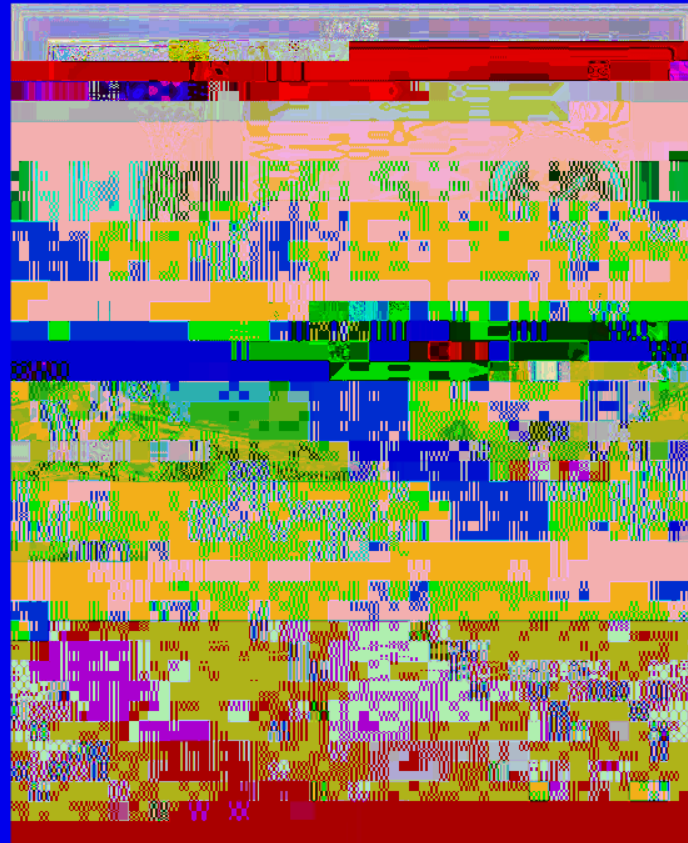


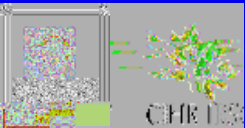
Conflict of Interest Disclosure: nothing to disclose



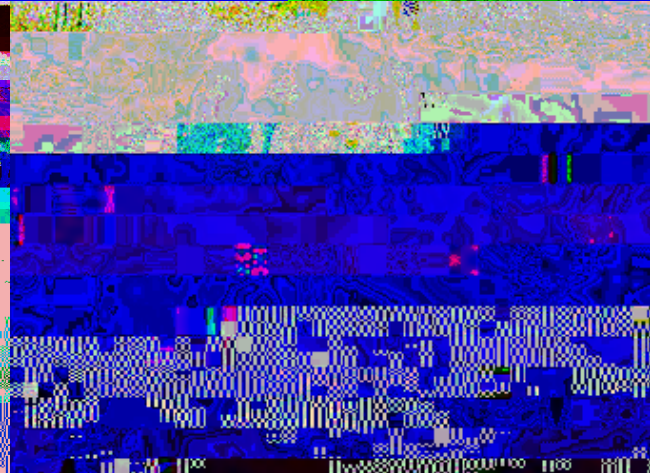
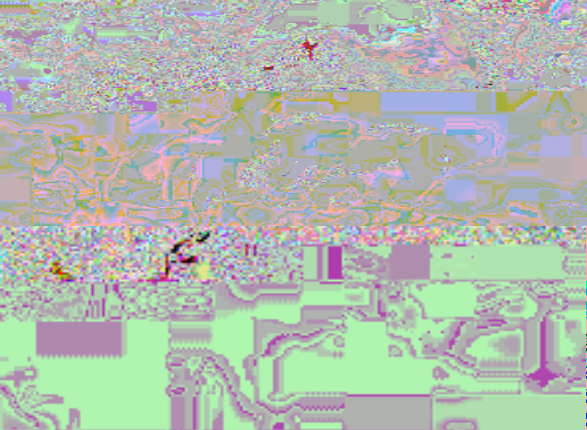
Origins of mothering: role of affect, executive function, and the brain in its regulation

Alison S. Fleming, students and colleagues

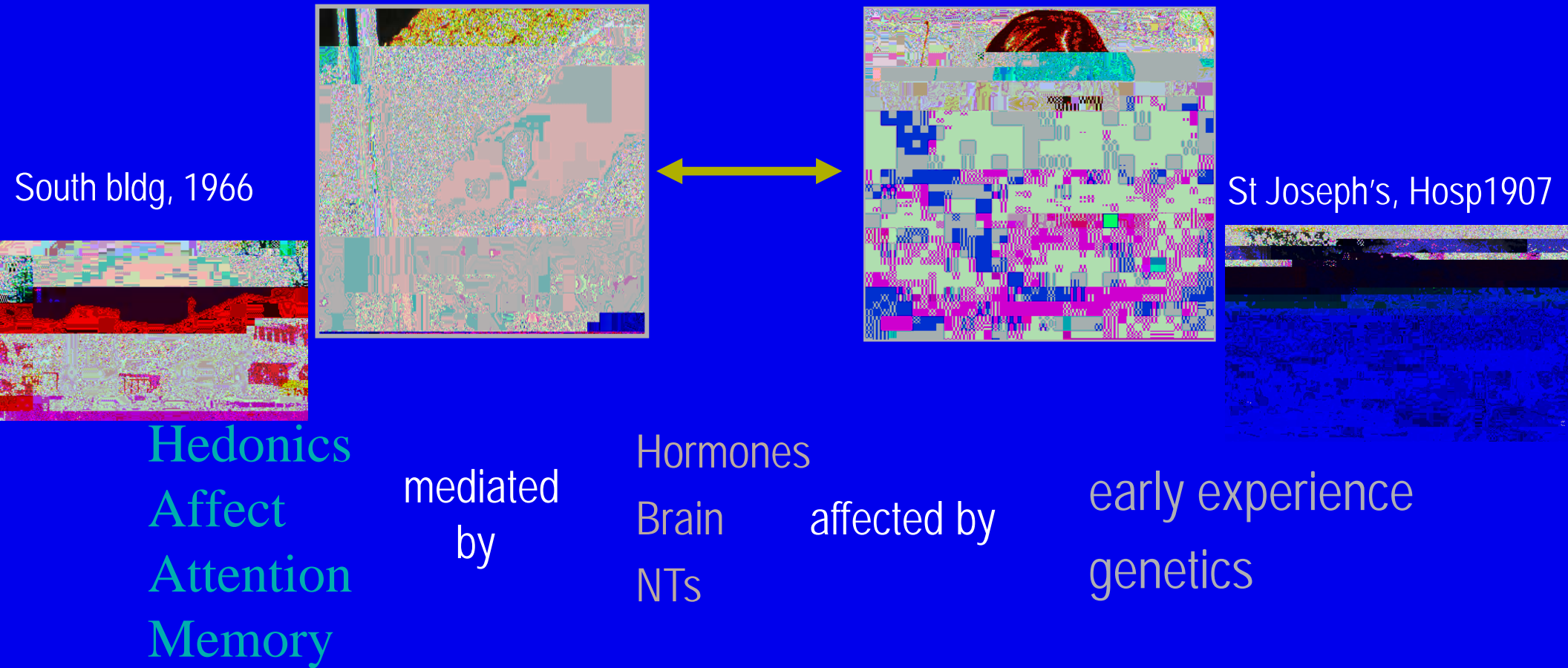
Psychology , UTM &
Institute for Human Development
University of Toronto



SSIRG CASH



Maternal Behaviour: Human and Animal Models



Today's task is to describe maternal behavior in terms of psychological components and-if time permits- their underlying neural mechanisms

- ONSET OF MB

- stimulus salience, 'reward'

- Affect

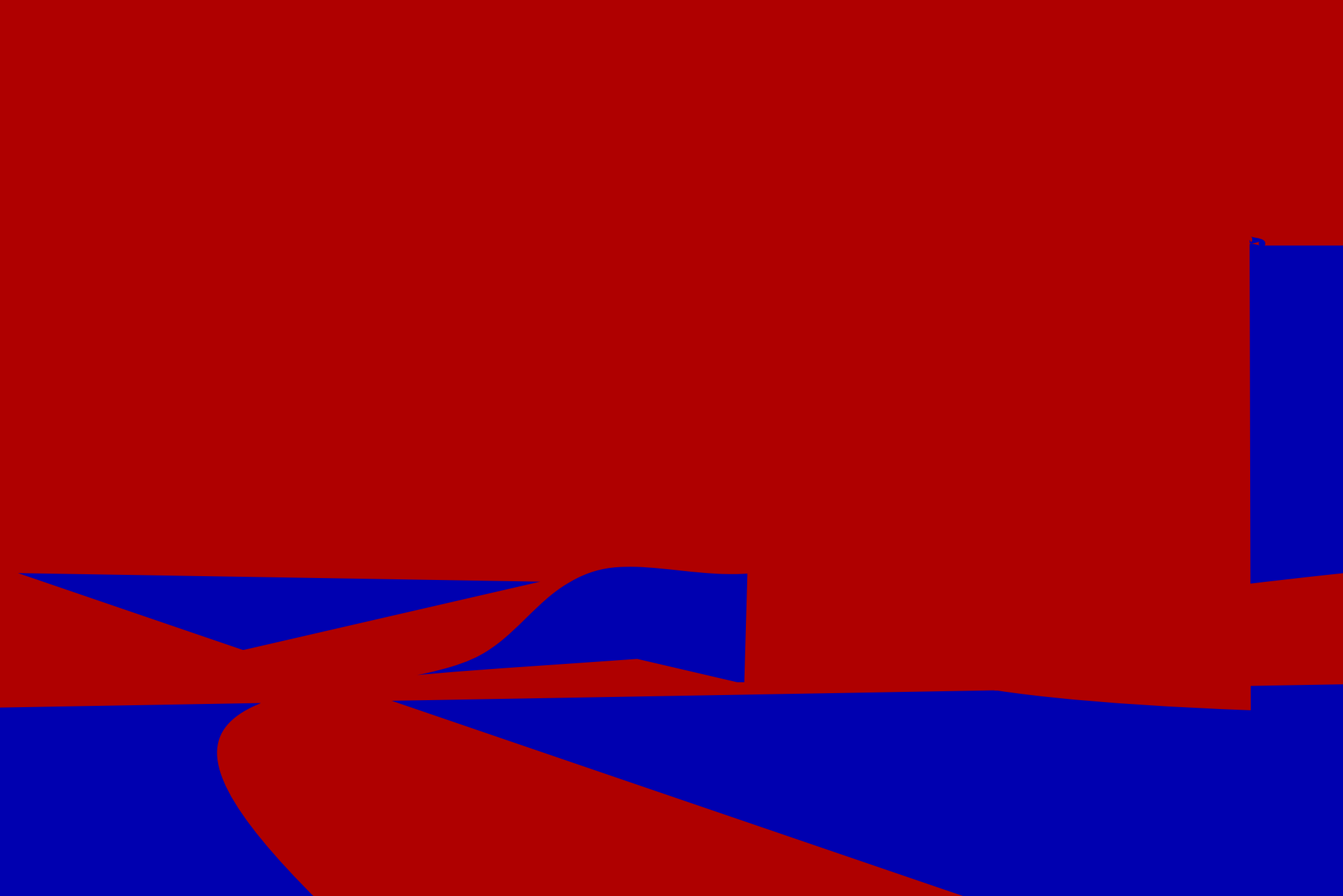
- *Nucleus accumbens (NAcc)*

- *Amygdala*

- ONGOING QUALITY OF MB

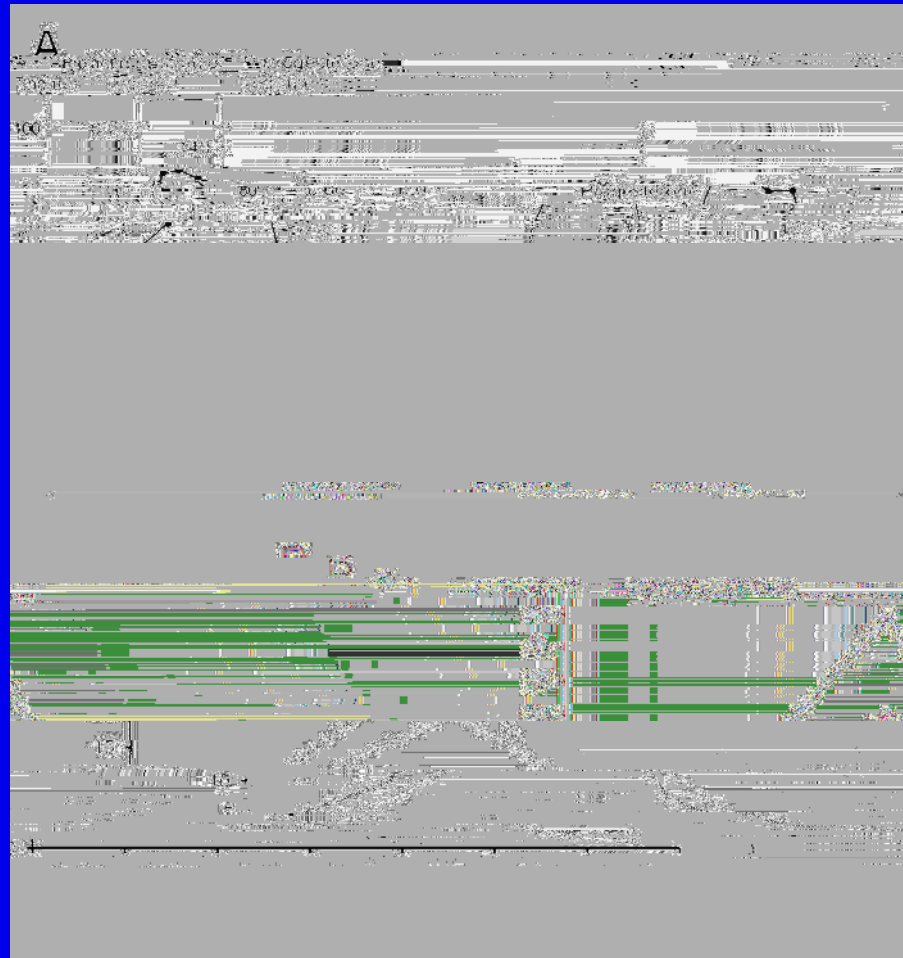
- attention, response inhibition, memory

- *Medial prefrontal cortex (mPFC)*



HORMONES: Changes in the estrogen /progesterone ratio during pregnancy associated with onset of PP maternal behavior (rats) and early attachment attitudes (human)

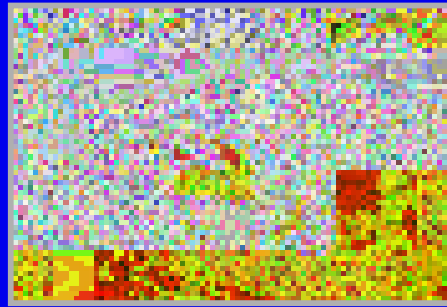
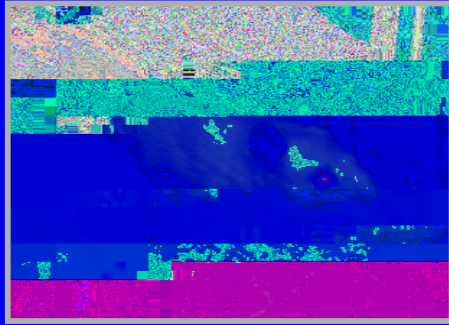
In rats and humans
Prolactin,
Oxytocin, and
Glucocorticoids also
Associated with an
Enhancement of
mothering



•RAT



- We believe that these hormonal changes affect mothers' maternal behavior by affecting brain systems and neurotransmitters related to
 - Affect
 - Stimulus salience
 - Reward
 - Attention/executive function
 - Memory



Background for today's talk derives from 40+ years of work on the psychobiology of maternal behavior in rat (YIKES!!)

Let me now describe some of the relevant work to lay the groundwork for the human studies that constitute the focus of the rest of the talk

Virgin females are 'timid' (neophobic) in general and normally avoid pups

Hormones and pup exposure shift mothers' affect and mothers do not avoid young

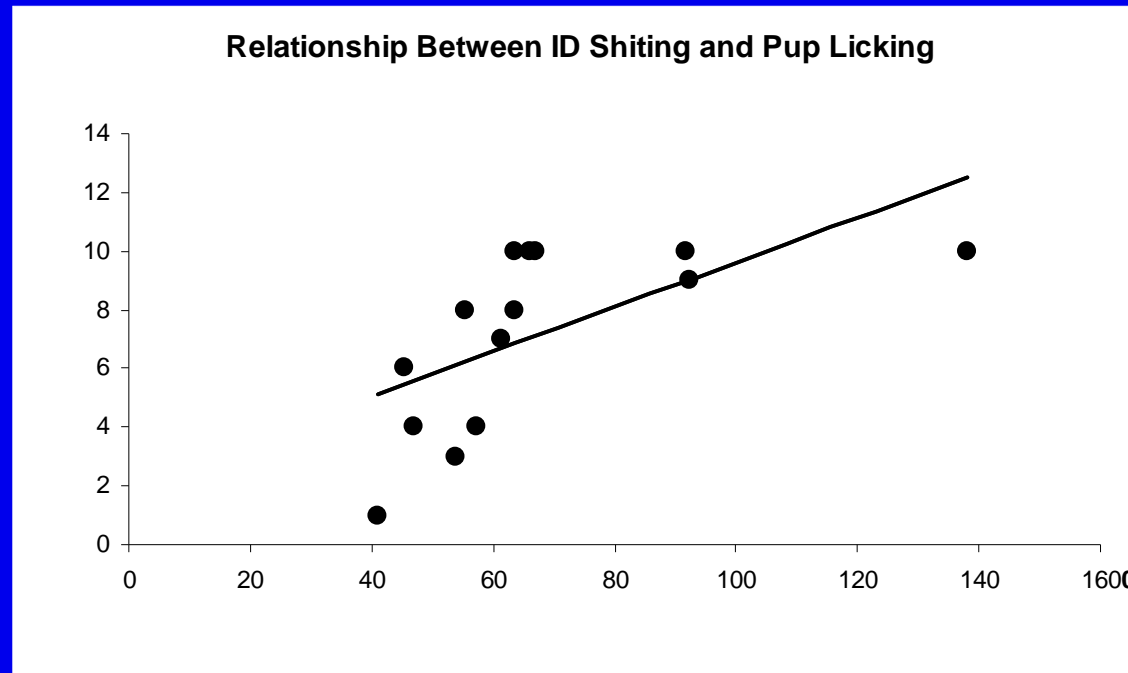
Pups have salience for the new mother

- Among rats and other mammalian mothers, new mother rats are attracted to the odours and ultrasonic vocalizations of newborn rat pups, whereas virgin non-mothers are not.
- Salience enhanced by
 - Hormones
 - Prior maternal experience
 - Early rearing experience

Mothers lick, retrieve, build nests and and forage for food . Normal execution of these behaviors and their sequential nature requires that mothers have good executive functions: that they can pay attention, easily shift attention, show good working memory, are not impulsive, and so on.

but one example,

- In new mother rats there is a strong positive correlation between attentional performance on a set shifting task and licking behavior..(Lovic & Fleming, 2004)



Early adversity (in rat, early social isolation rearing) disrupts later maternal behavior, affect, and executive function: replacement lick-like stroking reverses these effects

- mothers who are reared apart from their own mothers and siblings grow up to show
 - reduced licking and crouching (motivation is present, intensity is reduced)
 - Greater ‘anxiety’, reduced attraction to infant cues, reduced attention, increased impulsivity, and reduced social learning



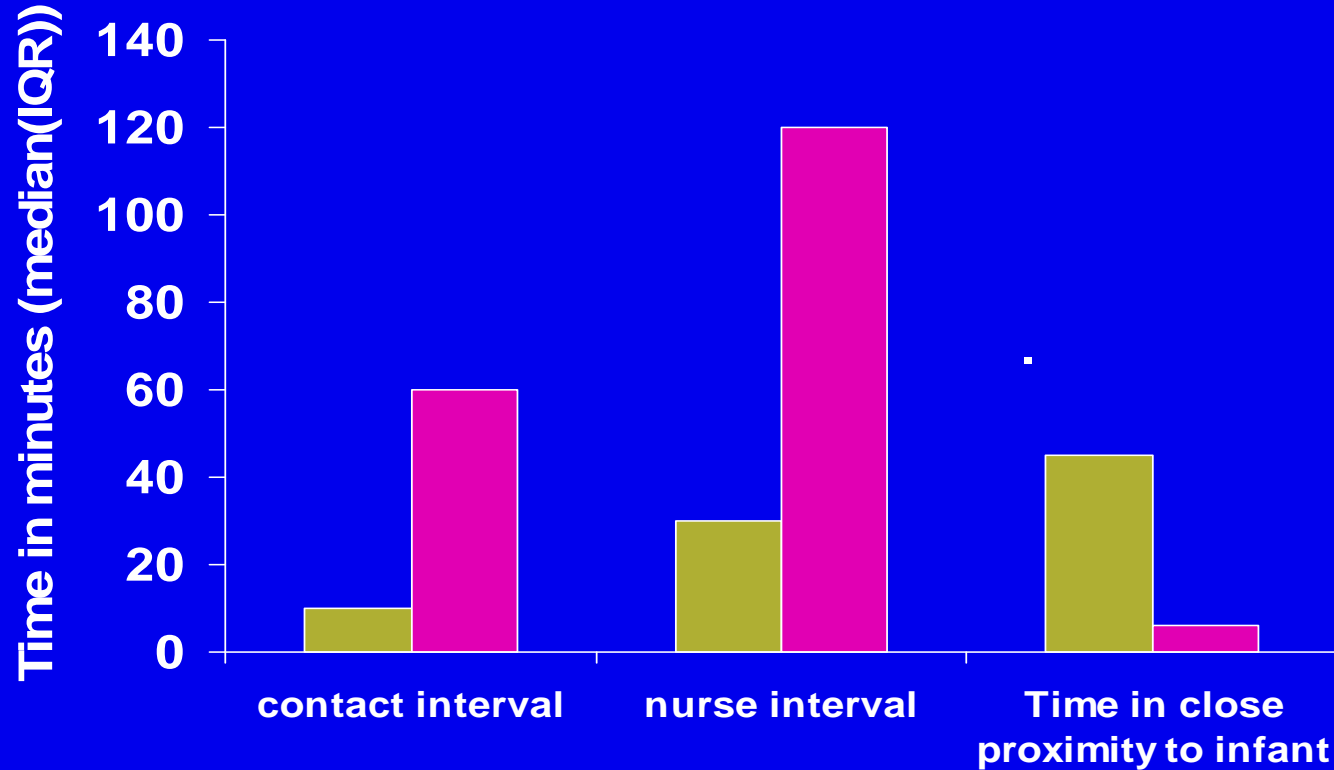
SUMMMARY OF THE RAT WORK

- to understand behavioral processes that underlie mothering, the female undergoes a change that involves
 - Reducing natural withdrawal tendencies
 - Becoming attracted to young that act as ‘rewards’
 - Becoming more attentive, less impulsive, with good working memory
- AND, as we will see later, specific brain systems are involved in regulating these processes and are affected by early experiences

To what extent do similar processes apply to human mothers?

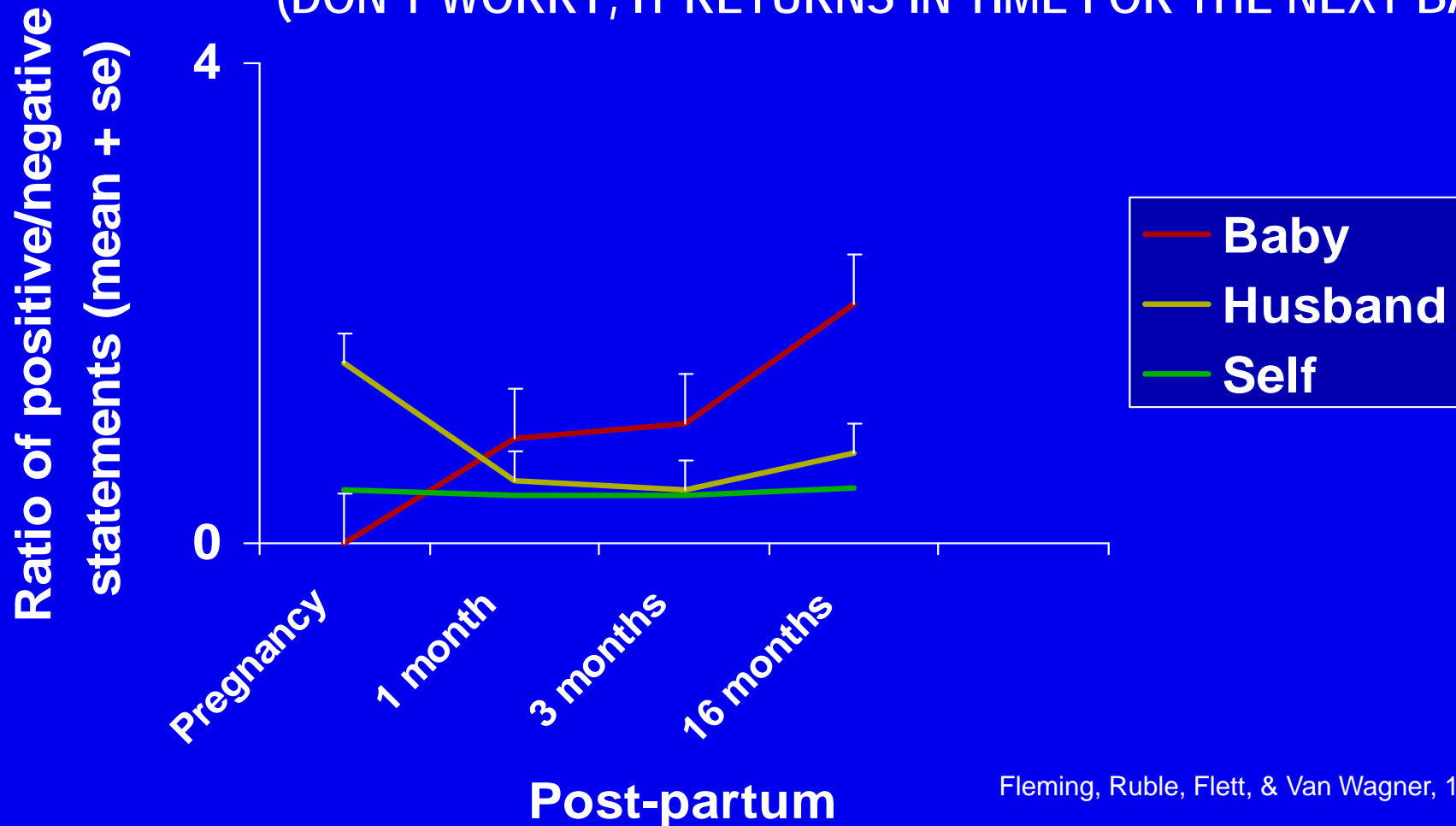
Human Studies

Mothers with More Postpartum Experience tend to also Find Infant Odors to be More Attractive



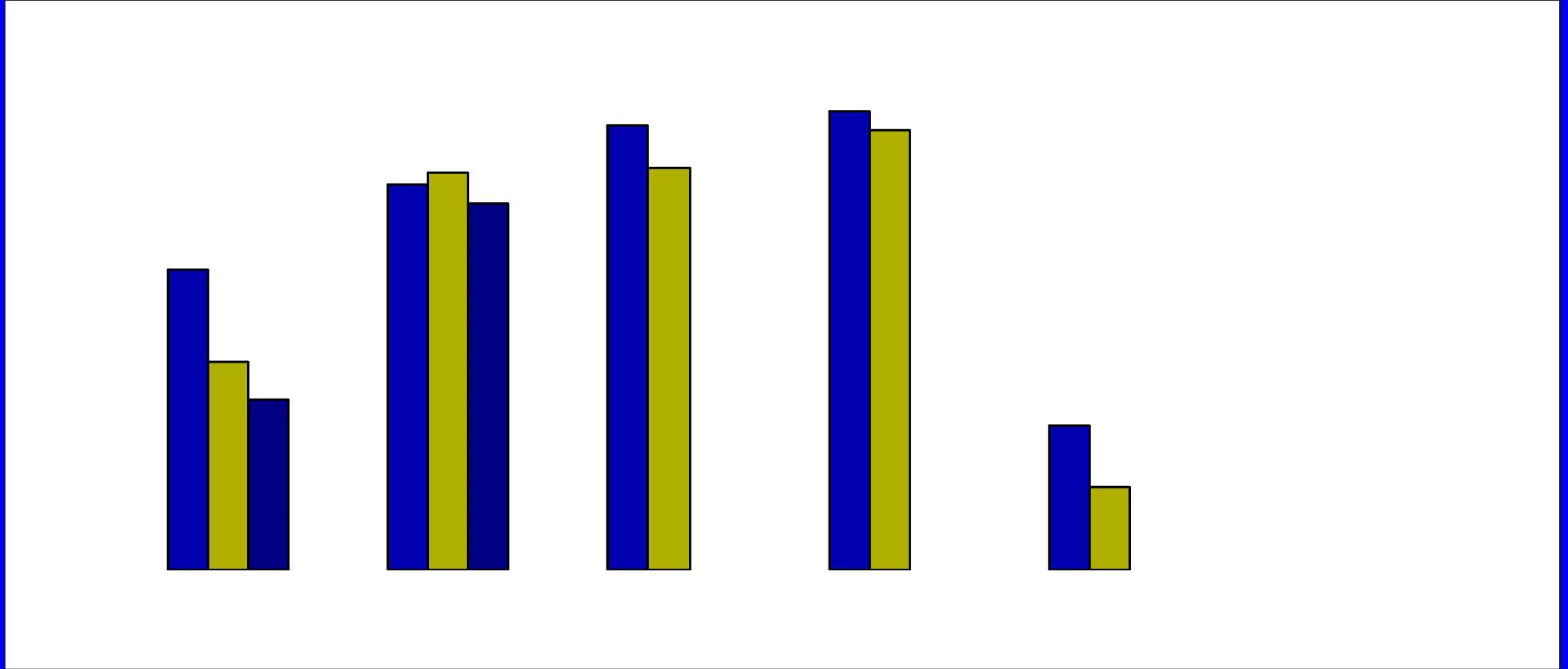


With Postpartum Experience New Mothers Become Increasingly More Positive About the Baby- and less positive about their partners
(DON'T WORRY, IT RETURNS IN TIME FOR THE NEXT BABY)



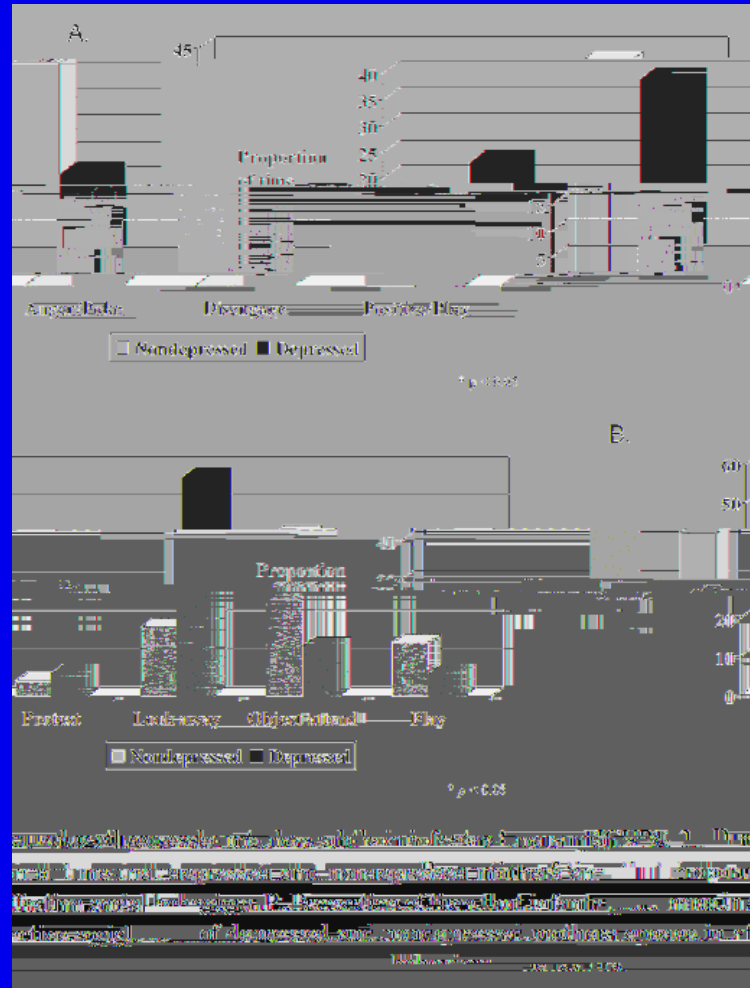
Depressed Mothers at 4-6 mo PP engage in less tactile affection with their babies and play with toys less than non depressed amothers

Depressed Mothers Are More Anxious and Negative when Listening to Pain Cries Compared to Non-Depressed Mothers

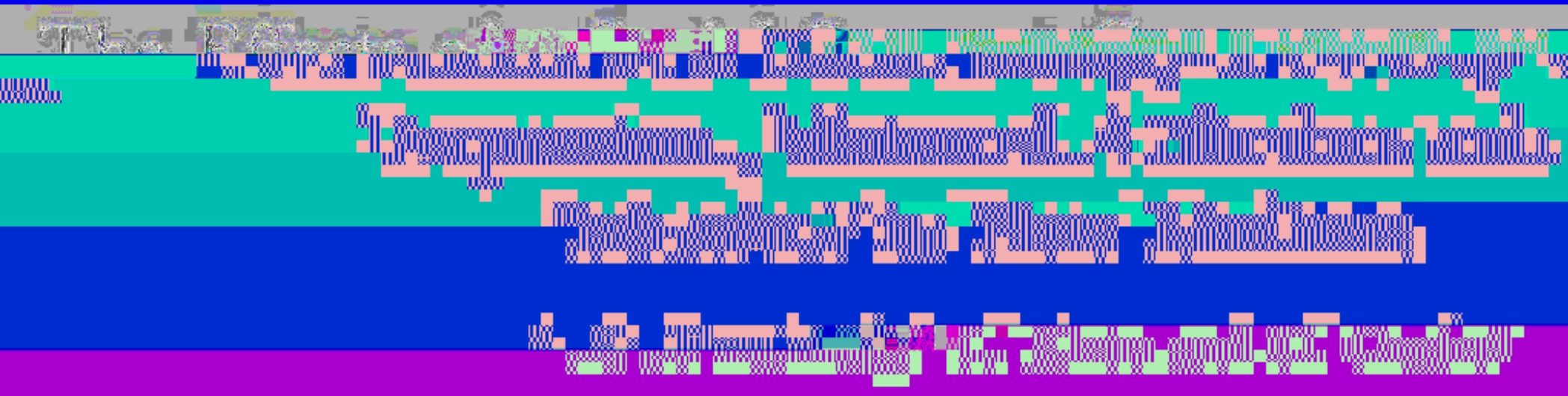


New mothers experiencing negative affect post partum who are less maternally responsive have infants who are disengage more

Affect



Tronick & Reck, 2009



JCPP, 33, 1992

Attention, executive function, and maternal behavior

- Once maternal, the new mother interacts with her baby, engaging in many affectionate and instrumental behaviors.

Normal execution of these behaviors and their sequential and contingent nature requires

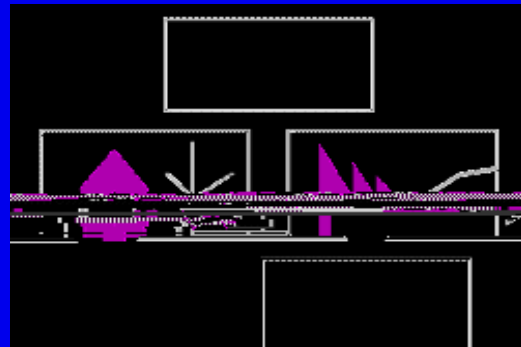
*Maternal Behaviour is related to
Executive Function:*

*More sensitive mothers also showed greater
attentional flexibility and scored better on the
spatial working memory tasks*

- Maternal sensitivity & attentional flexibility
(ED errors): $r = .26^*$
- Maternal Sensitivity & spatial working memory:
 $r = .39^*$

Mothers who Show Reduced Attention or SPW (on CANTAB: Set-Shifting Task) also Show Reduced Maternal Sensitivity

Attention
ED Shift on CANTAB



-.25

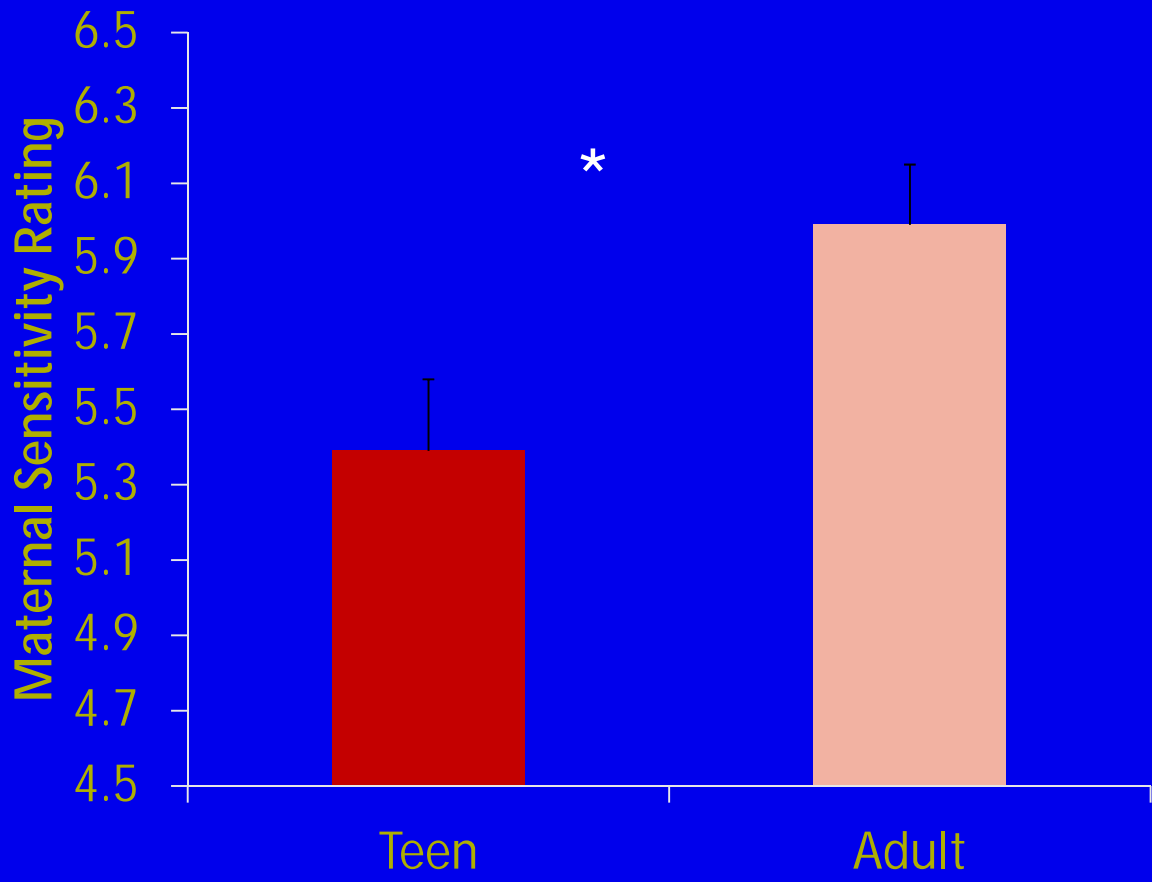


Ainsworth
Sensitivity
Rating Scales

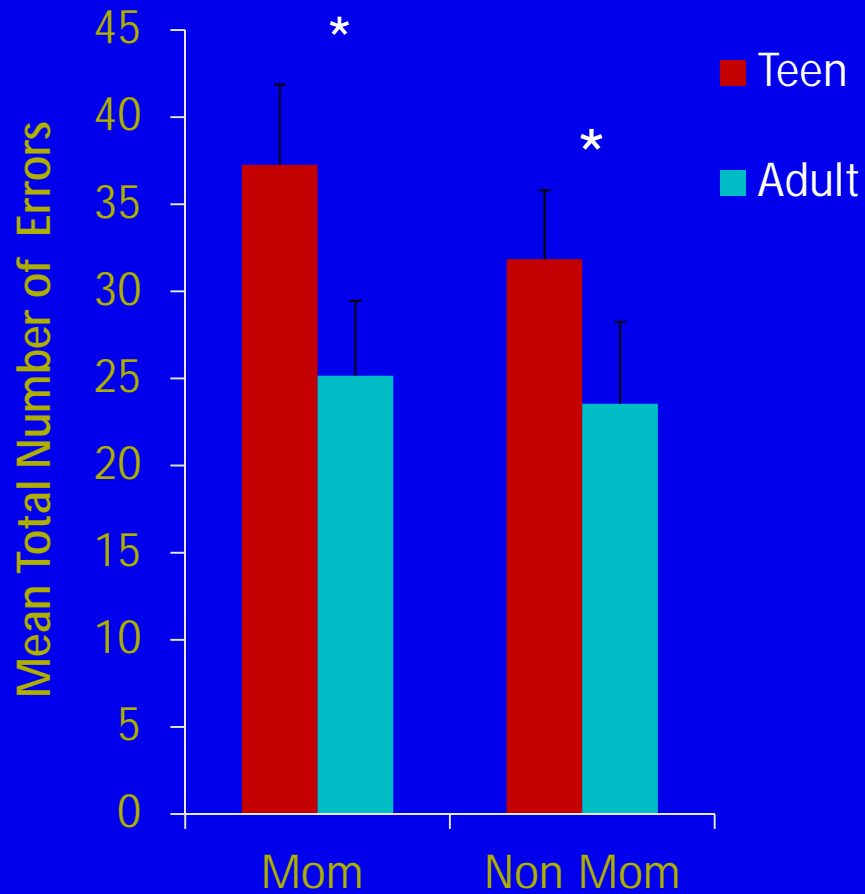




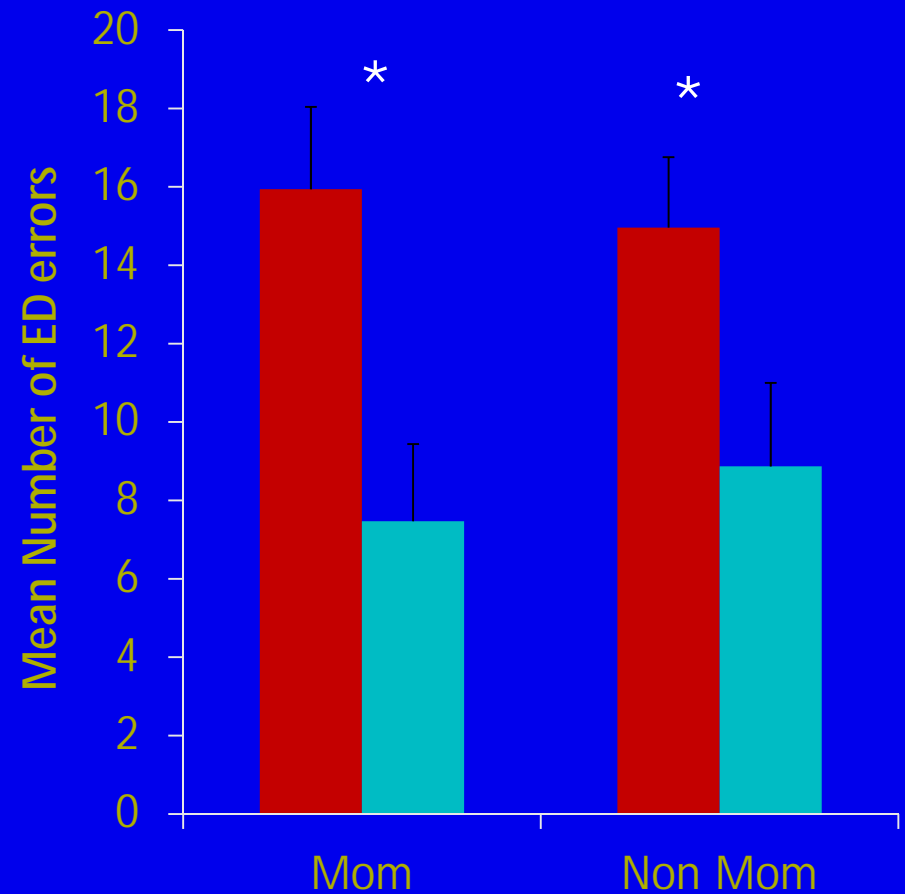
Teens exhibit less maternal sensitivity than adults during interactions with their infants



Teens have poorer attentional flexibility than adults, independent of maternal status



Teen vs. adult $F(1, 113) = 4.44, p < .05$



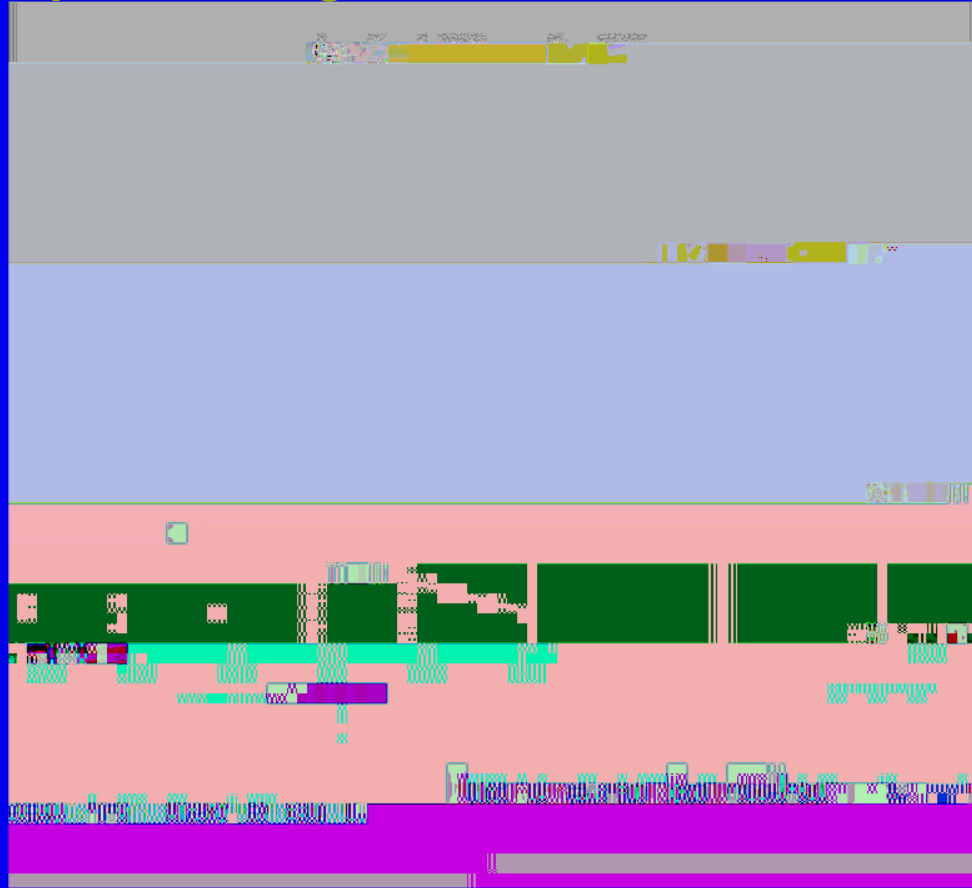
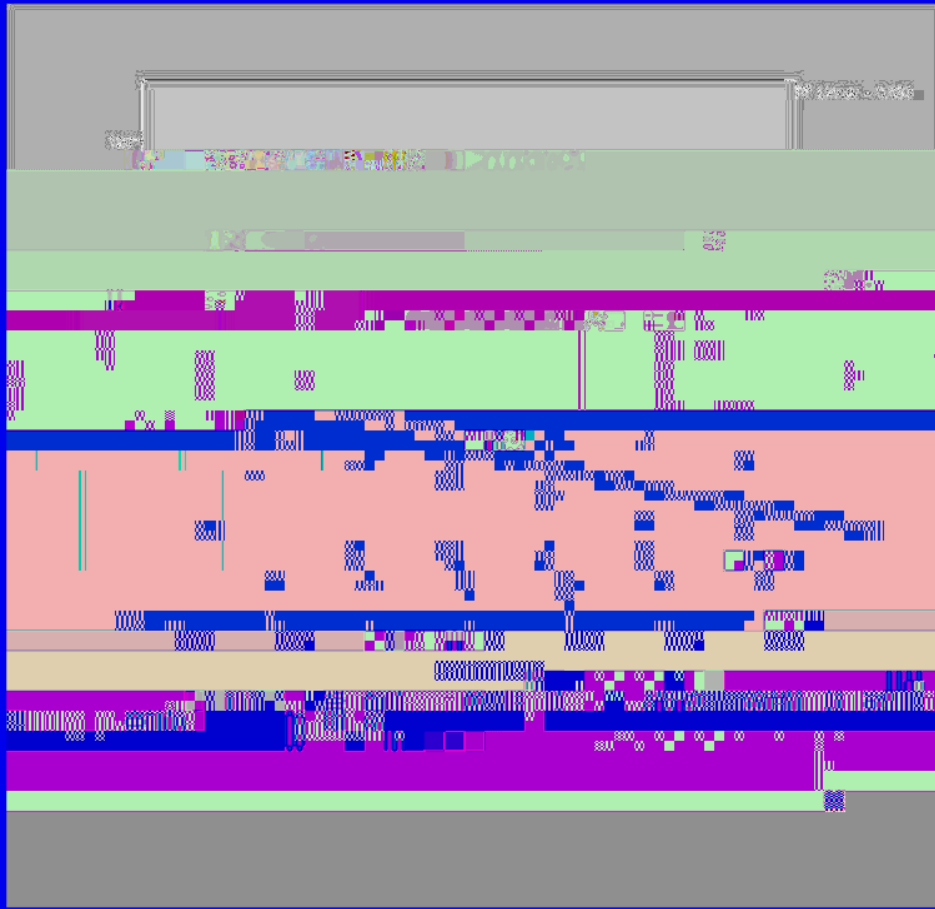
$F(1, 113) = 10.38, p < .02$

Teens perform less well on the

Teen vs. Adult: $F(1, 107) = 5.60, p < .05$



In teenagers, higher maternal sensitivity is related to reduced attentional errors and reduced impulsivity



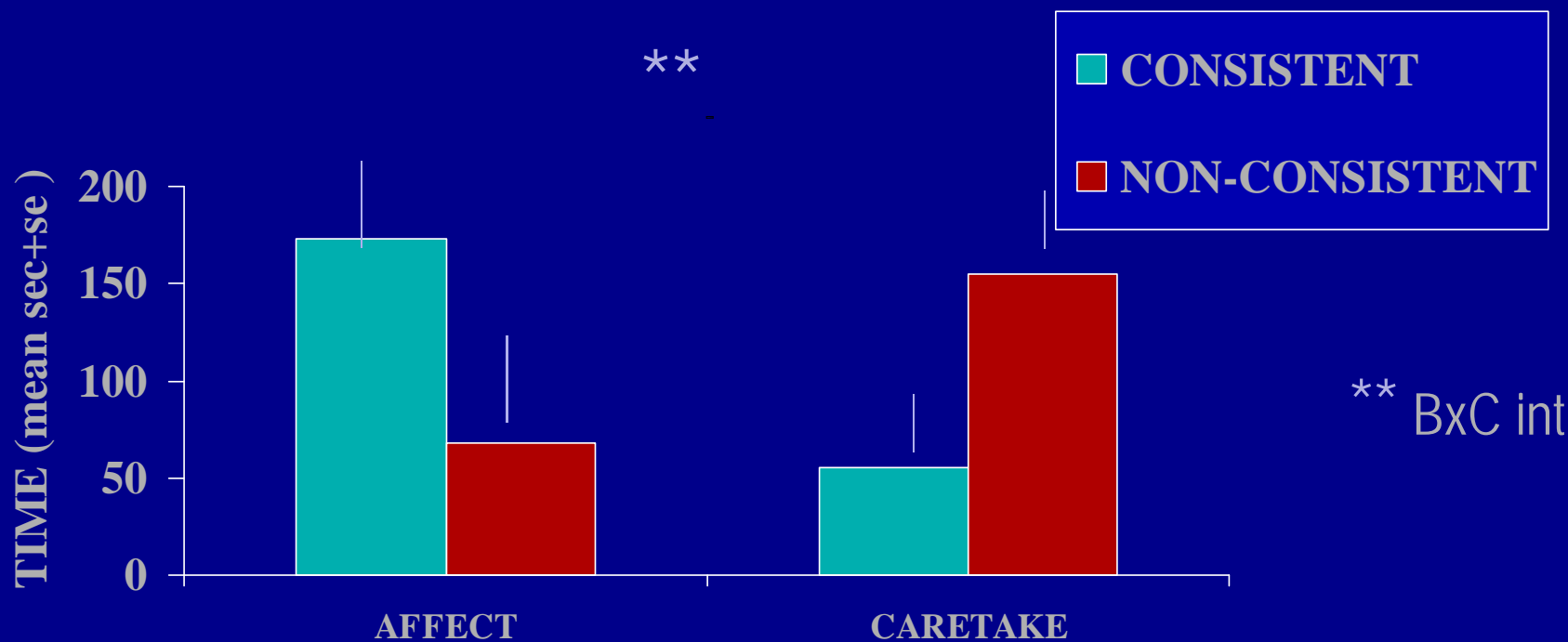
Chico et al., in prep

How do early experiences in family of origin affect maternal behavior and sensitivity at 6 months postpartum?



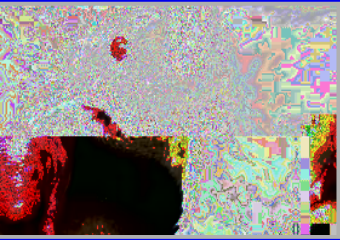
Early experiences affect mothering

In humans, mothers who grew up in a more adverse early environment show reduced Affectionate Touching and more Instrumental Touching with their Infants; They also attend less to their infants
Effects strongest in First time mothers and in Teen mothers



What is the role of brain in regulating mothering behavior and the associated processes of reward, affect, and attention?

NEURONATOMY: Hormones and Experience act on Multiple systems that



Amygdala: Affect

Fleming et al., 1980a,b; 1994, 1999a,b; Li et al., 2003a,b; Numan et al., 2006

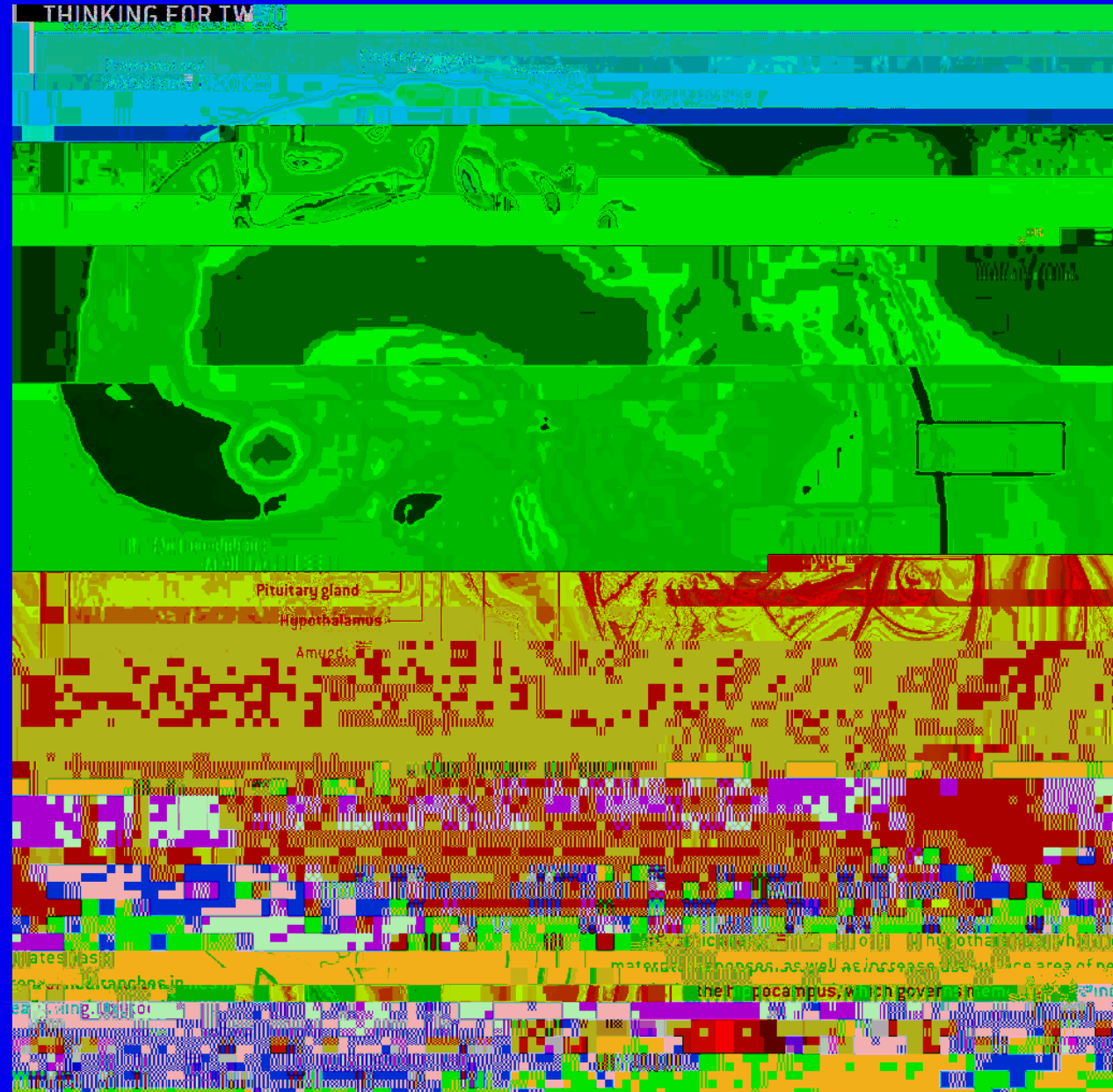


Medial prefrontal cortex: attention, flexibility, working memory

What is the role of the human brain in regulating mothering behavior and the associated processes of reward, affect, and attention?

Similar systems in
the human brain
have been related to
mothering

See Barrett & Fleming, 2011;
Kinsley & Lambert, 2009



BRAIN REGIONS THOUGHT TO BE INVOLVED IN HUMAN MATERNAL BEHAVIOR

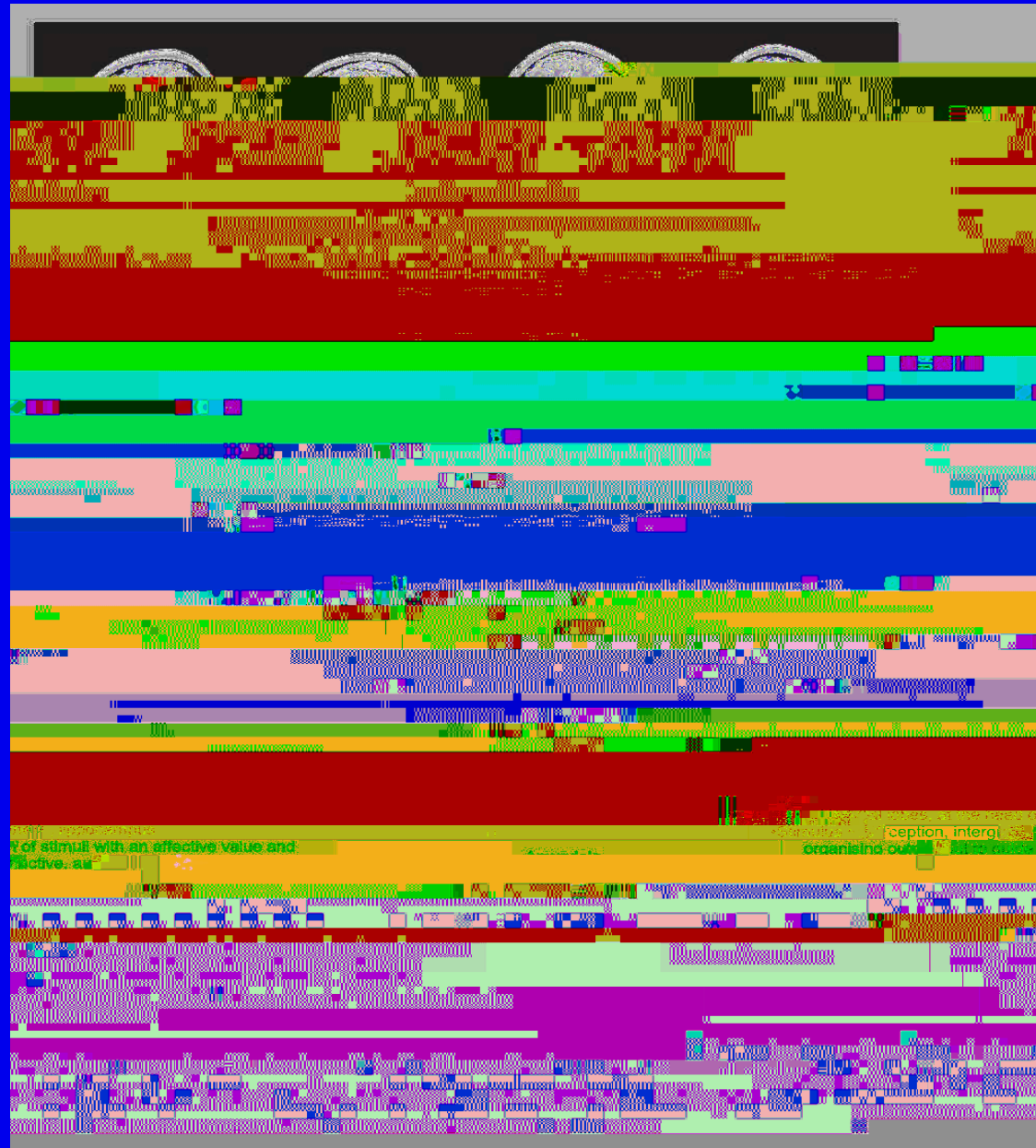
Are also thought to mediate processes of stimulus salience, reward, affect, and cognition

PREFRONTAL
CORTEX

HYPOTHAL

AMYGDALA

NUCLEUS
ACCUMBENS





Have embarked on a series of fMRI studies exploring activation patterns in
NAC, AMYG, mPFC,
and
other brain sites in the maternal circuit

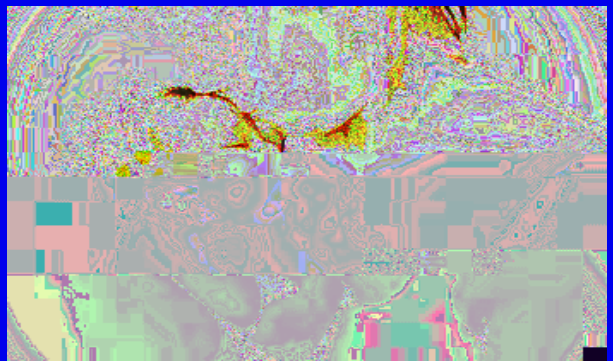
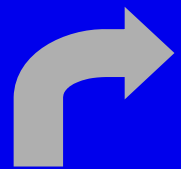
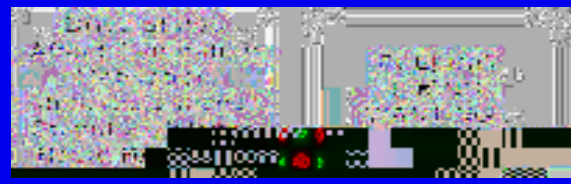
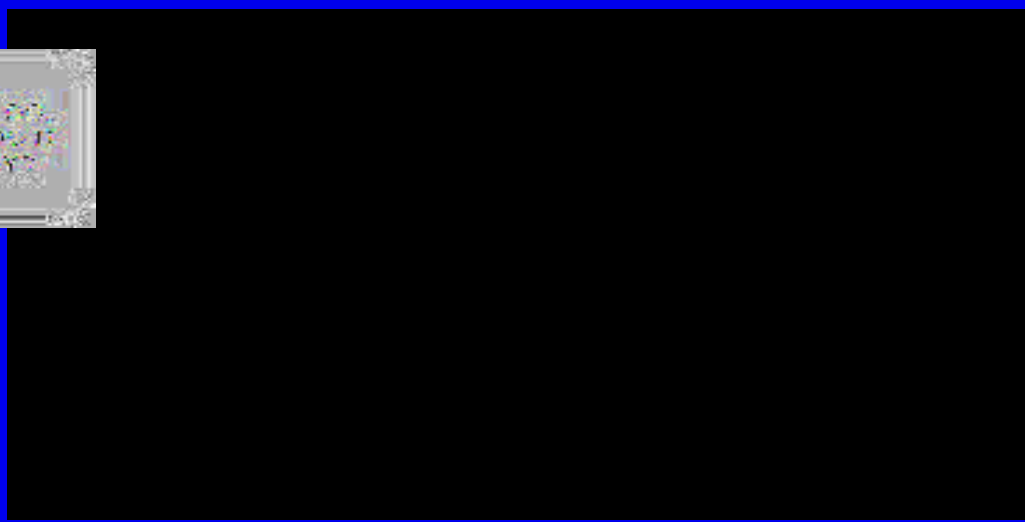
Study: Maternal affect and quality of parenting experiences are related to amygdala response to infant faces (barrett et al., in press)

Using a whole brain analysis and an ROI approach, we examined mothers' pattern of brain response to visual infant cues varying in emotional valence, familiarity, and as a function of mothers' early life experiences.



Attention Control
Executive Control
Task Disruption
Affect Regulation
Integration
Empathy

EMOTIONAL
REGULATION
AND CBXT



fMRI Study: Brain response to infant stimuli in new mothers

@3 months

Recruit on maternity ward:

- Moms age 20-40
- Healthy singleton
- No history of DEP
- No involvement of child services

@ 1-2 weeks

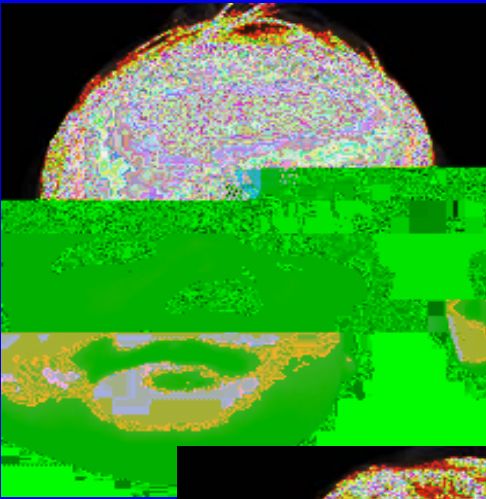
Session 1:

1. Photography Session
-positive and negative facial expressions
2. Intake and SCID screening

Session 2:

- 1.fMRI session
2. Questionnaires:
 - EPDS
 - STAI-T

Post-processing of pictures: photoshop and ratings

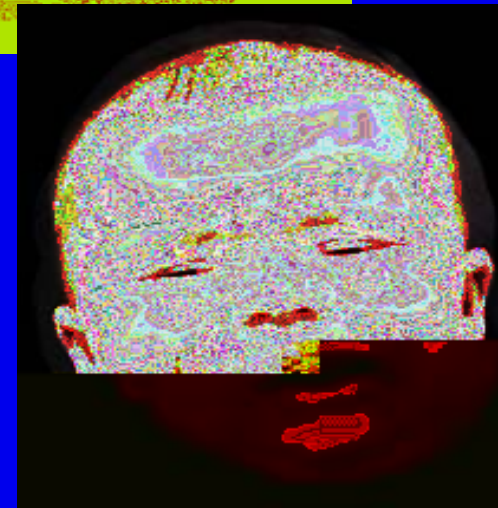
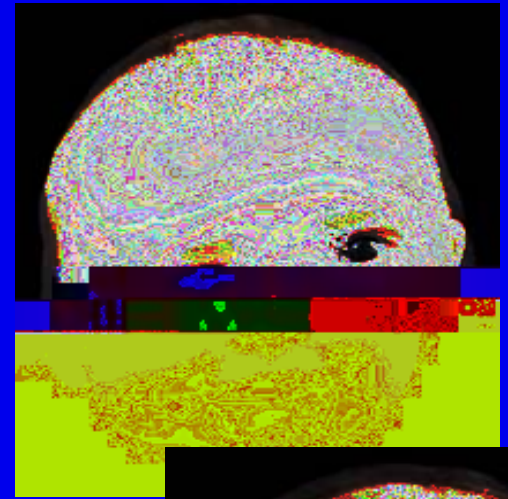


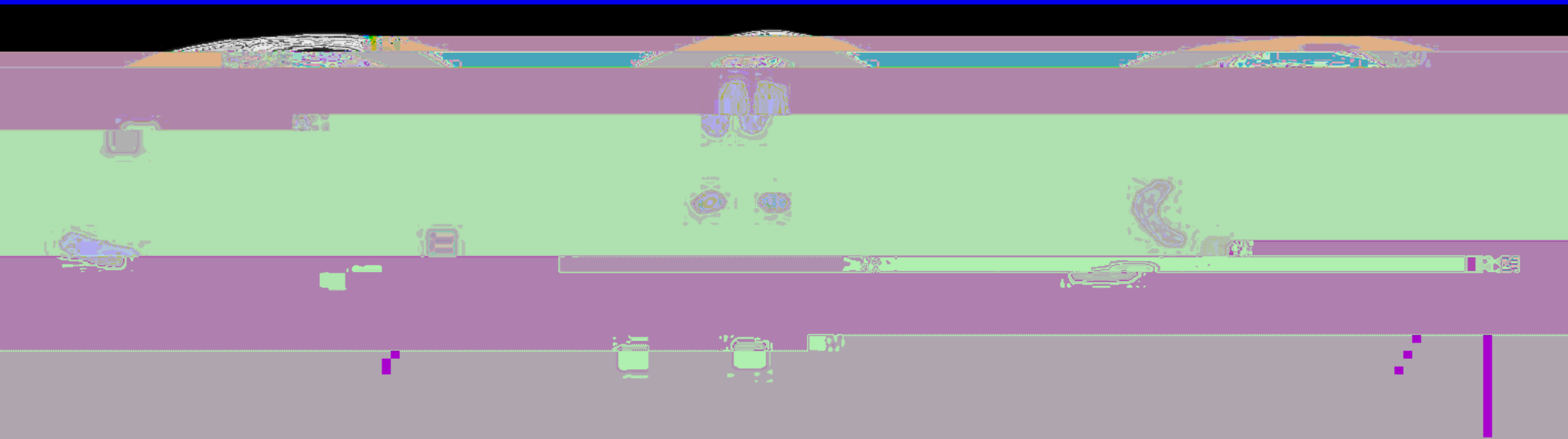
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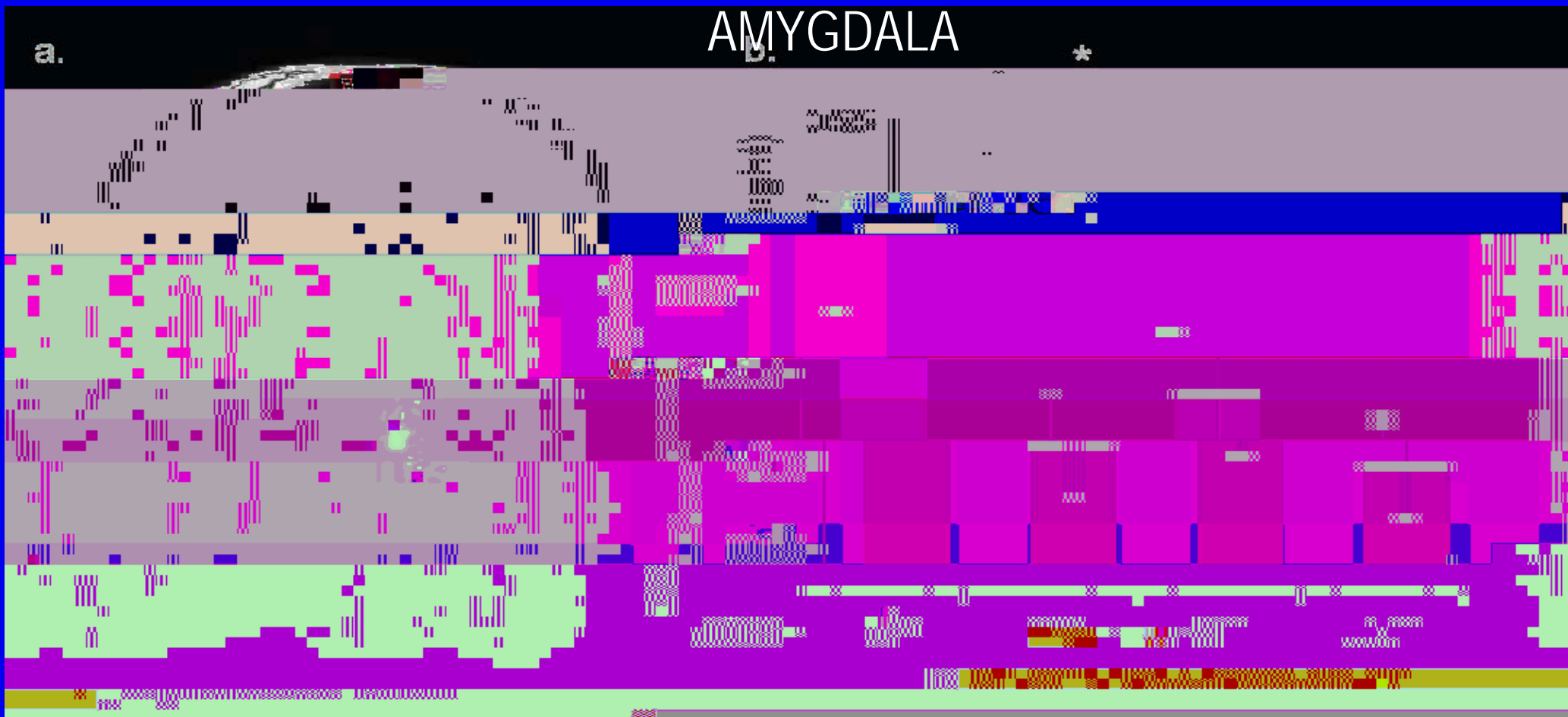
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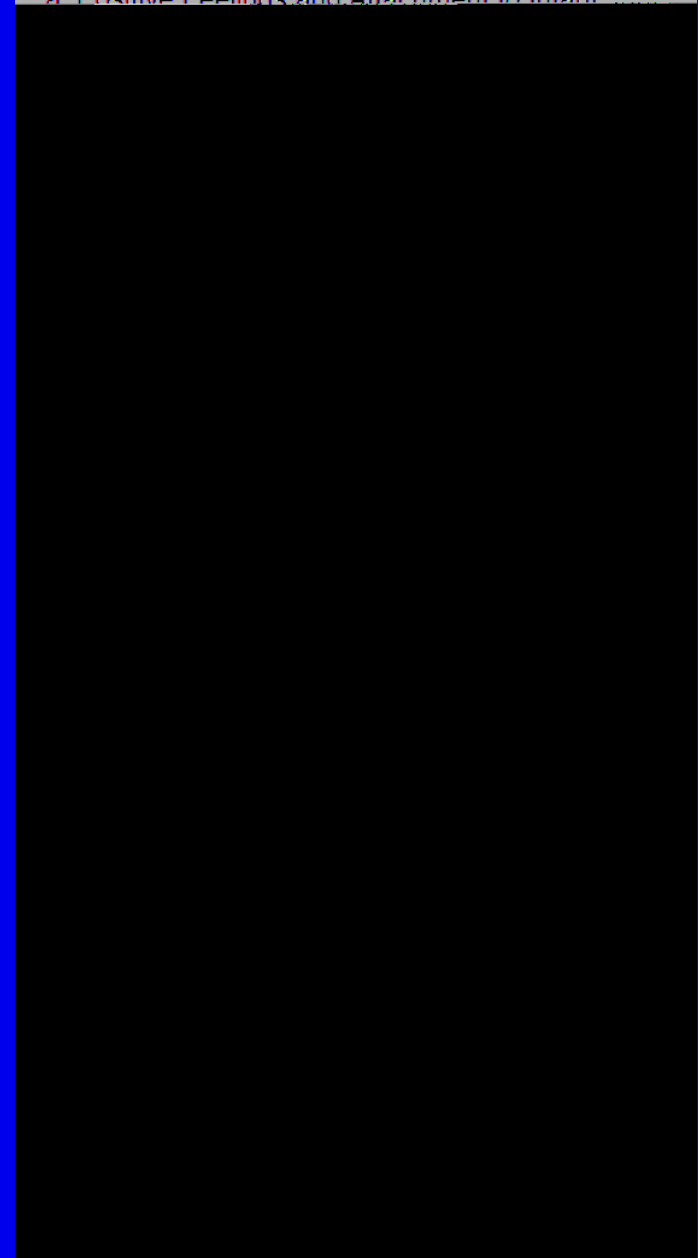
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Greater BOLD response to own positive infant faces over other positive infant faces in Amygdala and nucleus accumbens (not shown) (not true of many control sites)



Mothers showing higher
BOLD responses in
AMYGDALA to own
positive vs other infant
pictures feel more
nurturant towards their
infants and experience
reduced reported
parental stress



Associated with infant cues



■ activation - Empathy (Woll et al., 2006)

activation on Theory of Mind Tasks (Fear and Ochsner, 2006; Decety and Sommerville, 2009; Mitchell and Colledge, 2009; Johnson et al., 2005; Woll et al., 2006)

activation in response to infant faces associated with attachment (Schore and Nelson, 2002; Gannon et al., 2006; 2007)



Summary

- Due to hormones, mothers change from animals that are neophobic and 'timid' to animals that will approach novel stimuli and pups.
- Young are first attractive, then rewarding, to the new mother as a result of both hormones and experience
- Rewarding and salient young regulate mothers' approach to and contact with the young. They enhance her motivation to mother.

Summary, cont'd

- Attraction to young pp is mediated by the 'reward' dopamine system, especially nucleus accumbens or mesolimbic DA system
- Altered emotional state pp is mediated by the amygdala system
- Altered attention pp is mediated by the mPFC system

Summary, cont'd again

- These brain systems interface with the final common path for the expression of mothering, the MPOA



