not simply preoccupied with one another. The loved other is often experienced as an almost **continual presence**, even an aura, that can change almost everything that one does – **heighten one's perception** of the world or reshape and refine one's very movements."

- **Early "excited love" evolves to high arousal romantic love infatuation.**
- Aron, Fisher, et al., Reward, motivation, and emotion systems associated with **early-stage intense romantic love**. *J Neurophysiology*, 2005.
- "Romantic love is... associated, particularly in early stages, with specific physiological, psychological, and behavioral indices...These include emotional responses such as euphoria, **intense focused attention on a preferred individual**, obsessive thinking about him or her emotional dependency on and **craving for emotional union with this beloved, and increased energy.**"

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BARNOAMMEN. NO

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- Helen Fisher et al., *Archives of Sexual Behavior*, 2002.
- fMRI of individuals who are "intensely in love" show activation in "dopamine-rich areas associated with mammalian reward and motivation, namely the **right ventral tegmental area**."
- "The results suggest that romantic love uses **subcortical** reward and motivation systems to focus on a specific individual, that **limbic cortical regions** process individual emotion factors."
- Fisher also describes "**quiet love**": "In humans, adult male-female attachment (often called 'companionate love') is ... characterized by feelings of **calm, security,**

- Mother-infant love shapes individual's capacity for adaptive emotional capacity of shared intimacy in moments of "**quiet love**." **Deep intimacy** includes "sharing that which is inmost" and Winnicottian states of being "**alone in the presence of the other**."
- Rainer Maria Rilke: "For **one human being to love another**, that is perhaps the most difficult of all our tasks, the ultimate, the last test and proof, the work for which all other is but preparation. I hold this to be the highest task for a bond between two people: that **each protects the solitude of the other**."

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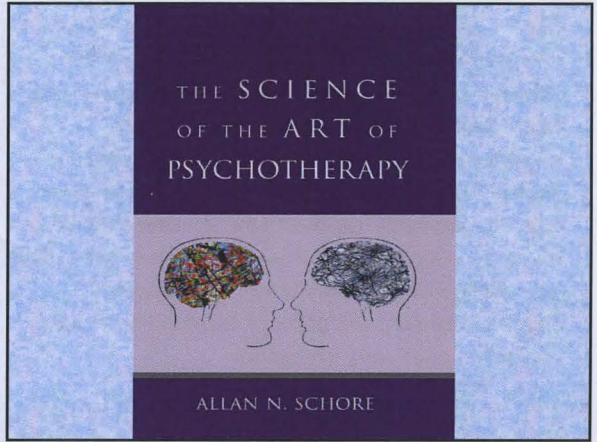
- Henry Krystal, *Integration & Self-Healing; Affect Trauma, Alexithymia*, 1988:
- "Just as white light contains all the colors of the spectrum, so **love encompasses all the feelings reflecting our living process**. When we get a chance to observe it, as in self-healing or in promoting the **expansion of the conscious recognition of our selfness**, we are especially prone to equate it with life forces, or the full enjoyment of our identity and unity. Love is the affective state that is favorable to the achievement of **the most comprehensive self-representation**."
- [mutual love expands implicit self in both]

- Aron & Aron (1996): **love as "self-expansion"**: "The model treats love (the desire for a relationship with a particular other) as arising from a desire to expand the self by **including that other into the self**, as well as by associating expansion with that particular other."
- Origin of adaptive expansive capacity of continually developing subjective self is early resonant, amplifying right brain-to-right brain imprinting of mother-infant love. **Neuroplastic expansion of right brain self**.
- Self expansion = internalizing loved others, at the level of overlapping neural representations of self and other.
- Maslow (1967): "**beloved people can be incorporated into the self**."

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- Earliest expressions of the evolutionary mechanism of **mutual love**, moments of **intense "emotional union"** continue to imprint and integrate developing "emotional" right brain, **thereby primary source of emotional-well being at later stages of life**.
- Noriuchi et al. (*Biological Psychiatry*, 2008): "The amount of love with which a mother interacts with her infant is highly influential on the stability of the mother-infant relationship and the quality of the mother-infant attachment, and **maternal love is essential for preservation of the human species**."



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TIDLIG BARNEHAGE  
AF UTOEGE - UUNVLKEMME  
TRUKTYNIG

MOR FAR  
DE 2 FØRSTE ÅR  
DE 1000 FØRSTE ÅR (9mm) + 1/2 2 ÅR

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REAGERER ULIGT PÅ TIDLIG BARNEH.  
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SKISMISE  
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