The Neurobiology of Maternal Addiction: 
What’s attachment got to do with it?

Dr. Lane Strathearn, MBBS FRACP PhD
Professor, Stead Family Department of Pediatrics, University of Iowa
Director, Division of Developmental and Behavioral Pediatrics, and the Center for Disabilities and Development, University of Iowa Stead Family Children’s Hospital

Pediatrics
Maternal care and addiction

- In 2011, 22.5 million (age 12+), 8.7% of the population, used illicit drug in the past month.

- Drug use is the highest among people in late teens and twenties.

- Almost 90% of substance-using women are of reproductive age.

- Maternal addiction is associated with a range of parenting difficulties.

US Department of Health and Human Services, 2012
Adverse Childhood Experience (ACE) Study

• Over 17,000 adults retrospectively report adverse childhood experiences, such as:
  - exposure to family substance abuse
  - child abuse and neglect
  - witnessing domestic violence, and
  - serious household dysfunction

• An ACE score, based on the number of adverse conditions experienced in childhood, was linked to current and past medical and psychiatric conditions
Adverse Childhood Experience (ACE) Study

• ACE score was progressively associated with an increased risk of:
  - coronary artery disease
  - chronic pulmonary disease
  - cancer
  - severe obesity
  - depression and anxiety
  - sexual promiscuity
  - perpetrating intimate partner violence
  - alcoholism
  - drug addiction
Adverse Childhood Experience (ACE) Study

• ACE score was progressively associated with an increased risk of:
  - coronary artery disease
  - chronic pulmonary disease
  - cancer
  - severe obesity
  - depression and anxiety
  - sexual promiscuity
  - perpetrating intimate partner violence
  - alcoholism
  - drug addiction
ACE Score predicts substance use risk

ACE Score predicts substance use risk. ACE Score

Alcoholic

Adjusted Odds Ratio

Felitti, 1998

University of Iowa
Stead Family
Children’s Hospital

Pediatrics
Mater-University of Queensland Study of Pregnancy (MUSP)

- 30-year longitudinal prenatal cohort study from Brisbane, Australia, from 1981
- Included 7223 mother-infant pairs
- Mothers and children followed at 6 months and 5, 14 and 21 years
- Outcomes linked to state-reported cases of child abuse and neglect
Mater-University of Queensland Study of Pregnancy (MUSP)

- **14-year follow-up**: 5158 (71%) evaluated
  - smoking: any or heavy use
  - alcohol: any or heavy use

- **21-year follow-up**: 3758 (52%) evaluated
  - cigarette use
  - early onset cannabis abuse and dependence
  - cannabis abuse and dependence at 21 years
  - injecting drug use
Neglect/emotional abuse predicts teenage alcohol use

Table 2 Odds ratios (OR) for alcohol use (ever drank a full glass of alcohol), and heavy alcohol use (five or more drinks in a session or three or more at least monthly) at 14-year follow-up.

<table>
<thead>
<tr>
<th></th>
<th>Unadjusted OR (95% CI)</th>
<th>Adjusted OR (95% CI)</th>
<th>Adjusted OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 5153)</td>
<td>(n = 5153)</td>
<td>(n = 5153)</td>
</tr>
<tr>
<td>Any alcohol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No reported maltreatment</td>
<td>1.62 (1.27, 2.06)</td>
<td>1.42 (1.10, 1.83)</td>
<td>1.13 (0.85, 1.50)</td>
</tr>
<tr>
<td>Any reported maltreatment</td>
<td></td>
<td>1.09 (0.45, 2.63)</td>
<td>1.11 (0.45, 2.71)</td>
</tr>
<tr>
<td>Physical abuse only</td>
<td>0.61 (0.24, 1.53)</td>
<td>0.52 (0.20, 1.33)</td>
<td>0.44 (0.16, 1.21)</td>
</tr>
<tr>
<td>Sexual abuse only</td>
<td>2.91 (1.89, 4.46)</td>
<td>2.38 (1.52, 3.74)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sexual + 1 or more other</td>
<td></td>
<td>1.60 (0.95, 2.68)</td>
<td>1.40 (0.82, 2.40)</td>
</tr>
<tr>
<td>Physical + neglect/emotional</td>
<td>1.48 (1.01, 2.19)</td>
<td>1.33 (0.89, 1.99)</td>
<td>1.05 (0.67, 1.65)</td>
</tr>
<tr>
<td>Heavy alcohol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No reported maltreatment</td>
<td>2.55 (1.80, 3.61)</td>
<td>1.95 (1.34, 2.84)</td>
<td>1.36 (0.89, 2.09)</td>
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<tr>
<td>Any reported maltreatment</td>
<td></td>
<td>0.65 (0.09, 4.76)</td>
<td>0.61 (0.08, 4.58)</td>
</tr>
<tr>
<td>Physical abuse only</td>
<td>1.91 (1.01, 3.58)</td>
<td>0.67 (0.16, 2.66)</td>
<td>1.00 (0.37, 2.70)</td>
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<tr>
<td>Physical + neglect/emotional</td>
<td>2.48 (1.45, 4.26)</td>
<td>1.34 (0.56, 3.24)</td>
<td>1.00 (0.37, 2.70)</td>
</tr>
</tbody>
</table>

*Adjusted for: family income, maternal alcohol use and maternal smoking (14-year follow-up); maternal education and marital status (prenatal); and race, age and gender. Additional adjustment for youth smoking (14-year follow-up). CI = confidence interval.

Mills, 2013
Neglect/emotional abuse predicts teenage smoking

<table>
<thead>
<tr>
<th>Table 3 Odds ratios (OR) for smoking (≥1 in past week, and heavy smoking (≥10 in week) at 14-year follow-up.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Unadjusted OR (95% CI)</strong> (n = 5154)</td>
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<tr>
<td><strong>Adjusted OR # (95% CI)</strong> (n = 5154)</td>
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<td><strong>Adjusted OR # (95% CI)</strong> (n = 5154)</td>
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<td>Any smoking</td>
</tr>
<tr>
<td>No reported maltreatment</td>
</tr>
<tr>
<td>1.00</td>
</tr>
<tr>
<td>Any reported maltreatment</td>
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<tr>
<td>2.63 (2.07, 3.35)</td>
</tr>
<tr>
<td>Physical abuse only</td>
</tr>
<tr>
<td>2.41 (1.09, 5.32)</td>
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<tr>
<td>Sexual abuse only</td>
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<tr>
<td>1.61 (0.75, 3.44)</td>
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<tr>
<td>Neglect/emotional abuse</td>
</tr>
<tr>
<td>3.89 (2.50, 6.06)</td>
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<tr>
<td>Sexual + 1 or more other</td>
</tr>
<tr>
<td>2.30 (1.36, 3.91)</td>
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<tr>
<td>Physical + neglect/emotional</td>
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<tr>
<td>2.54 (1.74, 3.71)</td>
</tr>
<tr>
<td>Heavy smoking</td>
</tr>
<tr>
<td>Any reported maltreatment</td>
</tr>
<tr>
<td>2.36 (1.61, 3.47)</td>
</tr>
<tr>
<td>Physical abuse only</td>
</tr>
<tr>
<td>3.00 (1.04, 8.65)</td>
</tr>
<tr>
<td>Neglect/emotional abuse</td>
</tr>
<tr>
<td>1.56 (1.54, 1.56)</td>
</tr>
<tr>
<td>Sexual + 1 or more other</td>
</tr>
<tr>
<td>3.50 (1.82, 6.74)</td>
</tr>
<tr>
<td>Physical + neglect/emotional</td>
</tr>
<tr>
<td>4.10 (2.59, 6.50)</td>
</tr>
</tbody>
</table>

*Adjusted for: family income, maternal alcohol use and maternal smoking (14-year follow-up); maternal education and marital status (prenatal); and race, age and gender. #Additional adjustment for any youth alcohol use (14-year follow-up). CI = confidence interval.

Mills, 2013
Neglect, emotional and physical abuse predict injecting drug use at 21 year old females

Binary and multivariable logistic regression associations of single and multiple types of substantiated childhood maltreatment and injecting drug use at 21-year follow-up, Brisbane, Australia.

<table>
<thead>
<tr>
<th>Childhood maltreatment</th>
<th>Group</th>
<th>Males (n = 1769)</th>
<th>Females (n = 1981)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Crude OR</td>
<td>Adjusted OR†</td>
</tr>
<tr>
<td>Physical abuse only</td>
<td>No</td>
<td>1.40 (0.18–11.05)</td>
<td>1.45 (0.18–11.96)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>3.22 (1.30–7.97) *</td>
<td>2.56 (0.99–6.58) *</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>3.09 (1.34–7.15) *</td>
<td>2.51 (1.05–5.98) *</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1.89 (0.66–5.48)</td>
<td>1.43 (0.48–4.23)</td>
</tr>
<tr>
<td>Emotional abuse only</td>
<td>Yes</td>
<td>2.38 (1.18–4.76) **</td>
<td>2.01 (0.98–4.11)</td>
</tr>
<tr>
<td>Sexual abuse + any other combination b</td>
<td>Yes</td>
<td>4.69 (0.49–45.52)</td>
<td>3.33 (0.32–35.18)</td>
</tr>
<tr>
<td>Physical abuse + emotional abuse or neglect</td>
<td>Yes</td>
<td>3.00 (1.12–8.01) **</td>
<td>2.22 (0.79–6.19)</td>
</tr>
<tr>
<td>Emotional abuse + any other combination d</td>
<td>Yes</td>
<td>3.05 (0.87–10.77)</td>
<td>2.18 (0.59–8.12)</td>
</tr>
</tbody>
</table>

*a Any combination of childhood maltreatment included neglect, sexual, physical or emotional abuse. Any other combination refers to: b neglect, physical or emotional abuse. c sexual or physical abuse; d neglect, sexual or physical abuse; and e sexual, physical or emotional abuse. † adjusted for receiving social security benefits, educational level, marital status at 21 years and paternal or maternal racial origin at pregnancy, maternal alcohol use at 3–6 months and chronic depressive symptoms from pregnancy to 3–6 months postpartum. * p < 0.05. ** p < 0.01. *** p < 0.001. **** p < 0.0001.

Abajobir et al. 2017

University of Iowa Stead Family Children’s Hospital
Neglect and physical abuse predict early onset of cannabis dependence

<table>
<thead>
<tr>
<th>Childhood maltreatment</th>
<th>Category</th>
<th>Unadjusted OR (95%CI)</th>
<th>Adjusted OR (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 3</td>
</tr>
<tr>
<td>Any maltreatment</td>
<td>No</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>4.21 (1.83-9.69)***</td>
<td>3.72 (1.59-8.75)**</td>
</tr>
<tr>
<td>Physical abuse</td>
<td>Yes</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>5.59 (1.89-16.54)**</td>
<td>4.86 (1.62-14.61)**</td>
</tr>
<tr>
<td>Emotional abuse</td>
<td>Yes</td>
<td>3.61 (1.07-12.19)*</td>
<td>3.16 (0.92-10.81)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>5.14 (1.49-17.69)***</td>
<td>4.54 (1.29-15.90)</td>
</tr>
</tbody>
</table>

Model 2: Model 1 + gender at birth, maternal age at pregnancy, maternal smoking at pregnancy and 6 months postpartum and family poverty over the first 5 years of age.
Model 3: Adjusted for Models 1 + 2 + educational level and marital status at 21 years.
Model 4: Adjusted for Models 1 + 2 + 3 + any substantiated childhood maltreatment excluding the variable of interest to avoid the effect of overlapping maltreatment.

\* p < 0.05;

\** p < 0.01;

\*** p < 0.001;

\**** p < 0.0001.

* Any childhood maltreatment included one or more combination of neglect, sexual, physical or emotional abuse.

Model did not adjust for other forms of childhood maltreatment.
ADVERSE CHILDHOOD EXPERIENCE

Increased susceptibility to addiction

Impaired maternal brain response and caregiving behavior
Possible Mechanisms

1. Cumulative exposures to stressful experiences

2. Latent effects of adversity during sensitive periods of development

What are the molecular and neuroendocrine mechanisms underlying these differences in addiction behavior outcomes?

Shonkoff et al, JAMA (2009)
Maternal Behavior in the Rat

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

Champagne, 2003
Frequency Distribution of Time Spent Licking/Grooming by Lactating Mothers

Champagne, 2003
EPIGENETIC MECHANISMS are affected by these factors and processes:

- Development (in utero, childhood)
- Environmental chemicals
- Drugs/Pharmaceuticals
- Aging
- Diet

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

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

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.

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

CHROMOSOME
DNA
CHROMATIN
METHYL GROUP
EPigenetic factor
HISTONE TAIL
Gene
DNA accessible, gene active
DNA inaccessible, gene inactive

University of Iowa Stead Family Children’s Hospital
Pediatrics
Epigenetic regulation of infant development – Two Examples

1. Stress Reactivity

2. Social Development
Epigenetic regulation of infant development – Stress Reactivity

- Offspring of High Licking/Grooming Rat Dams
  - \( \downarrow \) DNA methylation of glucocorticoid receptor (GR) promoter
  - \( \uparrow \) GR gene expression in the hippocampus
  - \( \uparrow \) regulation of HPA stress response (glucocorticoid release)
  - \( \downarrow \) stress/anxiety related behaviors

Epigenetic regulation of infant development – Social Development

- Offspring of High Licking/Grooming Rat Dams
  - DNA methylation of estrogen receptor-α (ERα) promoter
  - ERα gene expression in the MPOA
  - oxytocin receptor binding in the MPOA
  - maternal caregiving/social behaviors (licking/grooming, arched back nursing)

Champagne et al, Endocrinology (2006)
ADVERSE CHILDHOOD EXPERIENCE

**Positive Valence Systems**
Approach motivation & reward valuation

**Social Processes**
Affiliation, attachment & social communication

**Negative Valence Systems**
Loss or threat (stress)

Genes/Molecules/Cells

Circuits/Physiology

Behavior/Self-reports

CHILDHOOD NEGLECT

ABUSE AND TRAUMA

? - Increased susceptibility to addiction
ADVERSE CHILDHOOD EXPERIENCE

CHILDHOOD NEGLECT

- Altered DA rec expression and DA production
- Altered brain reward sensitivity (e.g. striatum)
- Sensation- or novelty-seeking; risk-taking behavior

Social Processes

- Altered OT rec expression and OT production
- Altered brain sensitivity to social cues (e.g. PFC)
- Social impairment, isolation and insecure attachment

Negative Valence Systems

- Altered GC rec expression and CRF production
- Altered amygdala activation and HPA stress response
- Anxiety, depression and trauma symptoms

Increased susceptibility to addiction

Impaired maternal brain response and caregiving behavior

RDoC categories

- Positive Valence Systems
  - Approach motivation & reward valuation
  - Dopamine (DA) System
- Social Processes
  - Affiliation, attachment & social communication
  - Oxytocin (OT) System
- Negative Valence Systems
  - Loss or threat (stress)
  - Glucocorticoid (GC) System

Genes/ Molecules/ Cells

- Circuits/ Physiology

Behavior/ Self-reports

University of Iowa Stead Family Children’s Hospital

Pediatrics
Neurobiology of addiction – and maternal care

SENSORY INPUT (e.g. child face/cry cues) → ? → MOTOR OUTPUT (e.g. addiction or caregiving behavior)
SENSORY INPUT
(e.g. child face/cry cues)

FOREBRAIN
“Frontal Cortex”

LIMBIC BRAIN
“Striatum”

MIDBRAIN
“Meso/Nigro…”

MOTOR OUTPUT
(e.g. addiction or caregiving behavior)
Neurobiology of addiction – and maternal care

SENSORY INPUT
(e.g. child face/cry cues)

VENTROMEDIAL PREFRONTAL CORTEX

VENTRAL STRIATUM

VENTRAL TEGMENTAL AREA

Mesocorticolimbic Dopamine Pathway:
“Reward”

MOTOR OUTPUT
(e.g. addiction or caregiving behavior)
Neurobiology of addiction – and maternal care

- **Mesocorticolimbic Dopamine Pathway:**
  - “Reward”

- **Nigrostriatal Dopamine Pathway:**
  - “Habit Formation”

**SENSORY INPUT**
(e.g. child face/cry cues)

**DORSOLATERAL PREFRONTAL CORTEX**

**DORSAL STRIATUM**

**VENTRAL TEGMENTAL AREA**

**VENTRAL STRIATUM**

**VENTROMEDIAL PREFRONTAL CORTEX**

**MOTOR OUTPUT**
(e.g. addiction or caregiving behavior)
Neurobiology of addiction – and maternal care

- **Nigrostriatal Dopamine Pathway:**
  - "Habit Formation"

- **Mesocorticolimbic Dopamine Pathway:**
  - "Reward"

- **Sensory Input** (e.g. child face/cry cues)
- **Hypothalamus**
- **Endogenous Oxytocin**
- **Motor Output** (e.g. addiction or caregiving behavior)
Neurobiology of addiction – and maternal care

SENSORY INPUT
(e.g. child face/cry cues)

HYPO-THALAMUS

ENDOGENOUS OXYTOCIN

VENTROMEDIAL PREFRONTAL CORTEX

AMYGDALA/INSULA

VENTRAL STRIATUM

+/-

VENTRAL TEGMENTAL AREA

Mesocorticolimbic Dopamine Pathway:
“Reward”

DORSOLATERAL PREFRONTAL CORTEX

DORSAL STRIATUM

+/-

SUBSTANTIA NIGRA

Nigrostriatal Dopamine Pathway:
“Habit Formation”

MOTOR OUTPUT
(e.g. addiction or caregiving behavior)
## Research Design

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>3rd trimester</td>
<td>7 mths</td>
<td>10 mths</td>
<td>14 mths</td>
</tr>
<tr>
<td>BIRTH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 min</td>
<td>5 min</td>
<td>6 min</td>
<td>20 min</td>
</tr>
<tr>
<td>Mother-infant separation 1</td>
<td>“Free play” interaction</td>
<td>Modified Still Face Procedure</td>
<td>Mother-infant separation 2</td>
</tr>
<tr>
<td></td>
<td>Blood draws</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Oxytocin</td>
<td></td>
<td></td>
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<tr>
<td>Adult Attachment Interview (DMM)</td>
<td></td>
<td></td>
<td>Functional MRI Scan</td>
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<tr>
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<td></td>
<td>Strange Situation Procedure</td>
</tr>
</tbody>
</table>

**Study Timeline**

**Data Collected**
Visit 1: Pregnancy

Visit 2: Videotaping

Visit 3: Scanning

Visit 4: Follow-Up

3rd trimester

7 mths

10 mths

14 mths

BIRTH

Mother-infant separation 1

“Free play” interaction

Modified Still Face Procedure

Mother-infant separation 2

Blood draws

• Oxytocin

Adult Attachment Interview (DMM)

Functional MRI Scan

Strange Situation Procedure

Study Timeline

Data Collected

ADULT ATTACHMENT

Pediatrics
Visit 2: Videotaping

Visit 1: Pregnancy
- 3rd trimester

Visit 2: Videotaping
- 7 mths
  - Mother-infant separation 1
  - 20 min
  - "Free play" interaction
  - 5 min
  - Modified Still Face Procedure
  - 6 min
  - Blood draws
  - Oxytocin
  - 20 min

Visit 3: Scanning
- 10 mths
- Functional MRI Scan

Visit 4: Follow-Up
- 14 mths
- Strange Situation Procedure

Study Timeline
- BIRTH

Data Collected
- Adult Attachment Interview (DMM)

ADULT ATTACHMENT
Visit 3: Scanning

Study Timeline

Data Collected

ADULT ATTACHMENT ➔ BRAIN / HORMONE / BEHAVIOR

Visit 1: Pregnancy

3rd trimester

Visit 2: Videotaping

7 mths

Visit 3: Scanning

10 mths

Visit 4: Follow-Up

14 mths

Adult Attachment Interview (DMM)

Blood draws
• Oxytocin

Mother-infant separation 1

“Free play” interaction

Modified Still Face Procedure

Mother-infant separation 2

Functional MRI Scan

Strange Situation Procedure
Visit 4: Follow-Up

**Study Timeline**

- **Visit 1:** Pregnancy
  - 3rd trimester
  - BIRTH

- **Visit 2:** Videotaping
  - 7 mths
  - 20 min: Mother-infant separation 1
  - 5 min: "Free play" interaction
  - 6 min: Modified Still Face Procedure

- **Visit 3:** Scanning
  - 10 mths
  - 20 min: Mother-infant separation 2
  - Functional MRI Scan

- **Visit 4:** Follow-Up
  - 14 mths
  - Strange Situation Procedure

**Data Collected**

- Adult Attachment Interview (DMM)
- Blood draws
  - Oxytocin

**Study Areas**

- ADULT ATTACHMENT
- BRAIN / HORMONE / BEHAVIOR
- INFANT ATTACHMENT

**References**

STIMULUS TYPES | IDENTITY
--- | ---
AFFECT Happy Face | Own Infant (OH) | Unknown Infant (UH)
AFFECT Sad Face | Own Infant (OS) | Unknown Infant (US)

2 sec

4-14 sec random inter-stimulus interval

Identity:
- Own: Happy Face (OH)
- Unknown: Happy Face (UH)
- Unknown: Sad Face (US)
- Own: Happy Face (OH)
- Own: Sad Face (OS)
Own Happy Faces: Secure vs. Insecure

VENTRAL STRIATUM

VENTROMEDIAL PREFRONTAL CORTEX

Strathearn et al. Neuropsychopharmacology (2009)
Own **Sad** Faces: Secure vs. Dismissing

Strathearn et al. *Neuropsychopharmacology* (2009)
Change in peripheral oxytocin with mother-infant interaction

![Graph showing the change in peripheral oxytocin with母亲-婴儿互动](image-url)
A

Strathearn et al. Neuropsychopharmacology (2009)

B

OXYTOCIN REGION

Brain Activation (beta weights)

HYPO-THALAMUS

VENTRAL STRIATUM

DOPAMINE REGION

Brain Activation (beta weights)

Change in Oxytocin (%)
Neurobiology of addiction – and maternal care

SENSORY INPUT (e.g. child face/cry cues)

HYPO-THALAMUS

ENDOGENOUS OXYTOCIN

VENTROMEDIAL PREFRONTAL CORTEX

VENTRAL STRIATUM

ANTERIOR MEDIAL STriosomal AReA

AMYGDALA/INSULA

DORSOLATERAL PREFRONTAL CORTEX

DORSAL STRIATUM

SUBSTANTIA NIGRA

MOTOR OUTPUT (e.g. addiction or caregiving behavior)

Mesocorticolimbic Dopamine Pathway: “Reward”

Nigrostriatal Dopamine Pathway: “Habit Formation”
In Summary

• Mothers with secure attachment
  - Increased dopamine reward responses in the brain on seeing their infant’s face
  - Increased oxytocin response on interacting with their infant

• Mothers with dismissing attachment
  - Greater activation of pain/disgust and cognitive processing regions of the brain

• Oxytocin response correlated with activation of brain reward and oxytocin-producing regions
Unresolved trauma in mothers

• Includes occurrences of childhood abuse, neglect, or death of a parent

• Current discourse from Adult Attachment Interview indicates that the trauma has not been adequately processed, and continues to interfere with current functioning
Amygdala activation to infant distress in mothers with unresolved trauma (DMM-AAI)

Kim et al. Social Neuroscience (2014)
Unresolved trauma in mothers

98% of study mothers with addiction problems also had unresolved childhood trauma (vs. 67% of control group; p<0.001)
Mothers without addiction problems (n=36)

Mothers with addiction problems (n=39)

Where to from here?

- Randomized controlled trial of intranasal oxytocin
  - Mothers with addictions vs. control mothers
  - Oxytocin vs. placebo
Nigrostriatal Dopamine Pathway: “Habit Formation”

Mesocorticolimbic Dopamine Pathway: “Reward”

INTRANASAL OXYTOCIN

SENSORY INPUT (e.g. child face/cry cues)

HYPO-THALAMUS

ENDOGENOUS OXYTOCIN

VENTRAL STRIATUM

DORSAL STRIATUM

AMYGDALA/INSULA

VENTRAL TEgmentAL AREA

DORSOLATERAL PREFRONTAL CORTEX

DORSAL STRIATUM

Ventricular PREFRONtal Cortex

MOTOR OUTPUT (e.g. caregiving behavior)
Attachment and Neurodevelopment Lab

- Attachment and Neurodevelopment Lab members, University of Iowa
  - Carol Mertens, Research Coordinator
  - Guifeng Xu, Graduate Research Student
  - Purva Rajhans, Post-doctoral Fellow

- Sohye Kim, Baylor College of Medicine/University of Massachusetts
- Peter Fonagy, University College London
- Collaborators at Yale Child Study Center: Linda Mayes, Helena Rutherford, Marc Potenza
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