**What is Monogamy?**

- Social monogamy - preference for a specific partner (sexual exclusivity not essential)
- Demonstrated by physical proximity
- Monogamy also often associated with paternal care
OXYTOCIN AND VASOPRESSIN

NEUROBIOLOGY OF PAIR-BONDING ("LOVE")

- Oxytocin/ vasopressin/ review
- Why were oxytocin and vasopressin originally identified as bonding hormones?
- Species differences...where are monogamous and polygynous species different?
Paraventricular nucleus
Supraoptic nucleus

AVP is also produced in:
Suprachiasmatic nucleus

(In males only):
Medial amygdala
Bed nucleus of the stria terminalis
OXYTOCIN AND VASOPRESSIN RECEPTORS

- OT has one receptor throughout the body, expressed in many tissues including brain, uterus, male reproductive tract, mammary glands, etc.

- AVP has three receptor subtypes: V1a, V1b, V2

![Graph A](image)

![Graph B](image)
COOL AVP EXPERIMENTS

1) Injection of prairie vole V1a receptor genes into mice
2) Up- and down-regulation of V1a receptors in voles via viral vectors
3) Genetic studies of AVP receptor promoter regions
Both OT and AVP are involved in social recognition and memory

- OT knockout mice do not "remember" other individuals.
- Long history of studying AVP and social behavior (David DeWied).

Both OT and AVP can induce a pair-bond in both sexes

Cho et al. 1999 - treatments given ICV

Administration of OT or AVP could induce a pair-bond in either sex

Blocking OT or AVP could eliminate a pair-bond in either sex

Stress and pair-bonding

- Formation of a pair-bond also affected by stress
- Females that receive additional corticosterone take longer to pair-bond; remove their adrenal gland and they pair-bond faster
- Males that receive additional corticosterone or CRH take a shorter time to pair-bond; remove their adrenal gland and they pair-bond slower
REWARD COMPONENTS

- Mating induces dopamine release in both males and females
- Dopamine has multiple receptors (D1, D2, D3, etc.)
- Blocking these receptors non-selectively reduces pair-bonding (haloperidol)
- A non-selective DA agonist (apomorphine) injected into the Nacc induced pair-bonding (but not when injected into the striatum) note: at low doses but NOT high doses

- High doses probably activating D1 in addition to D2
- D2-type specific receptor agonist, quinpirole, induces partner preferences
- Blockade of D1 specifically does not inhibit partner preferences
- Activation of D1 prevents quinpirole-induced preferences

- Overall message:
  - D2 activation = partner preference
  - D1 activation = no partner preference
1) Both oxytocin and vasopressin are necessary in both sexes.
2) However, vasopressin may be more “important” in males and oxytocin is more “important” in females.
3) Dopamine is also a critical component of pair-bonding in both sexes.
4) Pair-bonding can be modulated by stress hormones (i.e. corticotropin-releasing hormone).
TITI MONKEYS

- Monogamous primate
- Strong pair-bond between male and female
- Males carry infants over 90% of time
- When separated, pair-mates have increased cortisol levels
- When infant is separated, neither father nor mother has elevated cortisol
- Infant has elevated cortisol when separated from father but not from mother

Early environment can affect the ability to form social bonds.
MODELS OF EFFECTS OF EARLY EXPERIENCE ON OXYTOCIN SYSTEMS

Based on models by Levine, Denenberg, Meaney, Champagne, Francis, Pedersen, Boccia, etc.
**Handling Effects on Male Alloparental Care**

Bales et al., Developmental Psychobiology.

**Partner Preference Test**

**Behaviors Scored**
- Location
  - Empty cage
  - Partner’s cage
  - Stranger’s cage
- Contact
  - No contact
  - Partner contact
  - Stranger contact
**Handling Effects on Female Pair-bonding**

Bales et al., Developmental Psychobiology,

**Handling Effects on Anxiety**

Bales et al., Developmental Psychobiology,
FEMALE OT RECEPTOR BINDING

MALE OT RECEPTOR BINDING
OT PRODUCTION IN THE SON
PHARMACOLOGICAL MANIPULATION OF OXYTOCIN - METHODS

- On day 1 of life, infants receive an injection of either:
  - 1) Oxytocin (OT)
  - 2) Oxytocin antagonist (OTA)
  - 3) Saline (SAL)
  - 4) They are handled only (HAN)
- Tested: parental care, partner preference, plus-maze, and intrasexual aggression

EXPOSURE TO OTA REDUCES ALLOPARENTAL CARE IN MALES

Bales et al., Developmental Psychobiology.

OT SHOWS A DOSE-RESPONSE IN FEMALES

Bales et al., Hormones and Behavior.
**MALE DOSE-RESPONSE**

![Male Dose-Response Graph]

**V1A RECEPTORS CHANGE IN MALES**

![V1A Receptors Change in Males Graph]

**INTRANASAL OXYTOCIN**

- Available for $29.95 on Amazon
- Chronic intranasal OT (not liquid trust brand) is in clinical trials for use with kids with autism
- No previous animal testing for long-term effects

*Bales et al., Neuroscience 2007*