

Pubertal Hormones Shape the Adolescent Brain

Cheryl Sisk

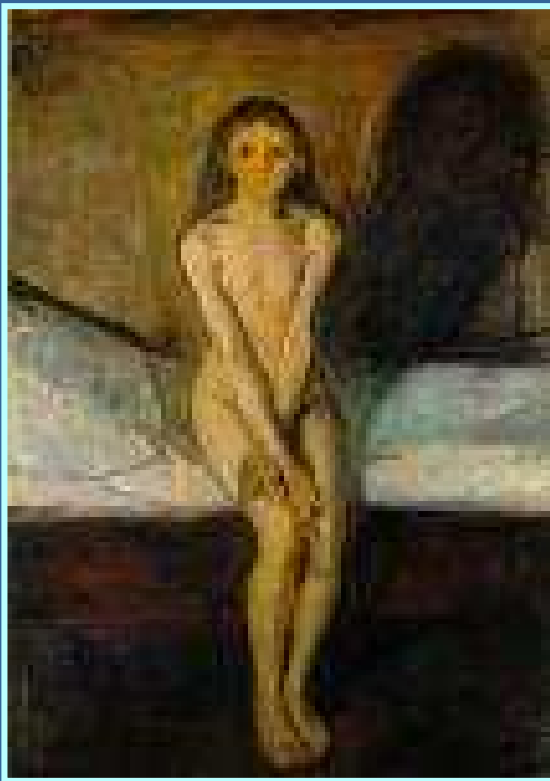


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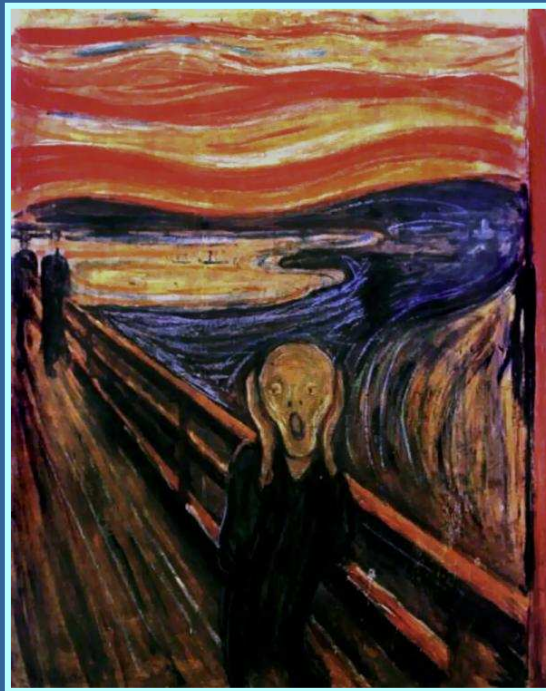
Department of
Psychology

Puberty: the period of first becoming capable of sexually reproducing

Adolescence: the period of life from puberty to adult maturity



Puberty
Edvard Munch, 1895



The Scream
Edvard Munch, 1895



The Kiss
Edvard Munch, 1897

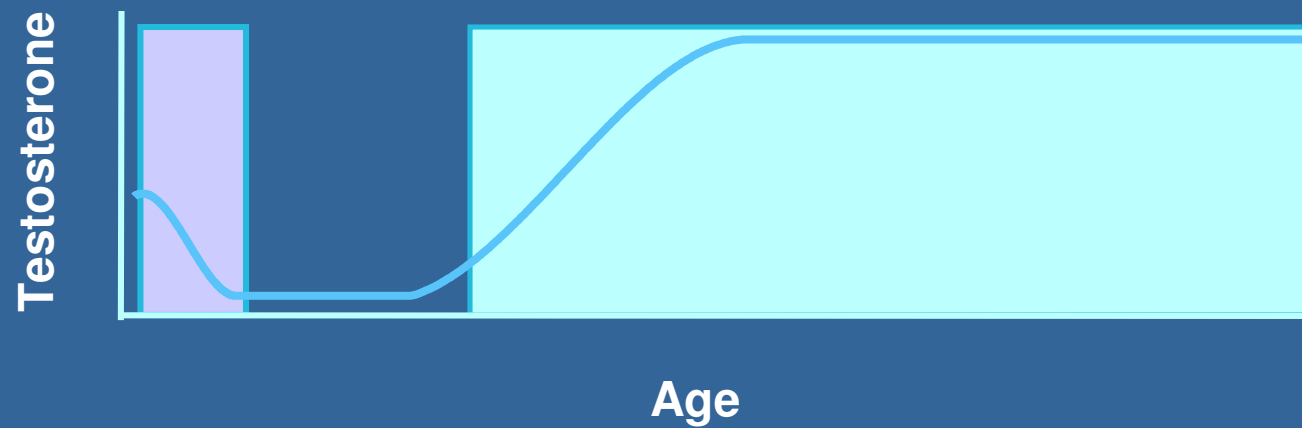
Sex-biased mental illnesses, puberty & adolescence

- **Eating disorders**
 - Rare before puberty and rare in males
 - Increased incidence with earlier onset of menstruation
- **Depression**
 - Twice as common in females
 - Sex difference emerges with puberty
- **Schizophrenia**
 - Emerges during late adolescence
 - Male > female: earlier age at onset, intensity of symptoms, poor prognosis

- Pubertal hormones organize the adolescent brain and program adult behavior
- The timing of puberty is a variable that contributes to individual differences in behavior in adulthood
- Pubertal hormones modulate mechanisms of adolescent brain remodeling

**Perinatal critical period:
organization of sexually dimorphic brain circuits**

**Puberty and adulthood:
activation of sex-typical behavior**



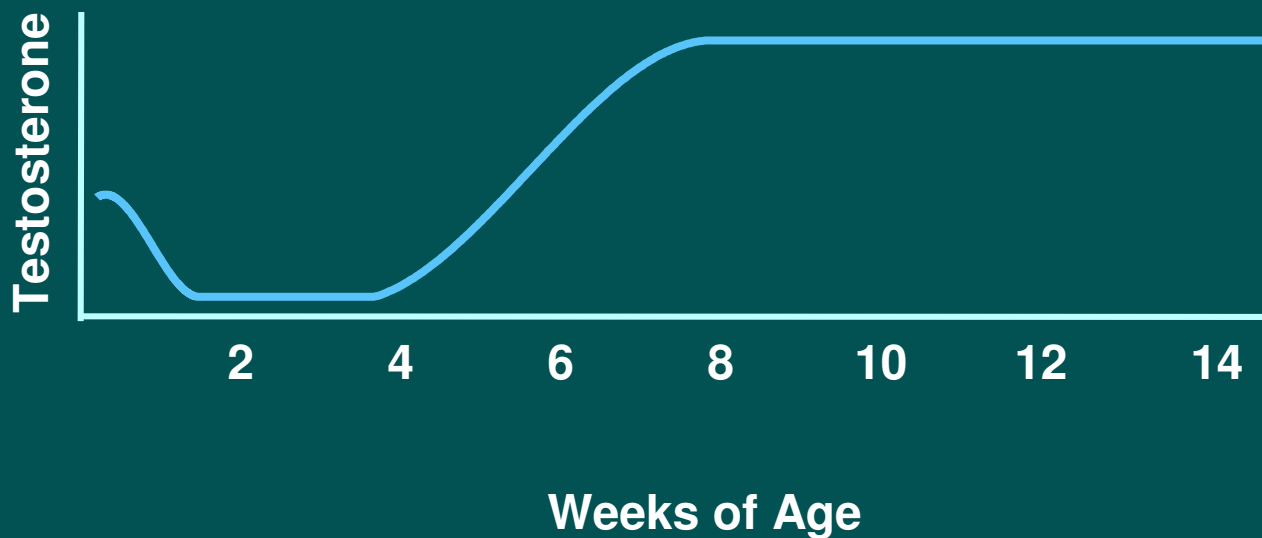
Do pubertal hormones organize behavioral circuits?



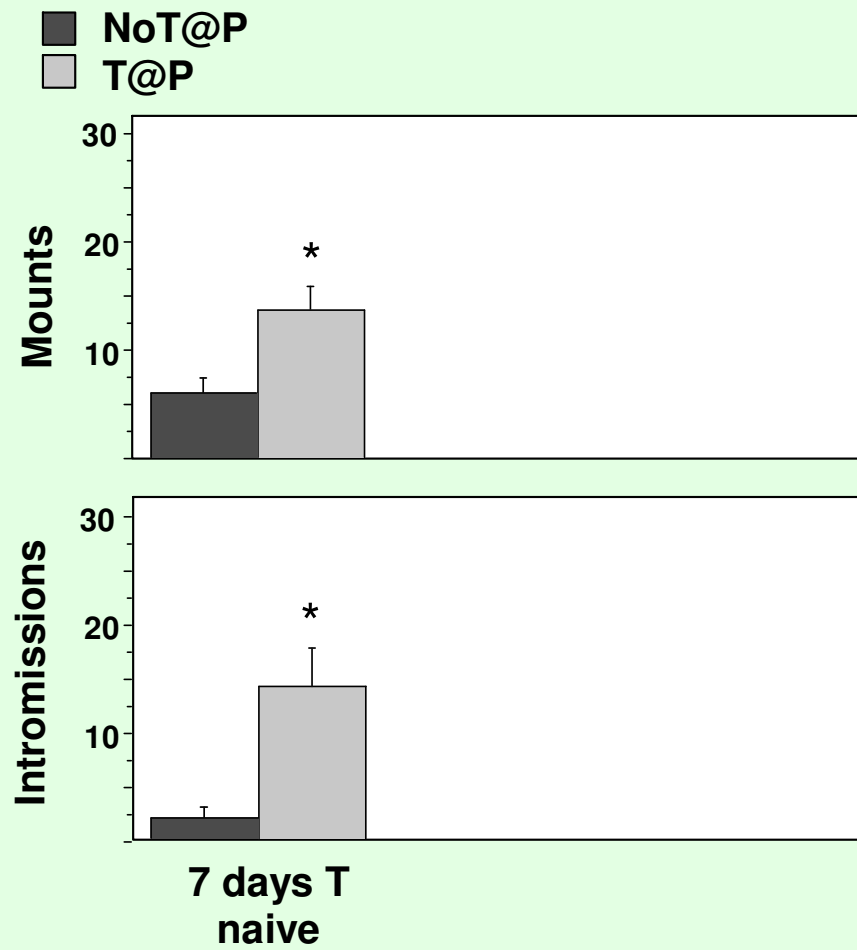
Kalynn Schulz

gdx +T & behavior
No T@P

gdx +T & behavior
T@P

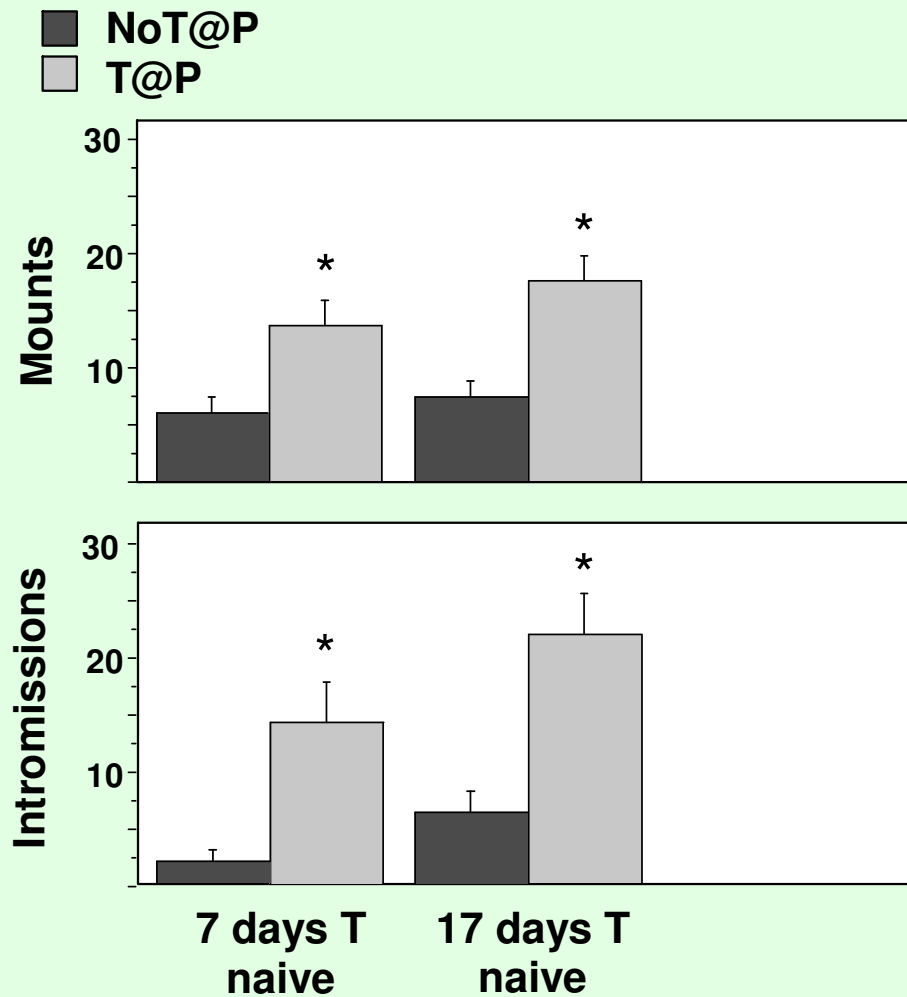


The absence of testicular hormones during puberty leads to deficits in adult behavior



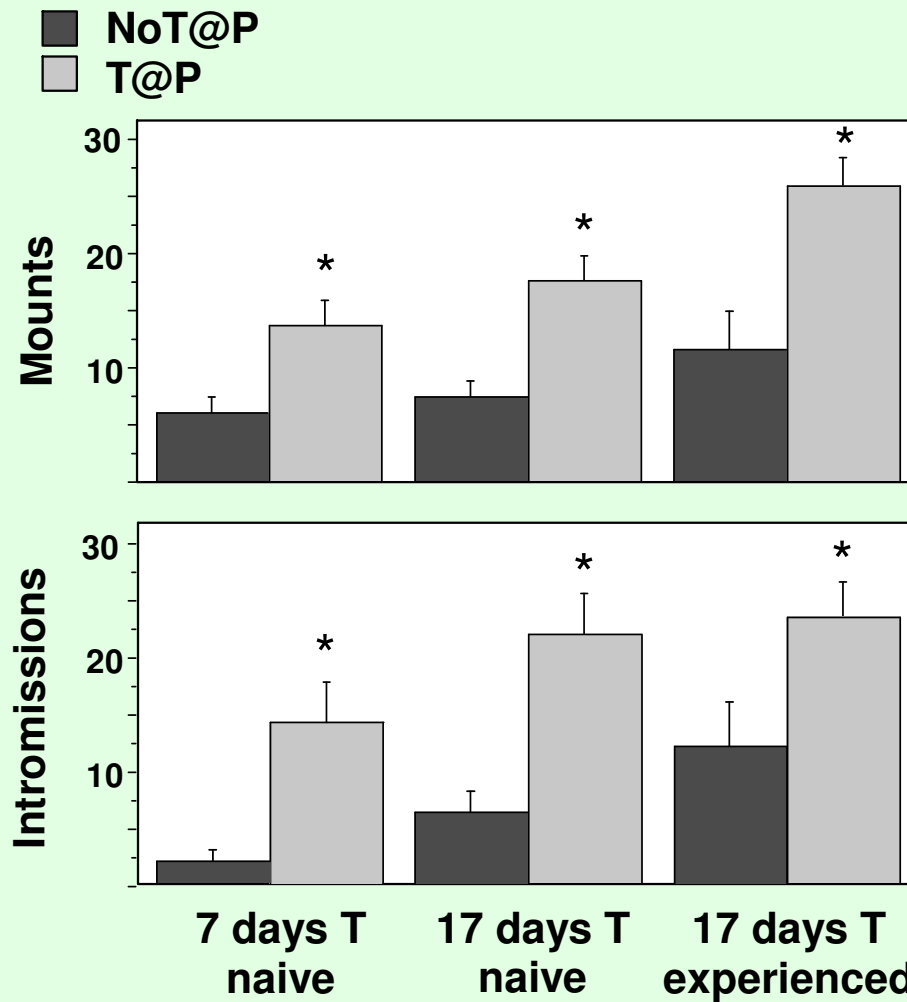
Schulz et al,
Hormones &
Behavior, 2004

Behavioral deficits are *not* reversed by prolonged testosterone in adulthood



Schulz et al,
Hormones &
Behavior, 2004

Behavioral deficits are *not* reversed by sexual experience in adulthood



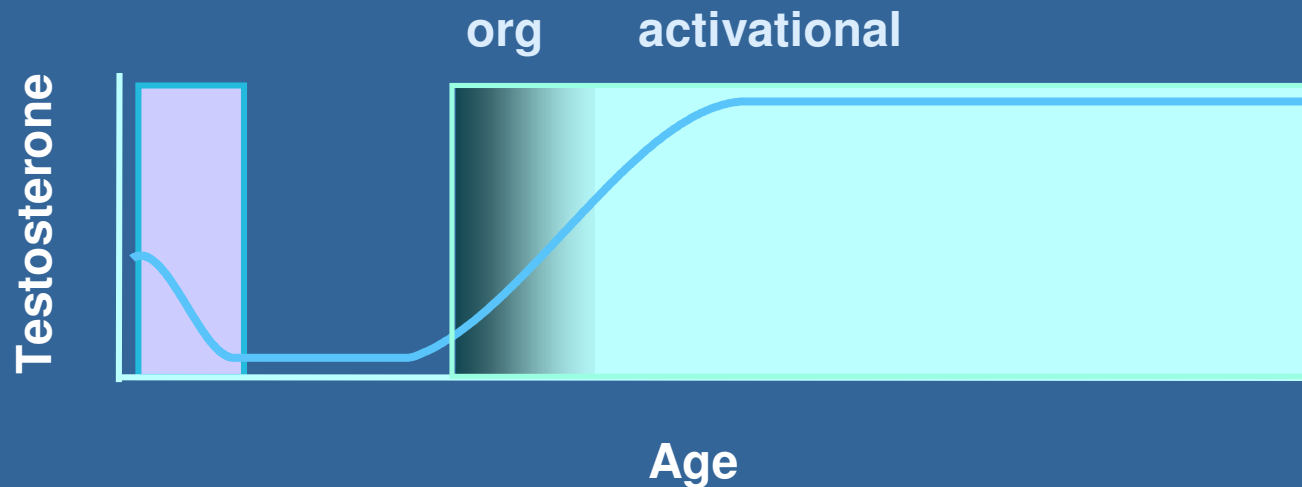
Schulz et al,
Hormones &
Behavior, 2004

Puberty: a finishing school for male social behaviors

Perinatal:
sex differentiation

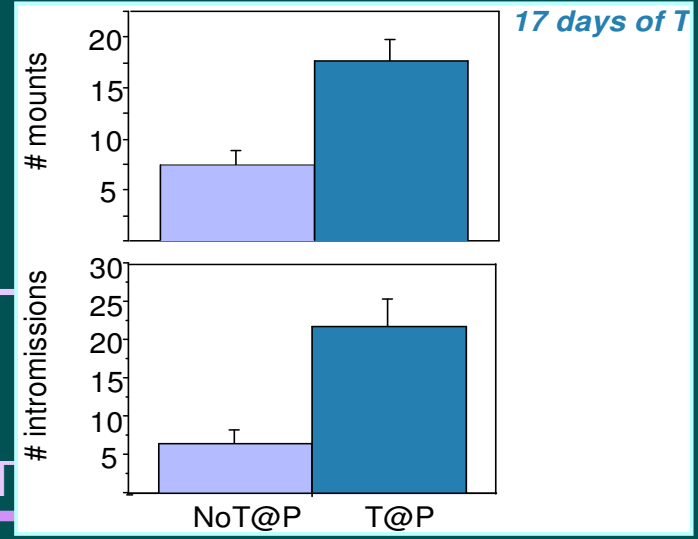
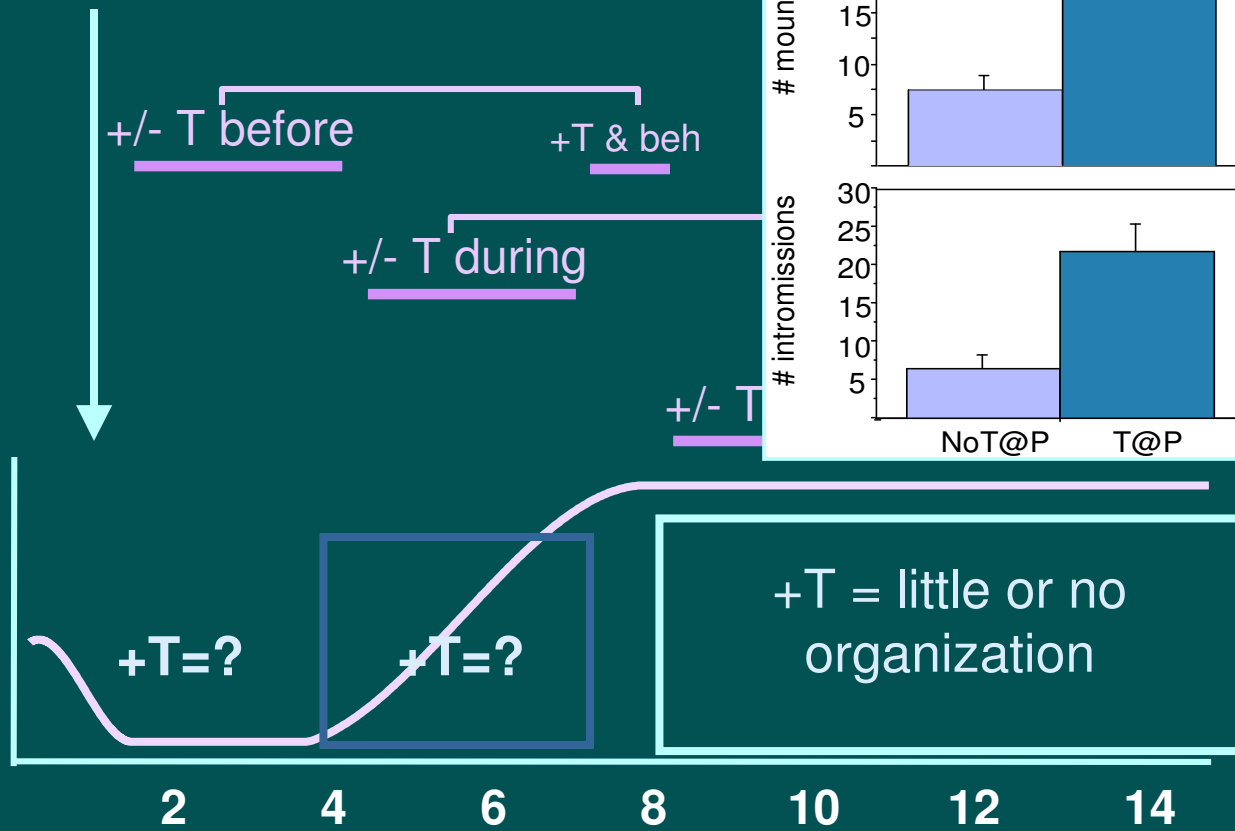
Puberty:
finishing

Adult-typical behavior

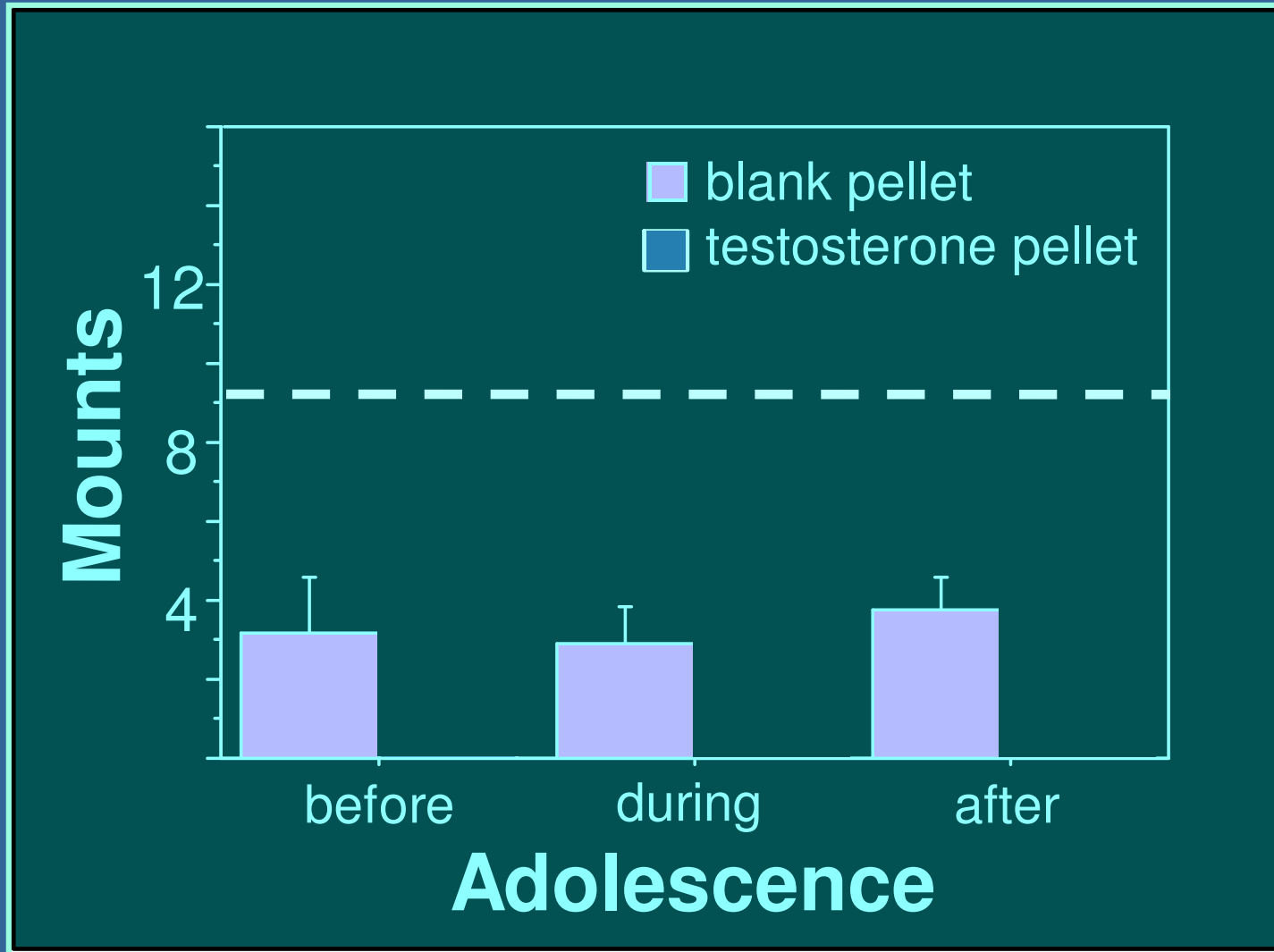


Gdx PND10

Testosterone

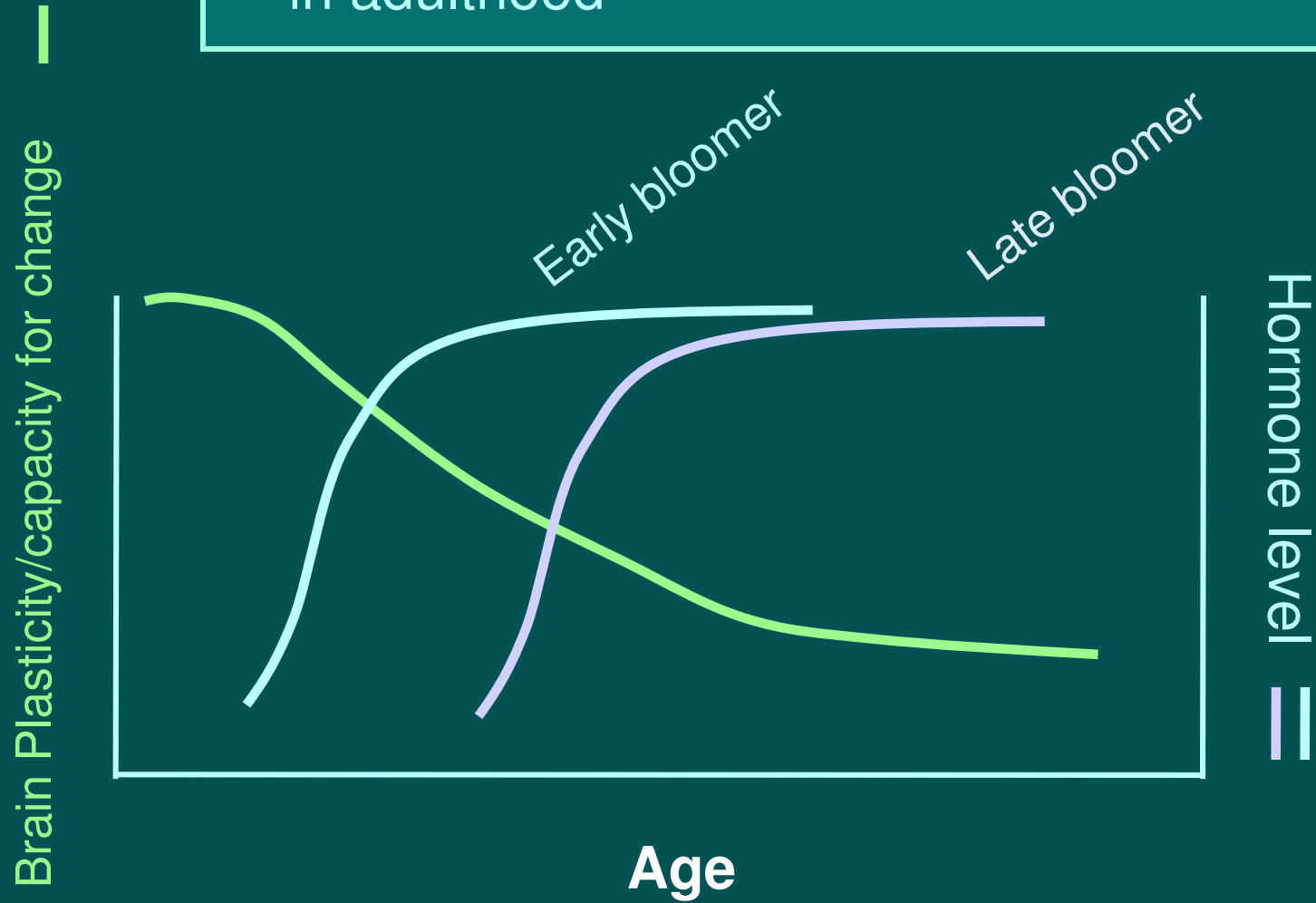


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Schulz et al, Soc Behav Neuroendo, 2007

Individual variation in the timing of puberty contributes to individual variation in behavior in adulthood



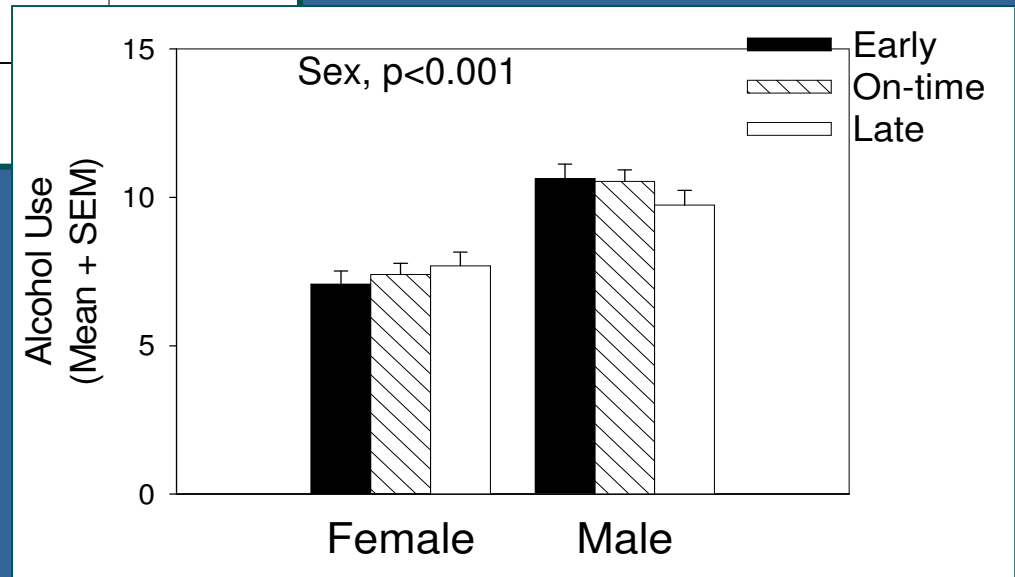
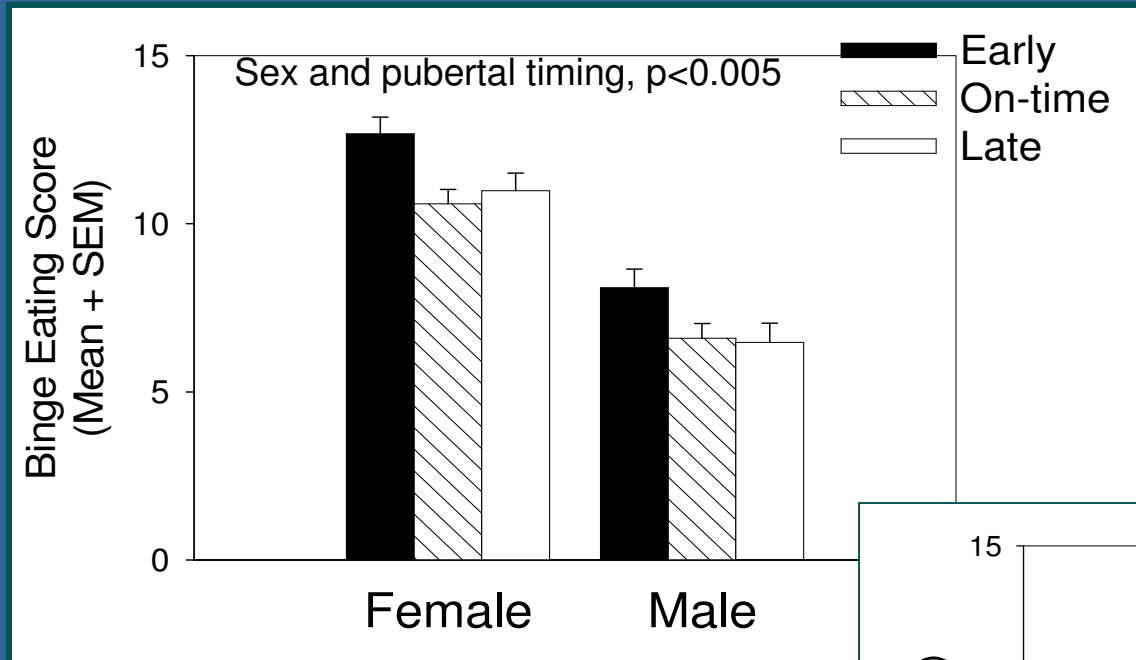
Pubertal timing and risk for disordered eating in humans

- 717 female, 643 male college students
- Retrospective estimate of when puberty occurred relative to peers (modified Pubertal Development Scale)
- Completed instruments assessing disordered eating, anxiety, alcohol use

Julia Zehr



Early puberty is associated with higher risk for disordered eating in adulthood



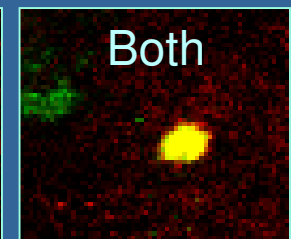
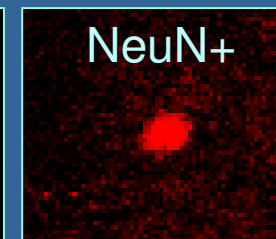
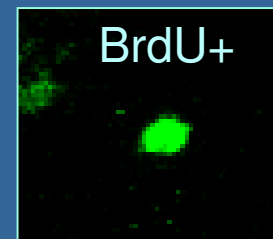
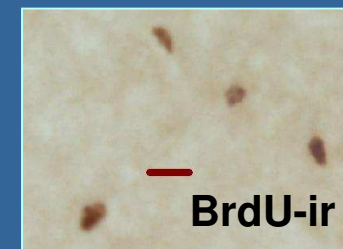
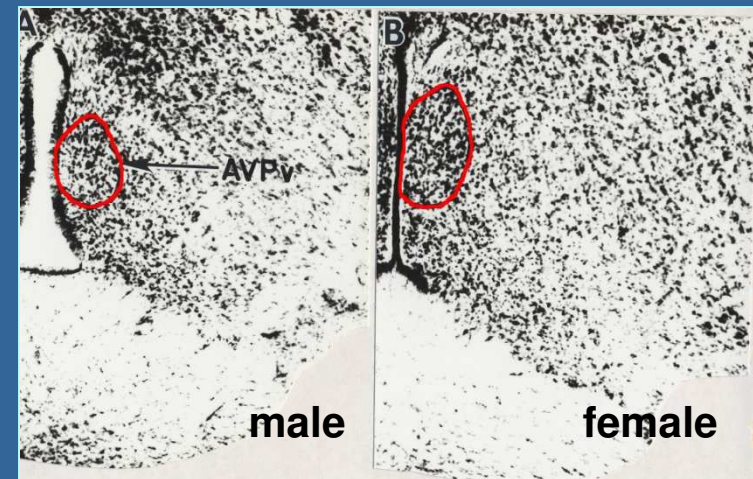
Zehr et al, Hormones
& Behavior, 2007

Remodeling the adolescent brain: what's in the tool box

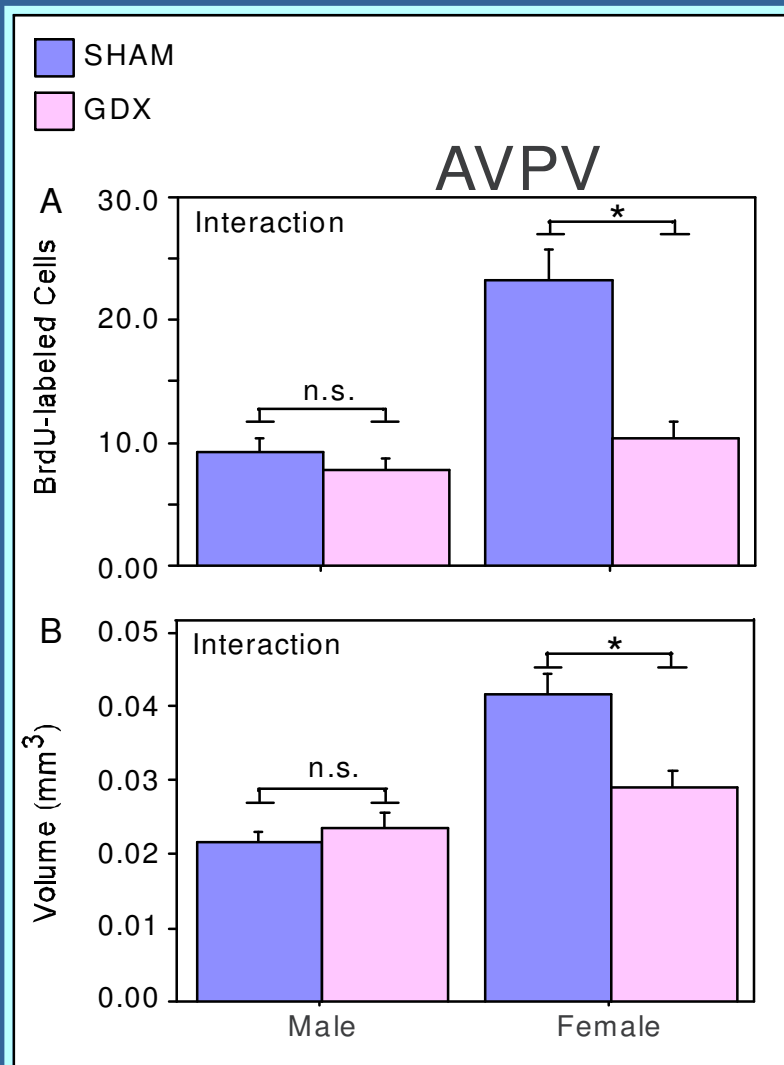
- Neurogenesis
- Cell death
- Synapse formation/proliferation
- Synapse elimination/pruning
- Myelination

Pubertal neurogenesis and the rat anteroventral periventricular nucleus (AVPV)

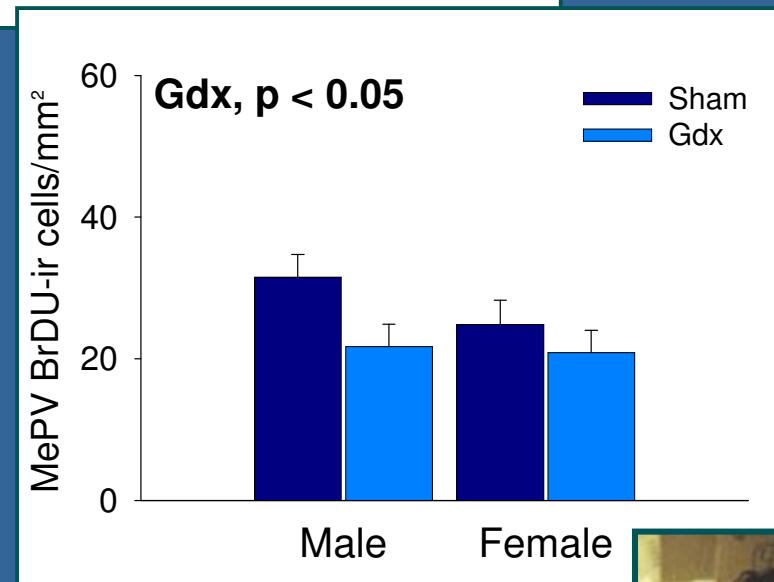
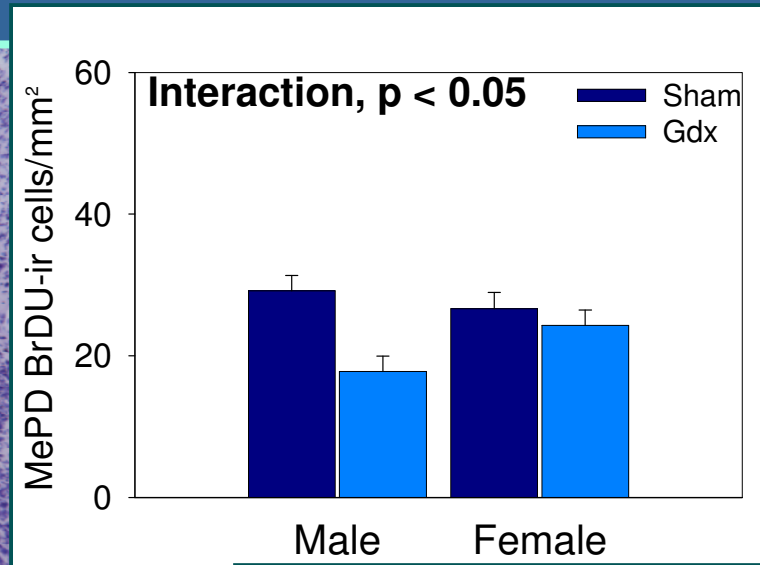
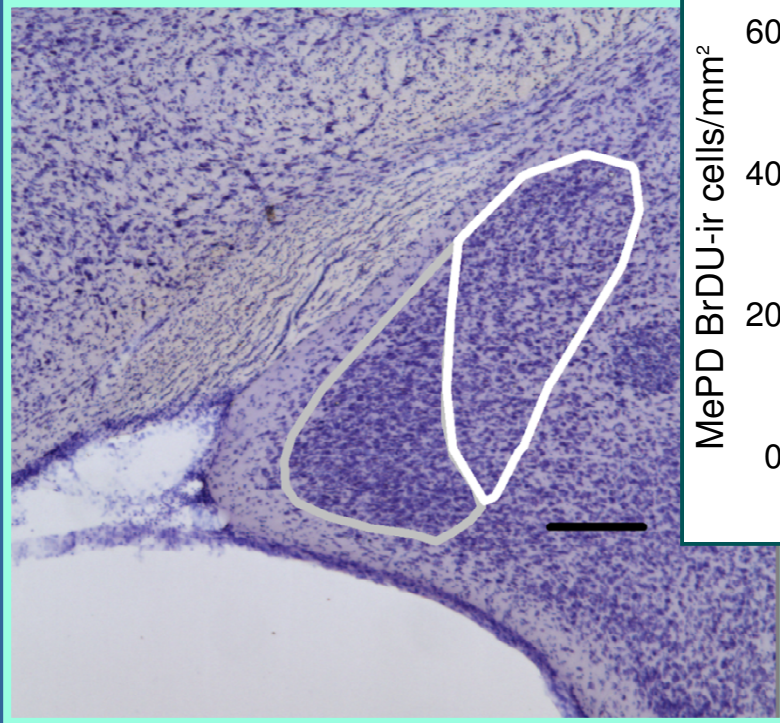
- Sexually dimorphic in structure and function; female biased, controls LH surge
- Sex difference emerges at puberty along with capacity to generate LH surge
- New neurons are added to AVPV during puberty; more in females than males



Pubertal ovarian hormones contribute to sex difference in volume and addition of cells



Eman Ahmed et al, SFN
2006



Medial Amygdala

- sensory and hormonal integration and associations
- evaluation of social sensory stimuli
- afferent input to executive function areas of cortex

Zehr et al, SFN 2007



Remaining Questions

- More on pubertal timing and other types of behavior
- Mechanisms
 - Why does the window of sensitivity to hormones close at the end of adolescence?
 - Through what molecules and signaling pathways do hormones organize (e.g., steroid receptors, growth factors)
 - What aspects of circuitry are being organized and how do they relate to function?
- Role of experience and relationship between hormones and experience
 - Can experience substitute for hormones?
 - Does experience mediate hormonal effects on behavior (indirect hormonal influences on brain and behavior)?

Acknowledgements

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