Conflict of Interest Disclosure: nothing to disclose

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

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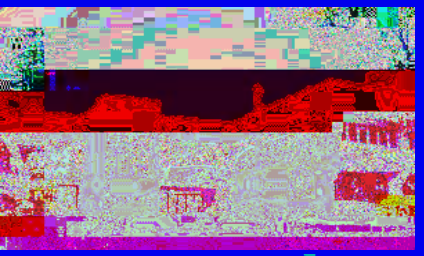
Maternal Behaviour: Human and Animal Models

South bldg, 1966



St Joseph's, Hosp1907

Hedonics
Affect
Attention
Memory

mediated by

Hormones
Brain
NTs

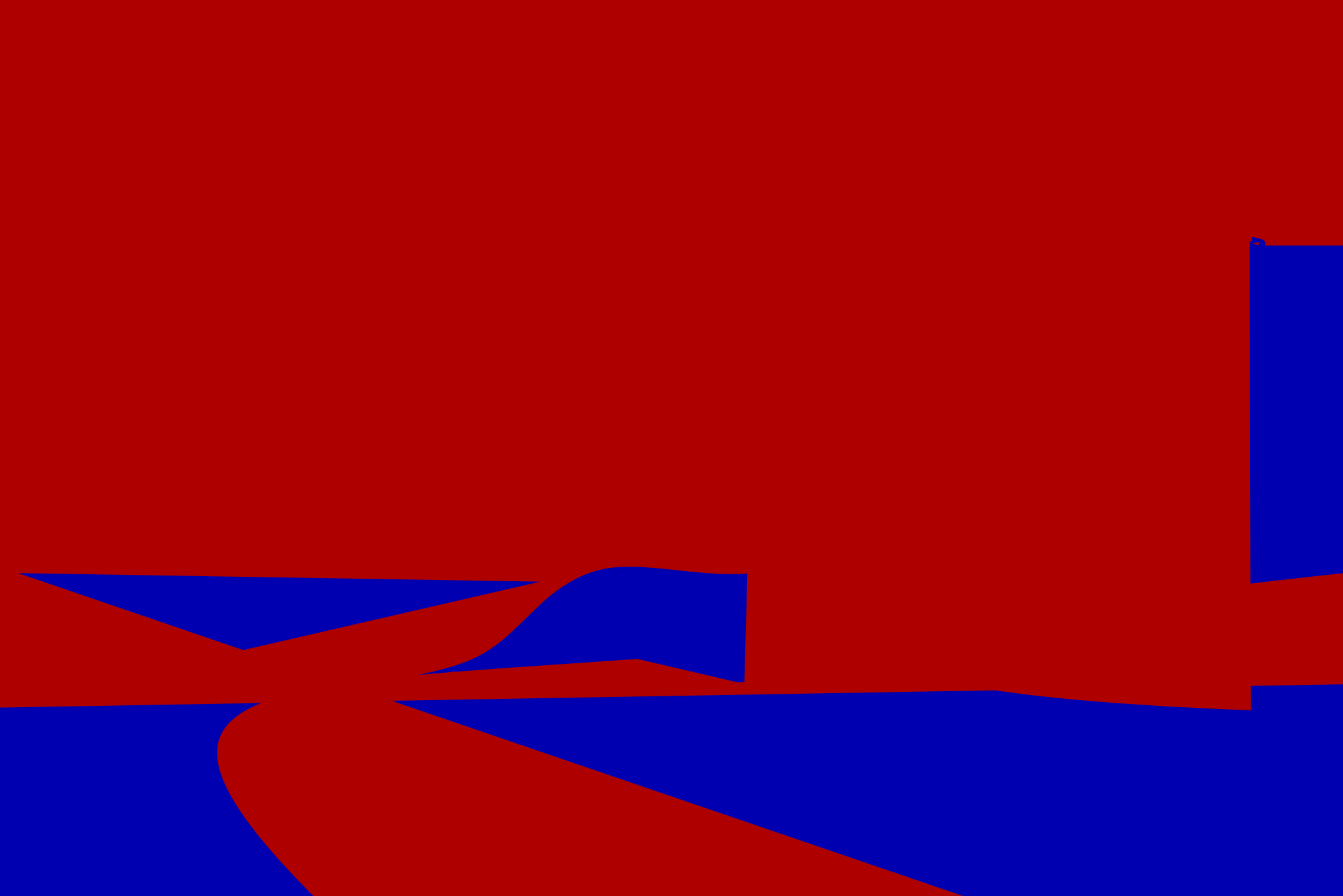
affected by

early experience
genetics

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,

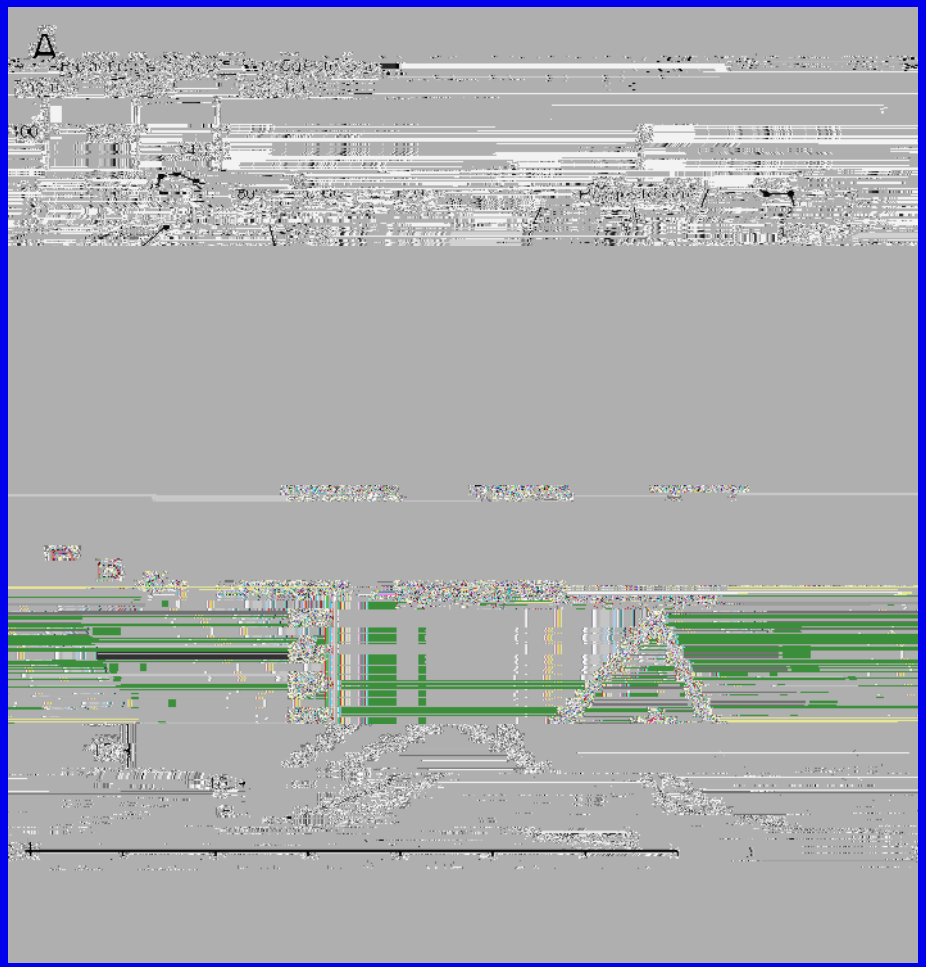
Oxytocin, and

Glucocorticoids also

Associated with an

Enhancement of

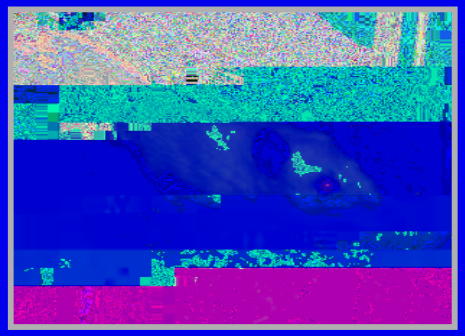
mothering

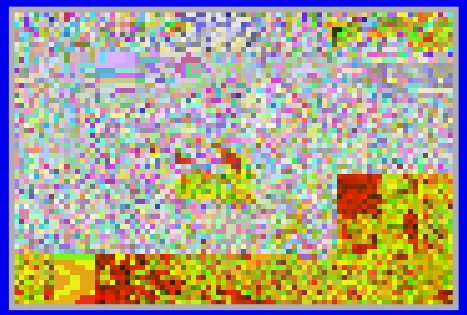


- RAT

Reviewed in Numan, Fleming, & Levy, 2006

- 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 todays 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

Reviewed in Fleming & Li, 2002;Numan, Fleming, & levy, 2006; Barrett & Fleming, 2011

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

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

Reviewed in Numan, Fleming, & Levy, 2006; Barrett & Fleming, 2011

Pups have salience for the new mother

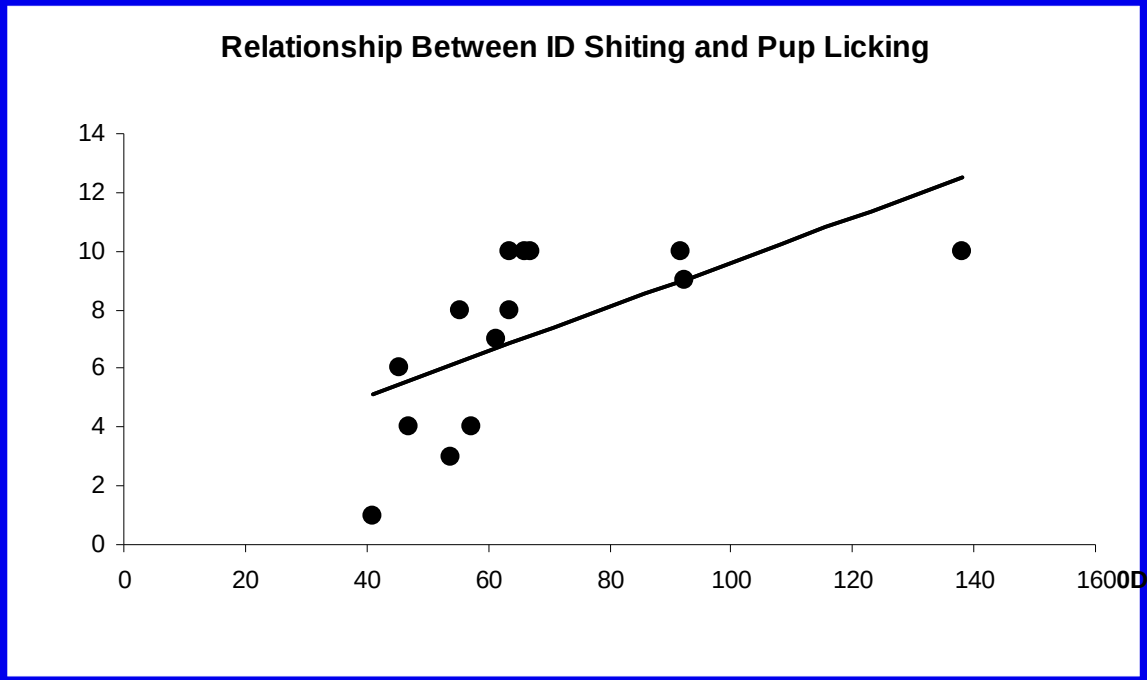
- Among rats and other mammalian mothers, new mother rats are attracted to the odours and ultrasonic vocalizations of newborn rat pups, whereas virgin non-mothers are not.

- 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.

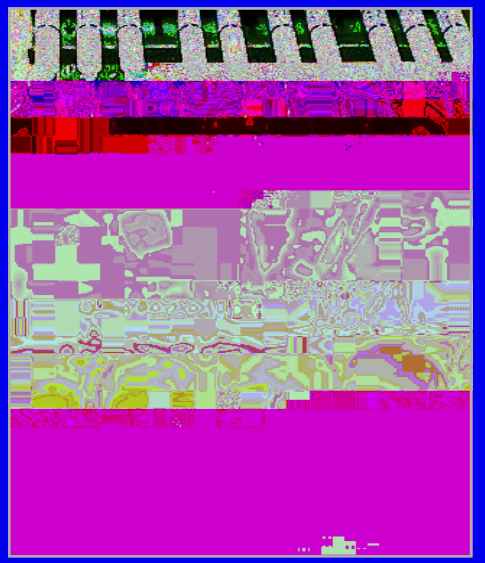
but one example,

- 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



Gonzalez et al., 2001; Lovic et al., 2004, 2010, 2011; Burton et al., 2006,2007,2011

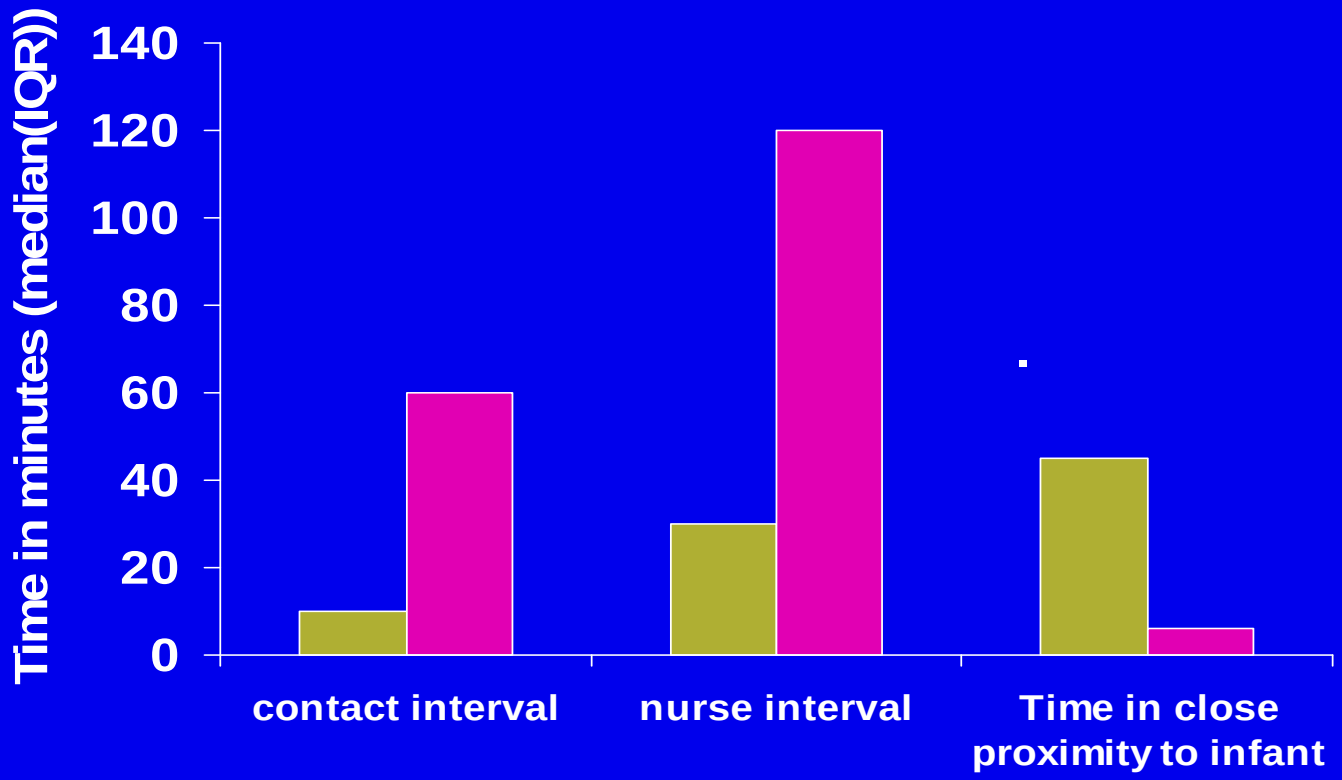
SUMMMARY OF THE RAT WORK

- 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?

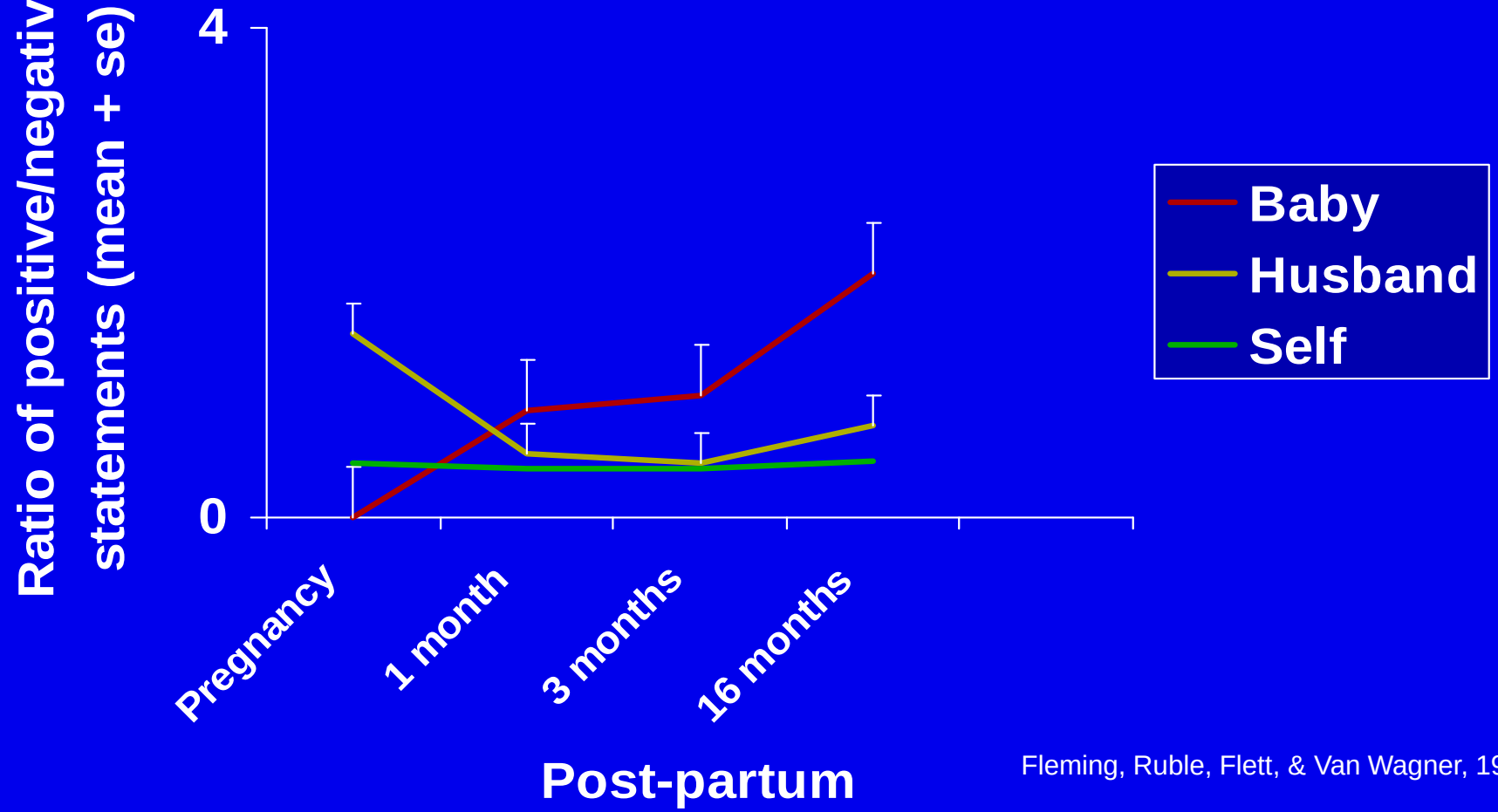
Human Studies

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

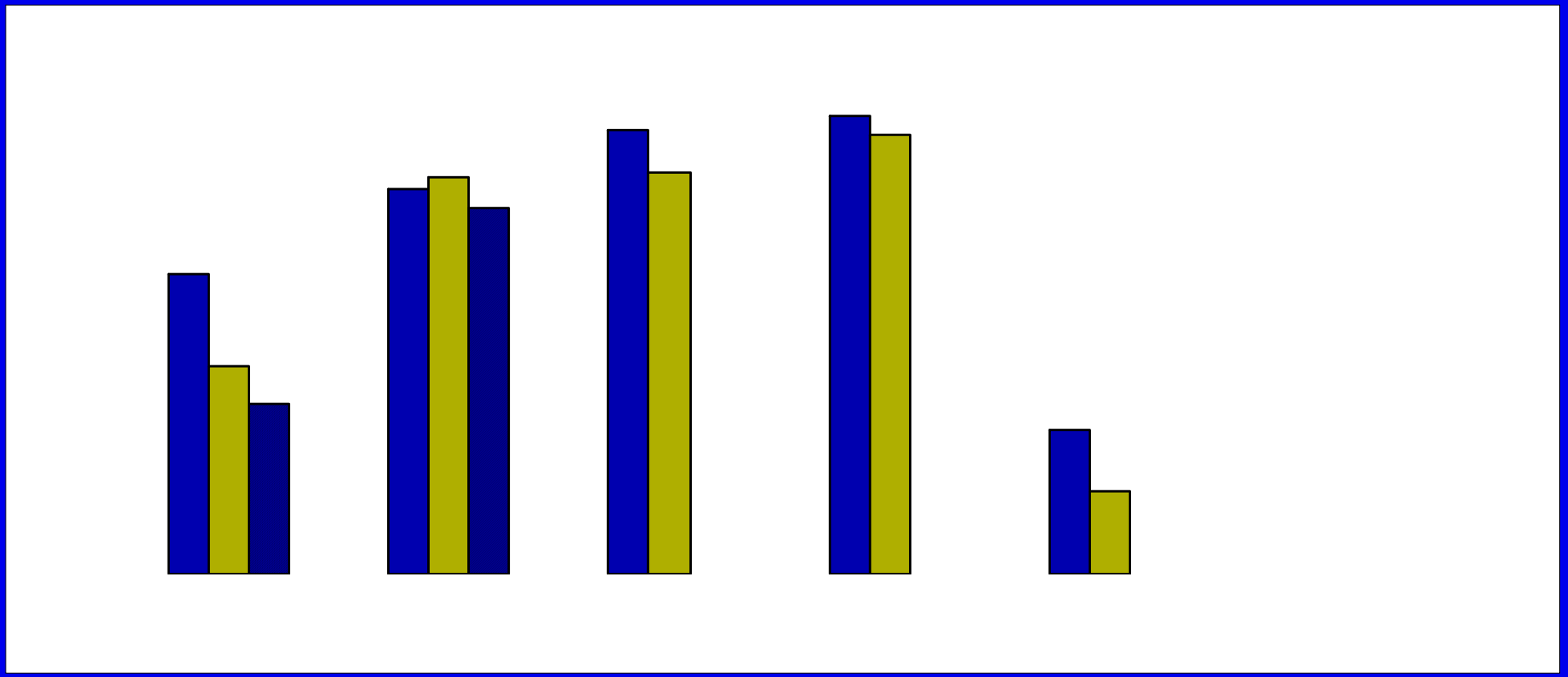
(DON'T WORRY, IT RETURNS IN TIME FOR THE NEXT BABY)



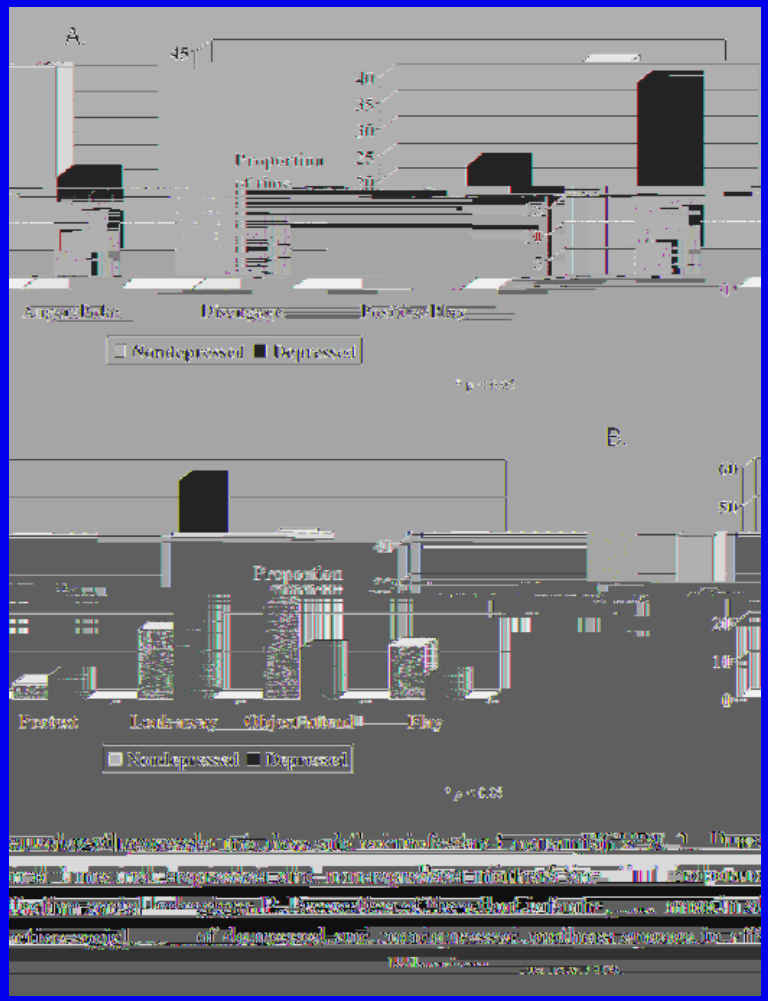
Fleming, Ruble, Flett, & Van Wagner, 1990

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



Tronick & Reck, 2009

JCPP, 33, 1992

Attention, executive function, and maternal behavior

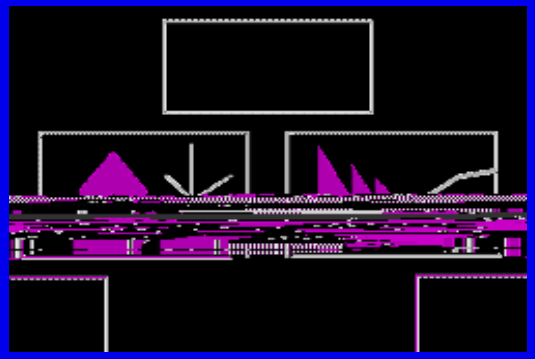
- Once maternal, the new mother interacts with her baby, engaging in many affectionate and instrumental behaviors.

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

- Maternal 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

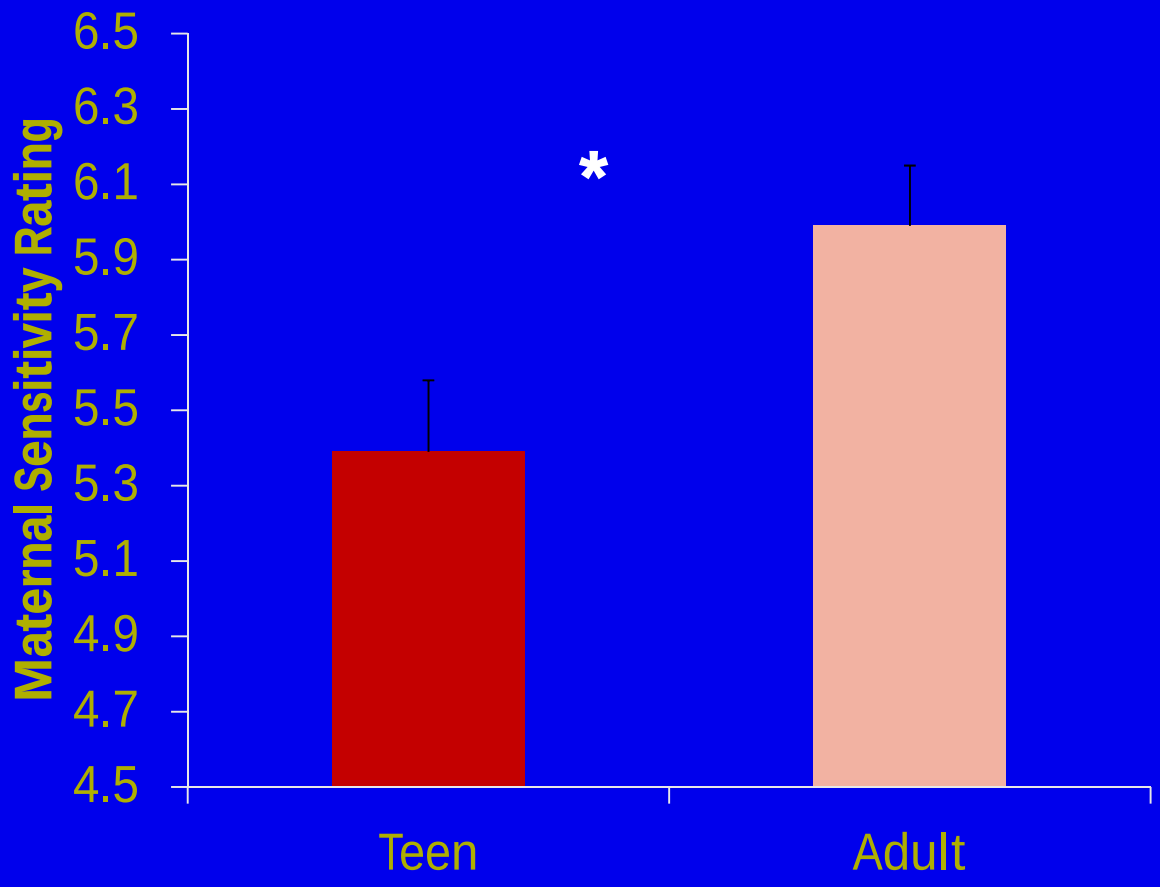


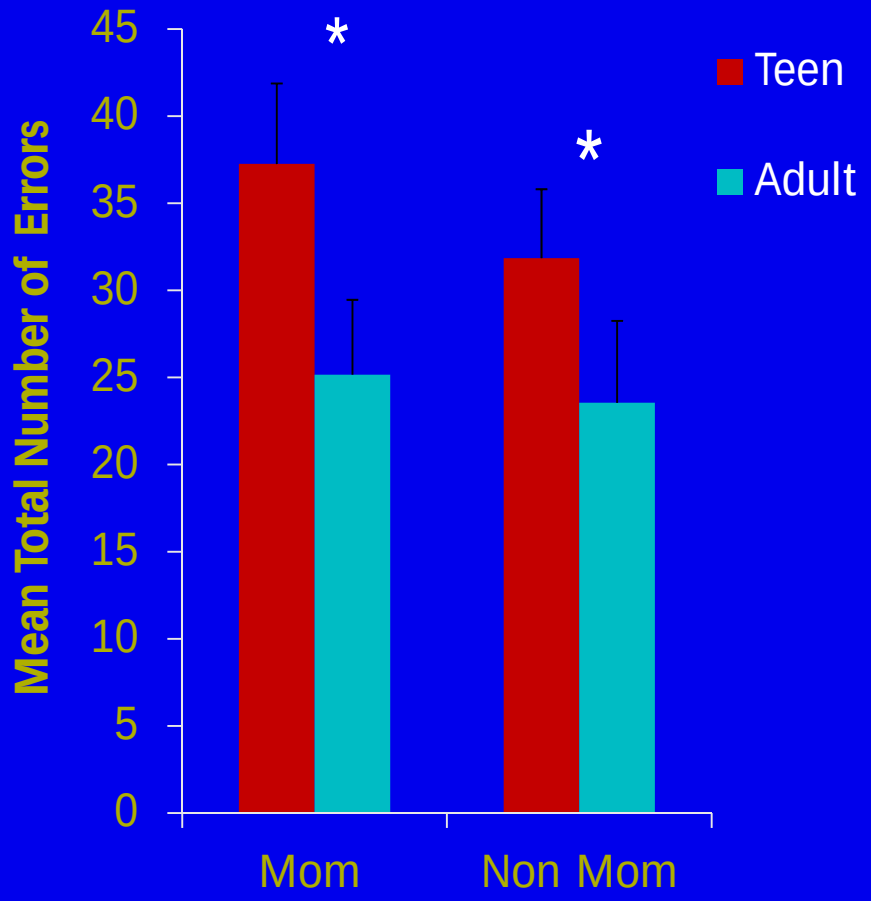
-.25

Ainsworth
Sensitivity
Rating Scales

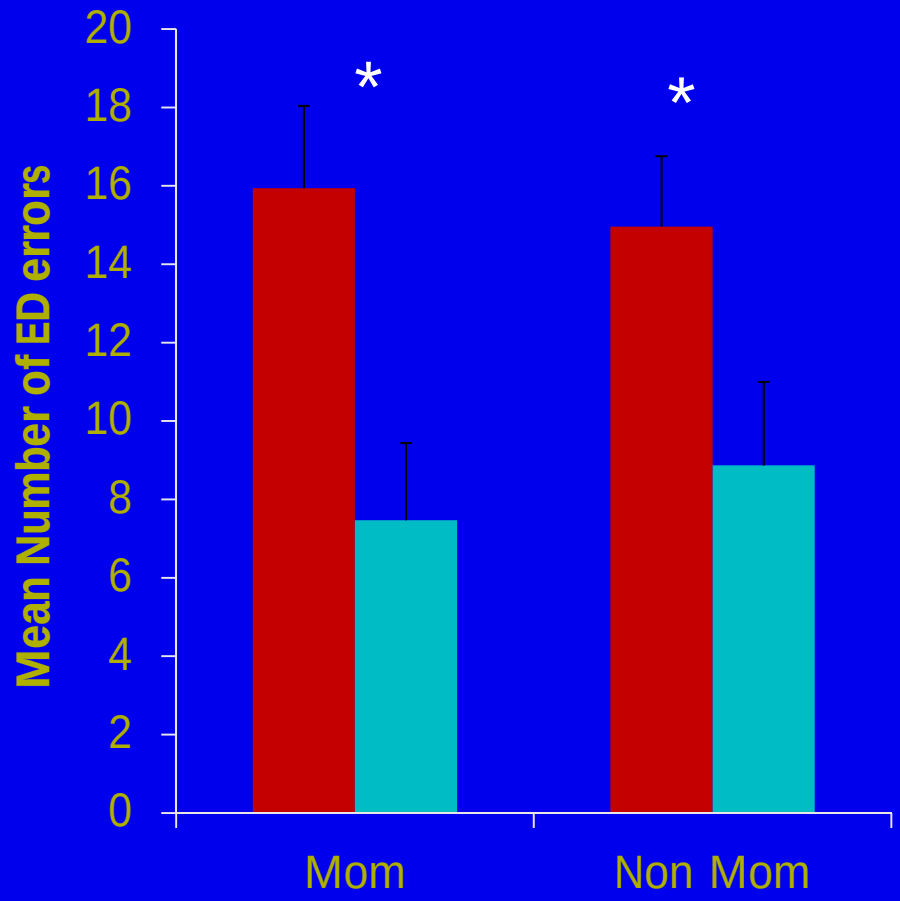
Numbers=stand. † weights

Gonzalez, Jenkins,, Steiner, & Fleming., in pres
Fleming & Gonzalez, 2008


Maternal Sensitivity Rating
6.5
6.3
6.1
5.9
5.7
5.5
5.3
5.1
4.9
4.7
4.5
*
Teen
Adult



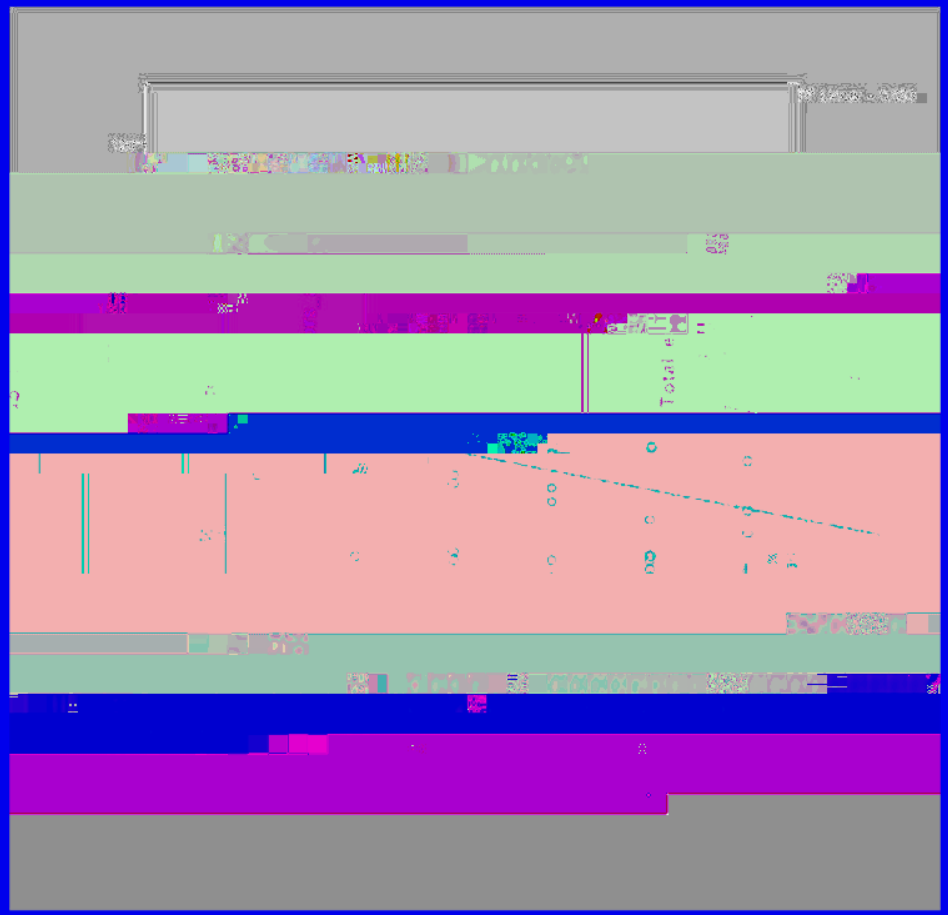
Teen vs. adult $F(1, 113) = 4.44$, $p < .05$

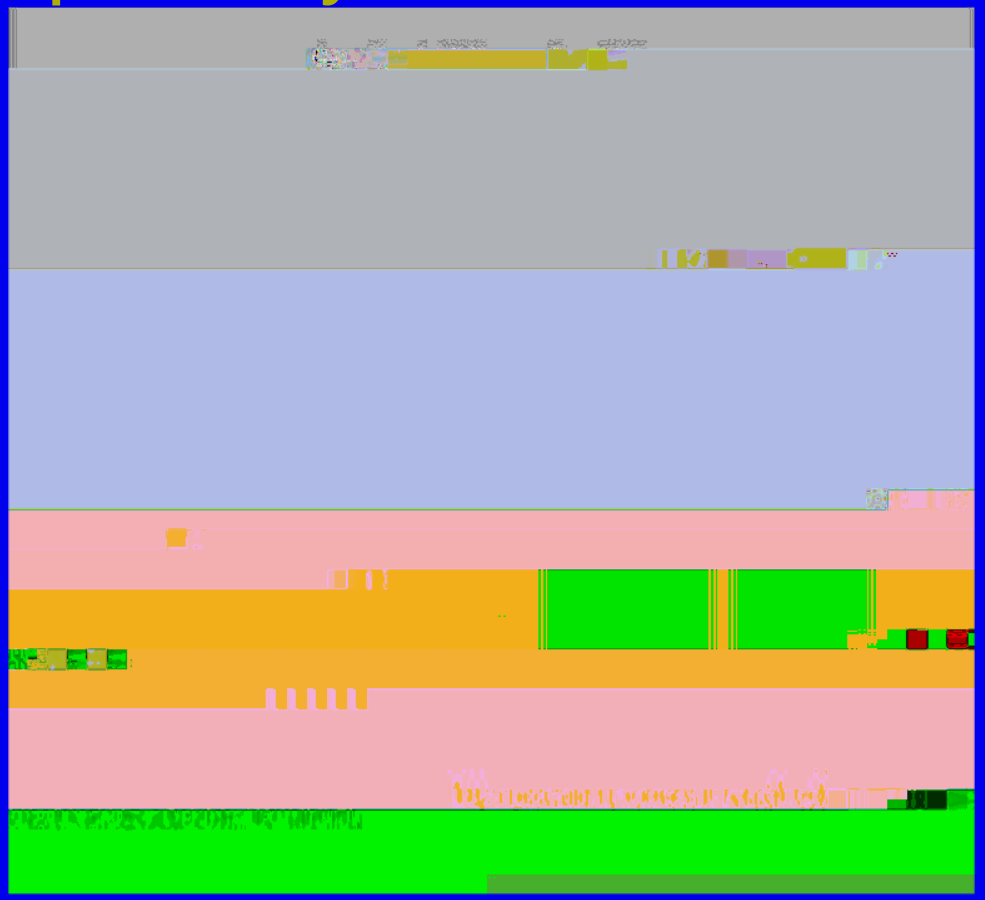


$F(1, 113) = 10.38$, $p < .02$

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

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





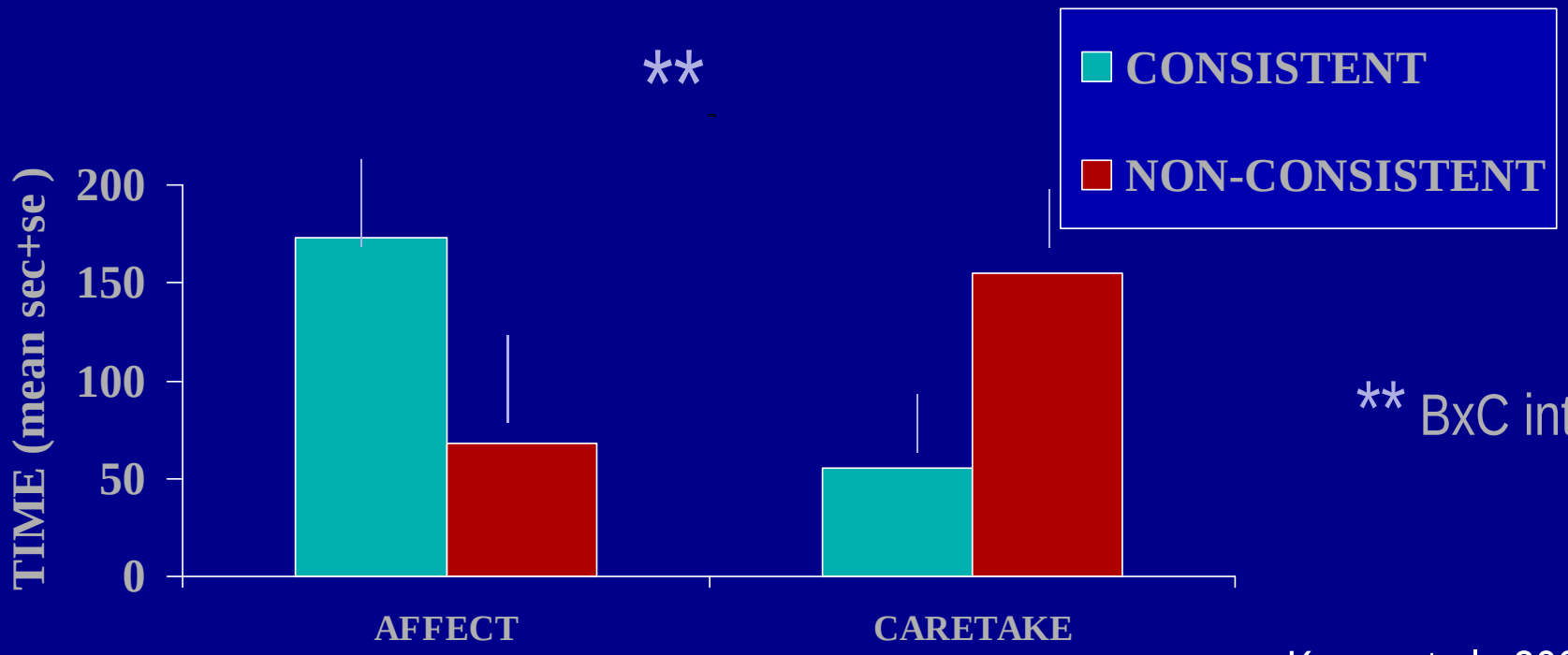
Chico et al., in prep

How does 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



** BxC int

Krpan et al., 2005

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

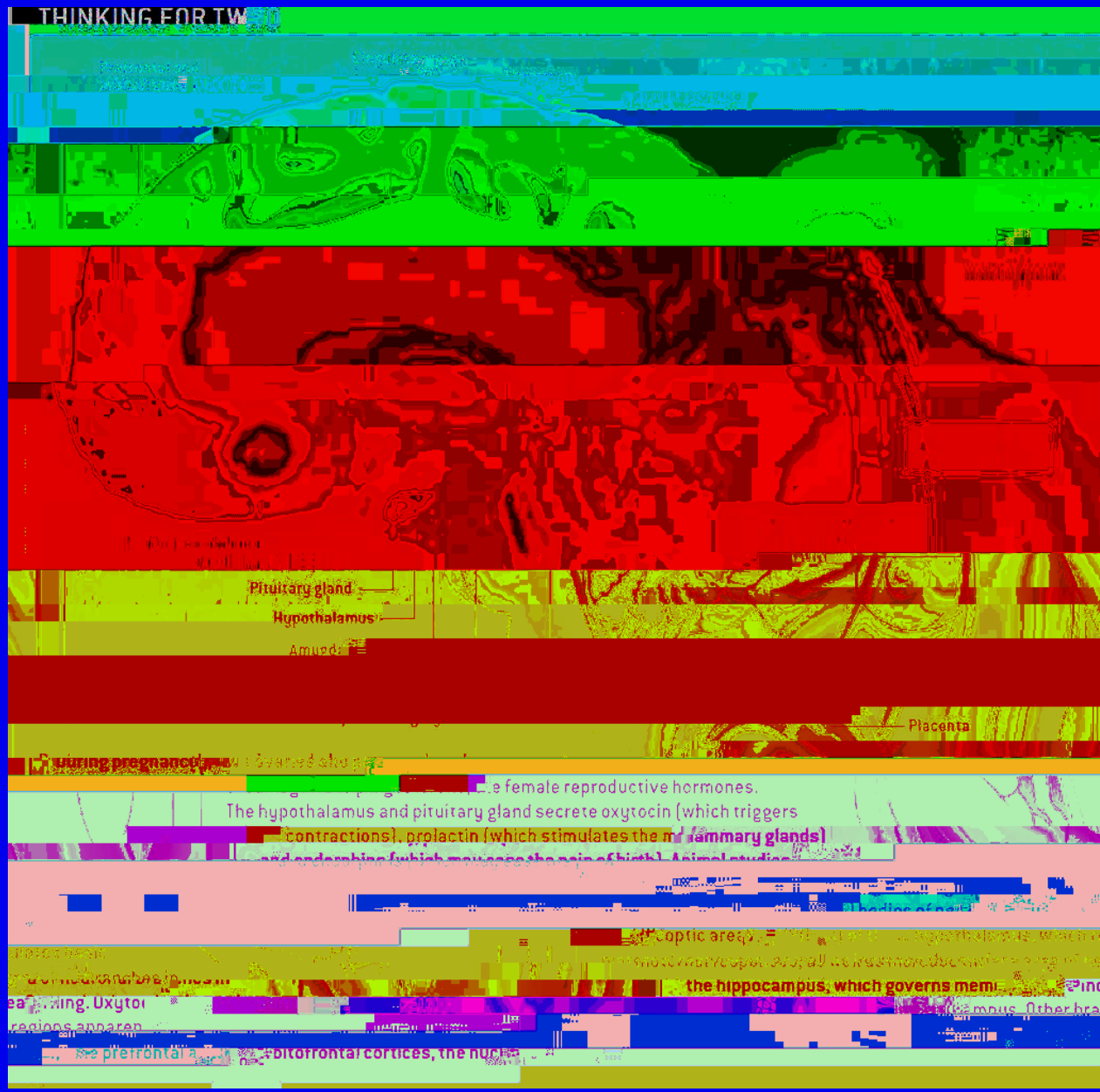
Medial prefrontal cortex: attention, flexibility, working memory

Afonso et al., 2007; Numan et al., 2006

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

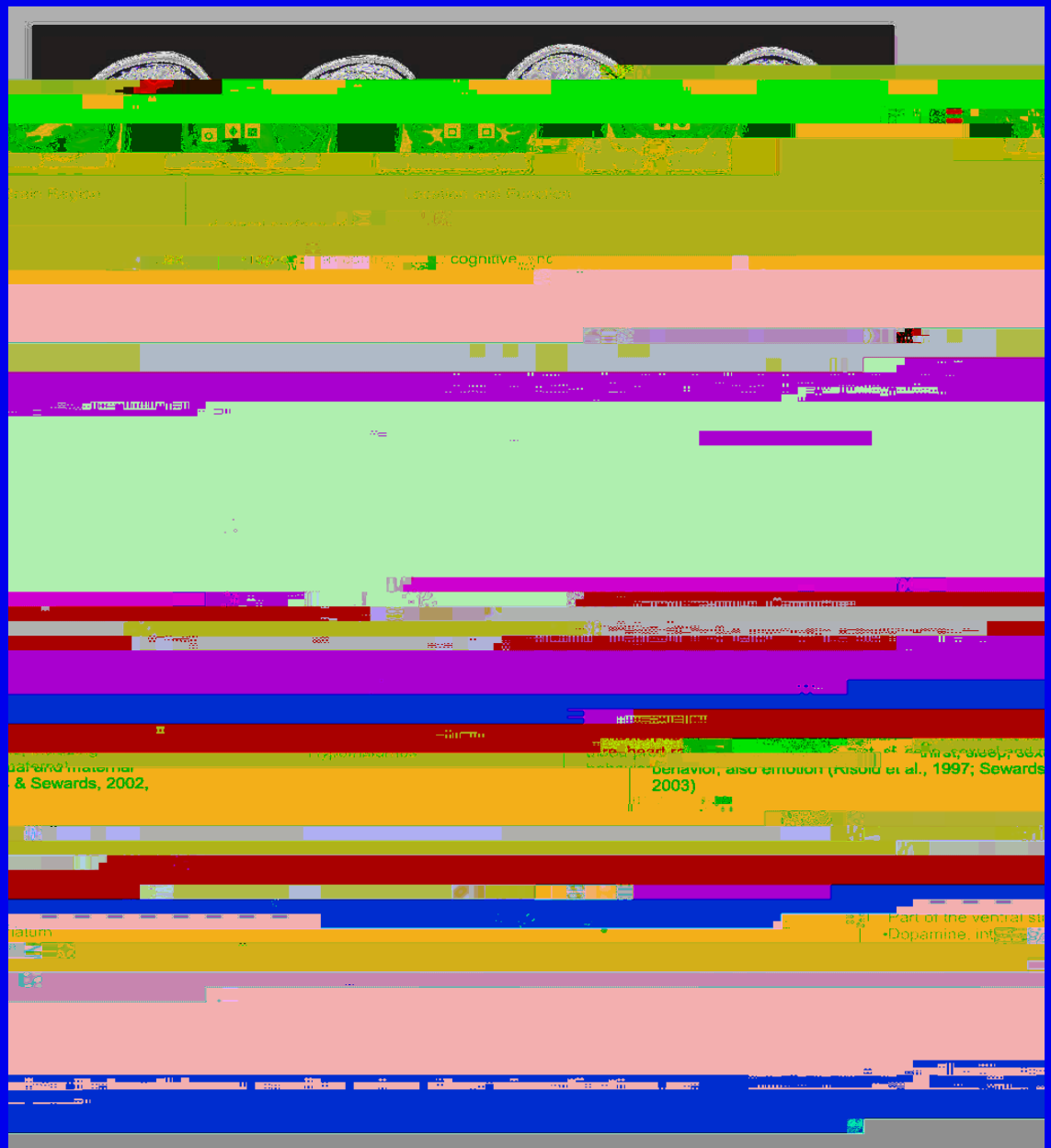
Are also thought to mediate processes of stimulus salience, reward, affect, and cognition

PREFRONTAL CORTEX

HYPOTHAL

AMYGDALA

NUCLEUS ACCUMBENS

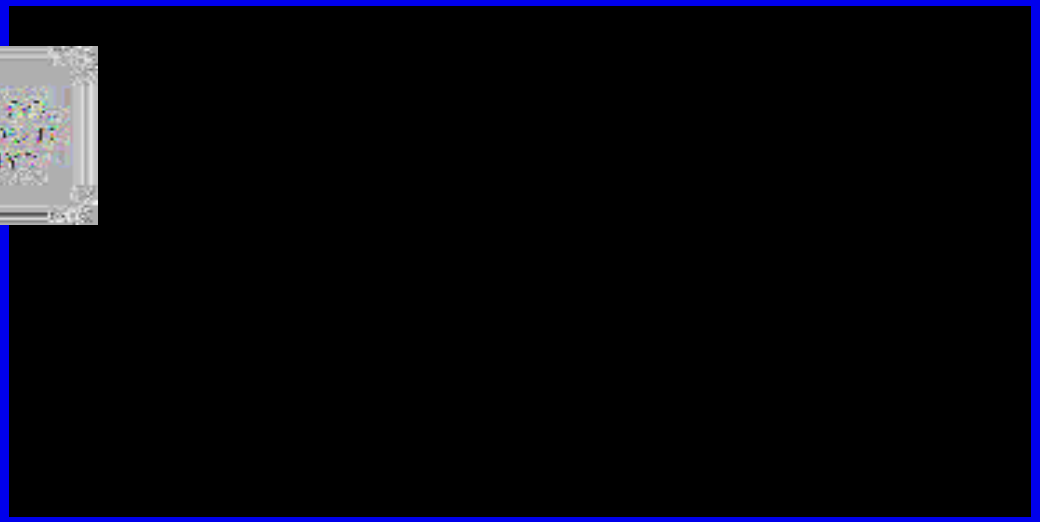


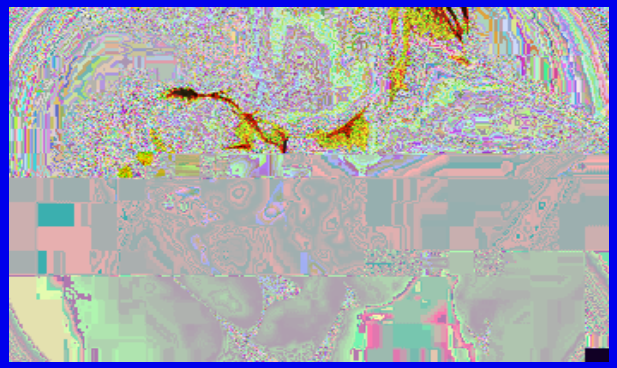
BARRETT & FLEMING, 2011

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.





fMRI Study: Brain response to infant stimuli in new mothers

@3 months

@ 1-2 weeks

Recruit on maternity ward:

•Moms age 20-40

•Healthy singleton

•No history of DEP

•No involvement of child services

Session 1:

1. Photography Session -positive and negative facial expressions

2. Intake and SCID screening

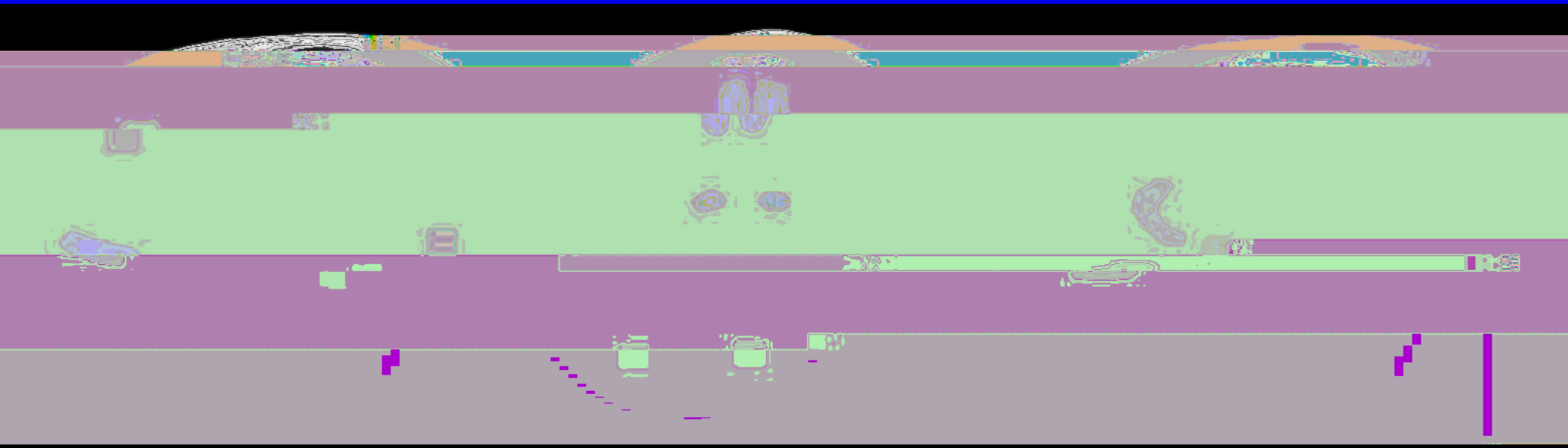
Session 2:

1.fMRI session

2. Questionnaires:
-EPDS
-STAI-T

Post-processing of pictures: photoshop and ratings

- DLPFC,
- OFC, BA25,
- pACC, HYPO,
- NAC, AMY



Yellow = Orbitofrontal cortex (OFC)

Purple = Dorsolateral prefrontal cortex (DLPFC)

Navy = Fusiform face area (FFA)

Light blue = Occipital face area (OFA)

Pink = Anterior hypothalamus/medial preoptic area (HYPO)

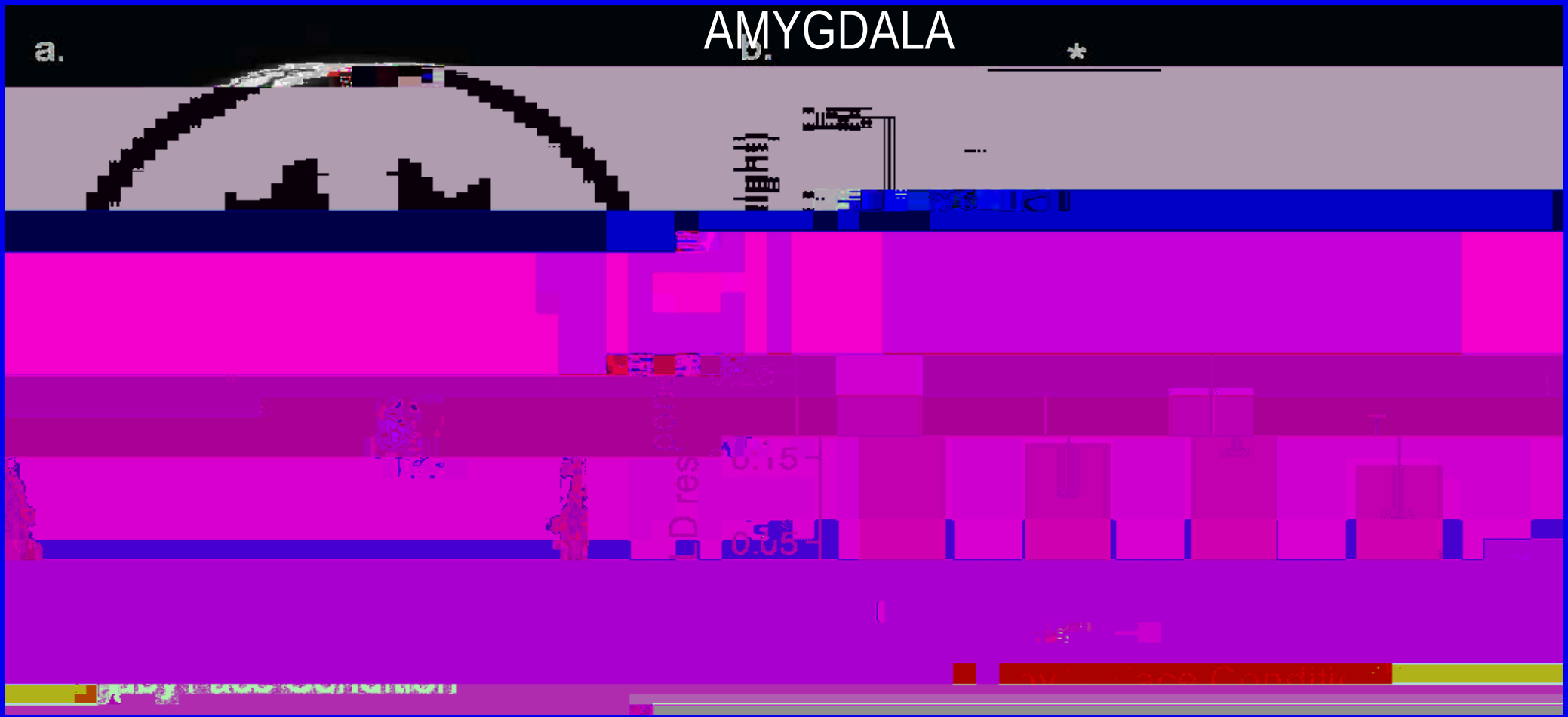
Blue = Subgenual anterior cingulate cortex (sACC)

Red = Perigenual anterior cingulate cortex (pACC

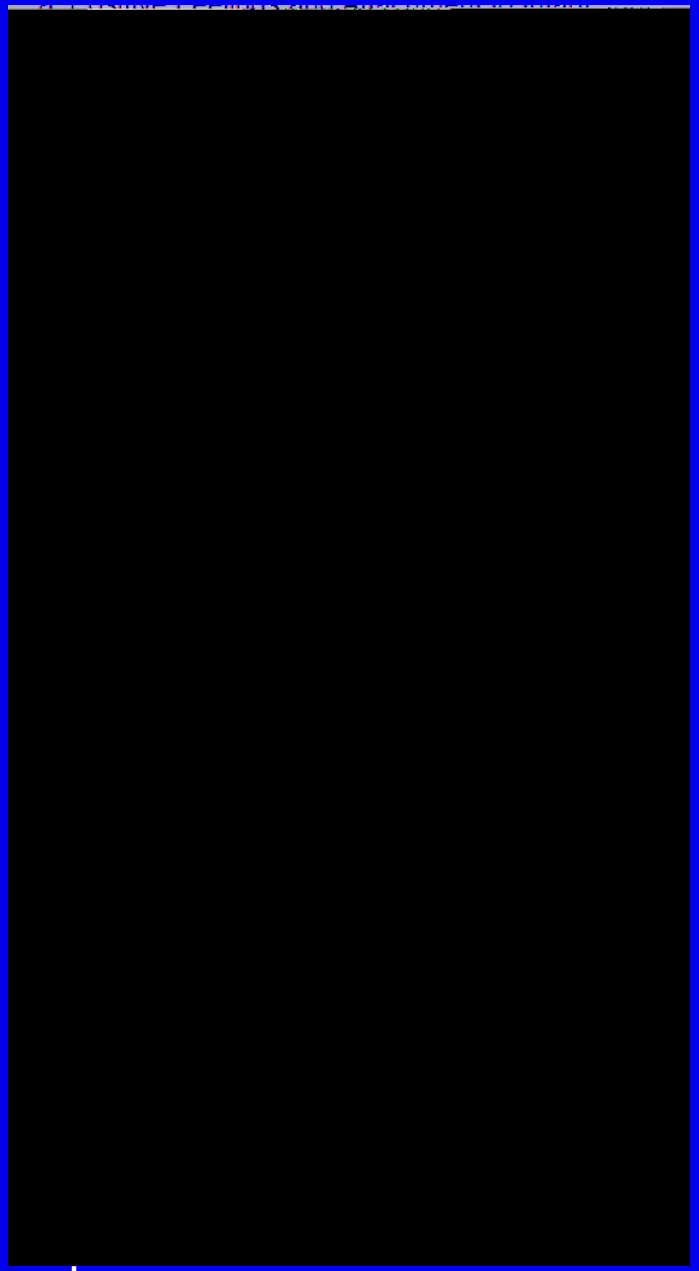
Brown = Nucleus accumbens (NAC)

Green = Amygdala (AMY)

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)

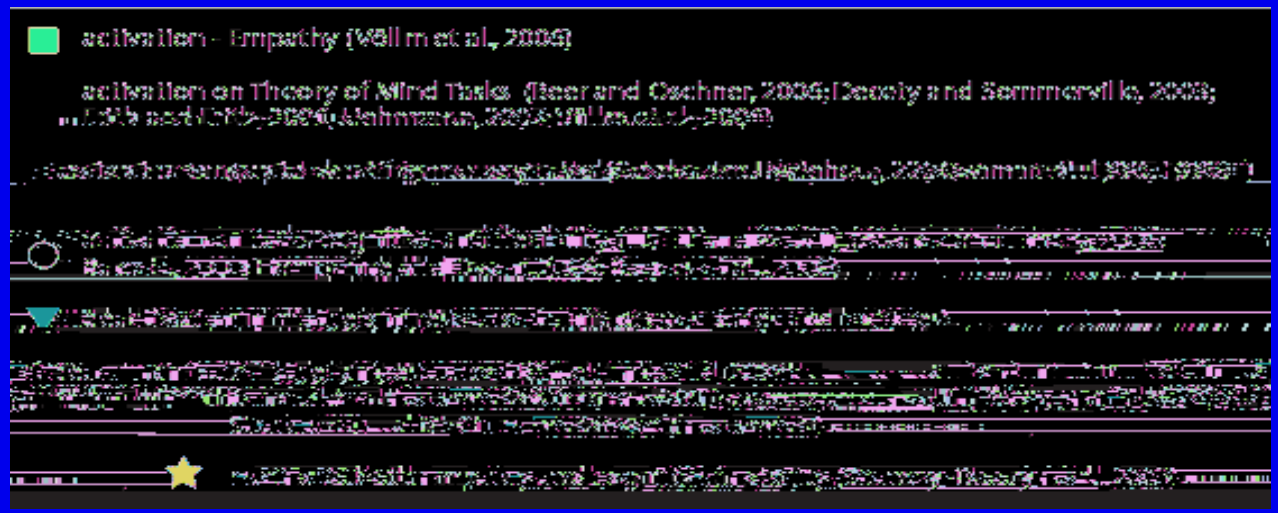


Mothers showing higher BOLD responses in AMYGDALA to own positive vs other infant pictures feel more nurturant towards their infants and experience reduced reported parental stress



Barrett, Wonch, Hall, Steiner, Gonzalez, & Fleming, in press

Associated with infant cues



Gonzalez, Atkinson, & Fleming, 2009

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
-