The Intergenerational Transmission of Attachment: What the Brain Has to Say

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Child Abuse and Neglect

- Every 10 days in England and Wales one child is killed at the hands of their parent
- 25% of children experience physical violence
- 6% of children experience frequent and severe emotional maltreatment
- 6% experience serious absence of care at home

Biological mothers are the most frequent perpetrators of maltreatment
Child Neglect

- Most prevalent and rapidly increasing form of child maltreatment
  - ~40% of reported cases are for neglect
- Yet, it is the least studied and most poorly understood type of maltreatment
Defining Neglect

- *Failure* to provide for a child’s intrinsic needs
- Culturally defined vs. universal
- Physical vs. emotional neglect
- Retrospective study (Dube, 2003)
  - 10% of the population experienced physical neglect
    - >50% of these also experienced emotional neglect
  - 15% emotional neglect
Physical Neglect

- Failure to provide:
  - Food
  - Clothing
  - Shelter
  - Medical care
  - Educational provision

Emotional Neglect

- Failure to provide:
  - Comfort
  - Protection
  - Love
  - Discipline
  - Encouragement
Consequences of Child Neglect

- Impaired cognitive development
- Language delays
- Increased risk of childhood aggression
- Internalizing and externalizing behavior problems
- Increased risk of subsequent abuse
Intergenerational Transmission of Attachment

- Overall, there was a 73% match of secure/insecure attachment between mothers and infants ($X^2 = 10.7$, df = 1, $\kappa = 0.46$, $p = 0.001$)
Intergenerational Transmission of Attachment

Shah, Fonagy, Strathearn, 2010
Intergenerational Transmission of Attachment

- Increased likelihood of inversion of patterns across Type A and C groups
Intergenerational Transmission of Attachment

MOTHER’S ATTACHMENT STRATEGY

INFANT’S ATTACHMENT STRATEGY
Intergenerational Transmission of Attachment

MOTHER’S ATTACHMENT STRATEGY

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Intergenerational Transmission of Attachment

“TRANSMISSION GAP”

Maternal sensitivity or “sensitive responsiveness”?

Mentalizing?

Genetic factors?

MOTHER’S ATTACHMENT STRATEGY

INFANT’S ATTACHMENT STRATEGY

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Intergenerational Transmission of Attachment

MOTHER’S ATTACHMENT STRATEGY

INFANT’S ATTACHMENT STRATEGY
Maternal Behavior in the Rat

- Pup vocalization
- Licking and grooming
- Arched-back nursing

Champagne, 2003
Oxytocin and Dopamine Systems

- Oxytocin “affiliation” pathways
  - Pituitary gland
  - Hypothalamus (MPOA, PVN)
- Dopamine “reward” pathways
  - Ventral striatum
  - Medial prefrontal cortex
- The development of these systems appears to be strongly influenced by early maternal care
Neuroendocrine Systems Important in Maternal Behavior

1. Dopamine (DA)
   - Nucleus accumbens - DA important in rat maternal behavior and released during mother-pup interaction
   - Important factor in cognitive development and establishing reward-based contingencies

2. Oxytocin
   - Central hormone critical for the social and maternal behavior,
   - Social memory;
   - Anxiolytic properties
Oxytocin and maternal caregiving

- In animal models of maternal care, oxytocin is critical for the initiation of maternal care.
- In ewes, oxytocin results in selective bonding with the lamb.
- Oxytocin neurons may also connect with the brain’s dopamine “reward” system, resulting in changes in “long-term conditioned preferences.”
Oxytocin and maternal caregiving

- Oxytocin is a peripheral hormone important in childbirth and lactation
- Breastfeeding/suckling stimulates its production
- It also has important central effects in the brain to help prepare for long-term child rearing
- “Calm and connection” effect
DNA Methylation and Epigenetics

- Early life somatosensory stimulation (“pup licking”) results in:
  - Change in methylation pattern at *stress receptor gene*, resulting in a reduced stress response
  - Change in methylation pattern for *estrogen receptor gene*, resulting in changes in *oxytocin functioning*, and enhanced maternal caregiving behavior in female offspring
  - Enhanced *dopamine production* in response to infant cues
EPIGENETIC MECHANISMS are affected by these factors and processes:
- Development (in utero, childhood)
- Environmental chemicals
- Drugs/Pharmaceuticals
- Aging
- Diet

CHROMOSOME
METHYL GROUP

DNA methylation
Methyl group (an epigenetic factor found in some dietary sources) can tag DNA and activate or repress genes.

CHROMATIN

DNA

Histones are proteins around which DNA can wind for compaction and gene regulation.

HEALTH ENDPOINTS
- Cancer
- Autoimmune disease
- Mental disorders
- Diabetes

EPIGENETIC FACTOR

Histone modification
The binding of epigenetic factors to histone “tails” alters the extent to which DNA is wrapped around histones and the availability of genes in the DNA to be activated.
Intergenerational Transmission of Attachment

- MOTHER’S ATTACHMENT STRATEGY
- INFANT’S ATTACHMENT STRATEGY
Intergenerational Transmission of Attachment

MOTHER’S ATTACHMENT STRATEGY

INFANT’S ATTACHMENT STRATEGY
Study Outline

Visit 1: Pregnancy
- 3rd trimester
- Mother-infant separation 1
- Blood draws:
  - Oxytocin
  - Cortisol
  - Adrenaline
  - Noradrenaline

Visit 2: Videotaping
- 7 mths
- "Free play" interaction
- Mirror-based interaction
- Blood draws:
  - Oxytocin
  - Cortisol
  - Adrenaline
  - Noradrenaline
- PANAS (1)
- Demographics
- ATQ
- Infant face images

Visit 3: Scanning
- 10 mths
- Mother-infant separation 2
- Blood draws:
  - Oxytocin
  - Cortisol
  - Adrenaline
  - Noradrenaline
- PANAS (2)
- IBQ
- PSI
- PANAS (2)
- IBQ
- PSI
- ATQ
- Demographics
- PDQ
- BDI
- PSI
- PANAS (2)
- IBQ
- PSI
- ATQ
- Demographics
- PDQ
- BDI

Visit 4: Follow-Up
- 14 mths
- Mother-infant separation 2
- Blood draws:
  - Oxytocin
  - Cortisol
  - Adrenaline
  - Noradrenaline
- PANAS (2)
- IBQ
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Study Timeline
- 3rd trimester
- BIRTH
- 7 mths
- 10 mths
- 14 mths

Data Collected
- AAI
- Demographics
- PDQ
- BDI
- PANAS (1)
- Demographics
- ATQ
- Infant face images
- PANAS (2)
- IBQ
- PSI

Study Outline

Visit 1: Pregnancy

Visit 2: Videotaping

Visit 3: Scanning

Visit 4: Follow-Up

Study Timeline

Data Collected

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Visit 2: Videotaping

Visit 1: Pregnancy
- 3rd trimester
- BIRTH

Visit 2: Videotaping
- 7 mths
- 20 min
- Mother-infant separation 1
- 5 min
- “Free play” interaction
- 6 min
- Mirror-based interaction
- 20 min
- Mother-infant separation 2
- Blood draws
  - Oxytocin
  - Cortisol
  - Adrenaline
  - Noradrenaline

Visit 3: Scanning
- 10 mths
- PANAS (2)
- IBQ
- PSI

Visit 4: Follow-Up
- 14 mths
- WTAR
- Breastfeeding duration
- Hours separated per week
- Bayley Scales of Infant Development
- Strange Situation Procedure

Data Collected
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Study Timeline
- 20 min
- 5 min
- 6 min
- 20 min
- 7 mths

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AAI
Visit 3: fMRI Scanning

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- 10 mths
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Study Timeline
- BIRTH
- 20 min
- 5 min
- 6 min
- 20 min

Mother-infant separation 1
"Free play" interaction
Mirror-based interaction
Mother-infant separation 2
Visit 4: Follow-Up

Visit 1: Pregnancy
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- 14 mths
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Study Timeline:
- Birth
- Mother-infant separation 1
- Blood draws
- Mother-infant separation 2
- Follow-Up
Three Affective States

Crying  Neutral  Smiling
2 sec

Own: Happy (OH)

Unknown: Happy (UH)

Unknown: Sad (US)

Own: Neutral (ON)

Unknown: Neutral (UN)

Own: Sad (OS)

2–6 sec random inter-stimulus interval
<table>
<thead>
<tr>
<th>STIMULUS TYPES</th>
<th>IDENTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own Infant</td>
<td>Unknown Infant</td>
</tr>
<tr>
<td>AFFECT</td>
<td></td>
</tr>
<tr>
<td>Happy</td>
<td>OH</td>
</tr>
<tr>
<td>Neutral</td>
<td>ON</td>
</tr>
<tr>
<td>Sad</td>
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2 sec
2 sec
2 sec
2 sec
2 sec
2 sec
2 sec

Own: Happy (OH)
Unknown: Happy (UH)
Unknown: Sad (US)
Own: Neutral (ON)
Unknown: Neutral (UN)
Own: Sad (OS)

2–6 sec random inter-stimulus interval
Functional Magnetic Resonance Imaging (fMRI)

- fMRI allows for the time course of human brain activity to be imaged.
The Hemodynamic Response

Neural pathway → Hemodynamics → MR scanner

Figure adapted from Chein & Schneider
Initial Findings

Amygdala

Cingulate Cortex

VTA

n=28, p<0.001 (uncorr.)

Ventral striatum

Substantia nigra

Amygdala
A. Dorsal striatum

B. Substantia nigra
A. Dorsal striatum

B. Substantia nigra
A. Dorsal striatum

B. Substantia nigra
A. Dorsal striatum

B. Substantia nigra
A. Dorsal striatum

B. Substantia nigra
A. Dorsal striatum

B. Substantia nigra
A. Dorsal striatum

B. Substantia nigra
A. Dorsal striatum

B. Substantia nigra

- Own baby face
- Unknown baby face

HAPPY | NEUTRAL | SAD
Attachment Theory

- Originally formulated by John Bowlby in 1969
- Innate biological system to ensure protection and reproduction
- Individual differences in attachment “security” are associated with maternal care and infant social/emotional development
Group Comparisons

- Comparison of 15 “secure” mothers and 15 “insecure/dismissing”
- No significant group differences were seen, with respect to:
  - Maternal SES, race, education or IQ
  - Self-reported parenting stress
  - Pre- or post-natal depression or psychopathology risk
  - Mother or infant temperament
  - Infant development at 14 months
  - Breastfeeding duration
Secure vs. Insecure/Dismissing

<table>
<thead>
<tr>
<th>SECURE</th>
<th>INSECURE / DISMISSING</th>
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<tbody>
<tr>
<td>Medial PFC</td>
<td>Dorsolateral PFC</td>
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<tr>
<td>Orbitofrontal cortex</td>
<td></td>
</tr>
<tr>
<td>Ventral striatum</td>
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Own Happy Faces: Secure vs. Insecure Attachment

Bilateral Ventral Striatum

Right Medial PFC

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<td>Ventral striatum</td>
<td>Dorsolateral PFC</td>
</tr>
<tr>
<td>Ventral striatum</td>
<td>Anterior insula</td>
</tr>
</tbody>
</table>
Own Sad Faces: Secure vs. Insecure Attachment

R Ventral Striatum

R Insula


Insula

y=17

(se=1.0, t=3.0, p=0.006)

Secure

Insecure/Dismissing

y=

(se=0.4, t=3.1, p=0.005)

Secure

Insecure/Dismissing
Change in peripheral oxytocin with mother-infant interaction

![Graph showing change in peripheral oxytocin](image)

- **Baseline**: Serum oxytocin (pg/ml)
- **Post "free play" interaction**: Serum oxytocin (pg/ml)
- **Post mirror-based interaction**: Serum oxytocin (pg/ml)
- **Baseline (Post-interaction)**: Serum oxytocin (pg/ml)

**Legend**
- Light green line with diamonds: Type B (Secure)
- Light purple line with circles: Type A (Insecure/Dismissing)

**Statistical Significance**
- *P < 0.05
- Mann-Whitney U
Own > Unknown Faces: Oxytocin Response

Hypothalamus/Pituitary Region

Oxytocin Response and Ventral Striatum Activation

Ventral Striatum activation

Marked, attuned non-imitative maternal vocalizations

**Type A**

\[ N = 15 \]

\[ \text{Mean Rank} = 13.50 \]
Marked, attuned non-imitative maternal vocalizations

![Graph showing adjusted frequency of attuned vocalizations for Type A and Type B with statistical analysis results]

- **Total N**: 39
- **Mann-Whitney U**: 82,500
- **Wilcoxon W**: 202,500
- **Test Statistic**: 82,500
- **Standard Error**: 33,990
- **Standardized Test Statistic**: -2.869
- **Asymptotic Sig. (2-sided test)**: .004
- **Exact Sig. (2-sided test)**: .004
Modified Still-Face
Intergenerational Transmission of Attachment

- Type B mothers
  - Have increased dopamine reward responses in the brain on seeing their infant’s face
  - Have increased oxytocin response on interacting with their infant
  - Are more attuned in their vocal communication with their infant
  - Are more likely to have Type B children
Intergenerational Transmission of Attachment

- Type A mothers
  - Have *decreased* dopamine reward responses in the brain on seeing their infant’s happy face
  - Have insula activation in response to their infant’s crying face
  - Have *less* oxytocin response on interacting with their infant
  - Are *less* attuned in their vocal communication with their infant
  - Are more likely to have Type C children
**Insecure/Dismissing Adult Attachment**

**Maternal Responses to Infant Cues**
1. **Brain**
   - Functional MRI
   - Eye gaze tracking
2. **Behavior**
   - Videotaped free play
   - Modified Still-Face paradigm

**Indirect Measures of Maternal Emotional Neglect**
- Reduced brain reward activation to infant faces
- Reduced eye gaze when viewing sad infant faces
- Reduced maternal sensitivity
- Reduced contingent responses to infant cues

**Future Directions: Exploring Emotional Neglect**

**RISK FOR EMOTIONAL NEGLECT**

**EFFECTS OF INTRANASAL OXYTOCIN**

- Dopamine and oxytocin
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