Motherly love may alter genes for the better

Grooming makes rats less fearful, research suggests

Genetic changes could be passed on to descendants

Ian Sample
Science correspondent

A good dose of motherly love may be enough to alter our genetic code, leaving us less fearful and stressed out in later life, researchers have found.

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A good dose of motherly love may be enough to alter our genetic code, leaving us less fearful and stressed out in later life, researchers have found.

The striking claim suggests that rather than our genetic blueprint being fixed before birth our bodies can tweak its biological book of instructions, allowing us to adapt more swiftly to a changing world, instead of waiting millions of years for evolution to take its course.

track way for the body to fine-tune itself

The Guardian, 14 February 2007

Weaver et al
The Journal of Neuroscience, February 14, 2007 • 27(7):1756 –1768

Molecules of Love

Molecules of Life? Molecules of Mind?

Reductionist Views

We know that genes and chromosomes are the cause of hereditary transmissions, not only of physical but of psychological variations; but we do not discover how psychological characteristics can be contained and transmitted in this inconscient material vehicle. ….

Continued….

Sri Aurobindo in Indeterminates, Cosmic Determinations and the Indeterminable, LD. P 299.

- In Continuation

that a play of electrons, of atoms and their resultant molecules, of cells, glands, chemical secretions and physiological processes manages by their activity on the nerves and brain of a Shakespeare or Plato to produce or could be perhaps the dynamic occassion for the production of a Hamlet or a Symposium or a Republic; but we fail to discover or appreciate how such material movements could have composed or necessitated the composition of these highest points of thought and literature: the divergence here of the determinants and the determination becomes so wide that we are no longer able to follow the process, much less understand or utilise.

It may even be said that the supraphysical can only be mastered in its fullness – to its height we can always reach – when we keep our feet firmly on the physical. 'Earth is his footing'[1] says the Upanishad. …. The wider we extend and surer we make our knowledge of the physical world, the wider and surer becomes our foundation for the higher knowledge, even for the highest, even for the Brahmavidya.

Sri Aurobindo, LD, The two Negations: The Materialist Denial p. 11

Reductionist View (?)

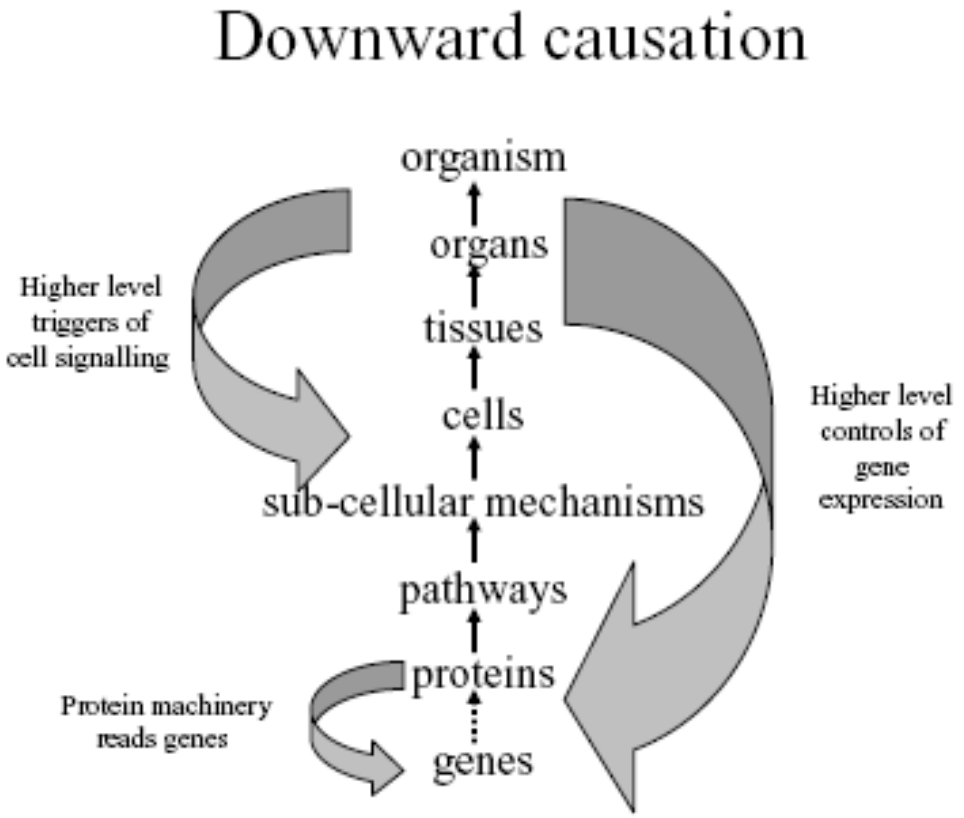


Figure 2. Figure 1 has been completed by adding the downward forms of causation, such as higher levels triggering cell signalling and gene expression

Note the downward-pointing arrow connecting from proteins to genes to indicate that it is protein machinery that reads and interprets gene coding. Loops of interacting downward and upward causation can be built between all levels of biological organization. Reproduced with permission from Noble (2006).

Oxford English Dictionary defines love:

> An intense feeling of deep affection or fondness for a person or a thing, a sexual passion, or sexual relations, in general.

Sri Aurobindo in LD, p. 205

> In its life-origin, the law of love is the impulse to realise and fulfill oneself in others and by others, to be enriched by enriching, to possess and be possessed because without being possessed one does not possess oneself utterly.

Sri Aurobindo, LD, p. 315

Love finds itself in a trinity of the Lover, the Beloved and Love.

Biological Functions of Love

To ensure the survival of the species via social attachments, gathering, copulation and reproduction.

3 Phases of Love

- 1. Being in Love: High passion, rapid rise in intimacy, increased commitment, euphoria. Lasts for 6 months. High stress, NGF rises in romantic love, Sympathetic ANS activated.

- 2. Passionate Love: Decreased stress. Safety, calm and balance. Hormones normalise. Pair bonding under OT, VP continues. Passion remains high, intimacy continues. Has health benefits.

3. Compassionate Love: decrease in passion, intimacy and commitment remains high. Similar to friendship.

Not all relationships evolve to 3rd phase. Transition from 2 to 3 is fragile. Some relationships may be stuck to phase 2 for all the life.

- Bulid up of Appetance (desire)
- Full Pleasure
- Decrease in Appetance

  To baseline level
- Activation of Aversion to stimulus

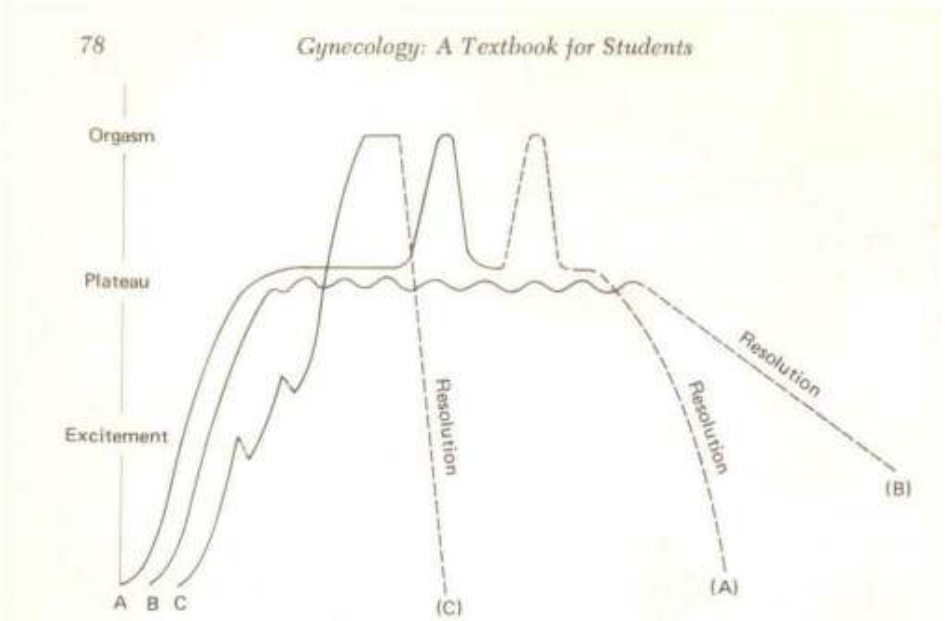


Fig. 51. Cycle of female sexual response. (A) Reaction pattern with single or multiple orgasms; (B) reaction pattern without orgasm; (C) reaction pattern without distinct plateau (from Masters and Johnson, 1967).

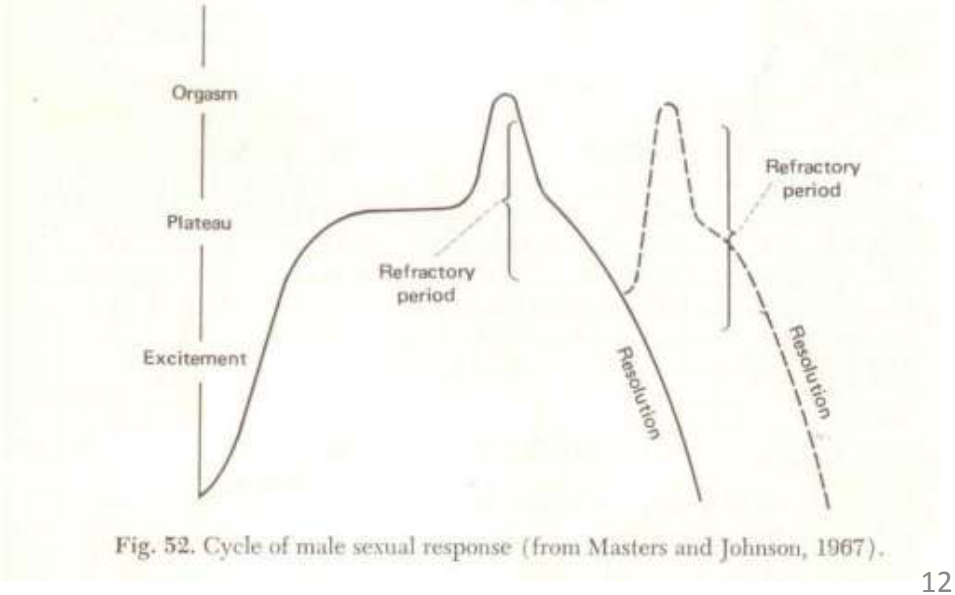
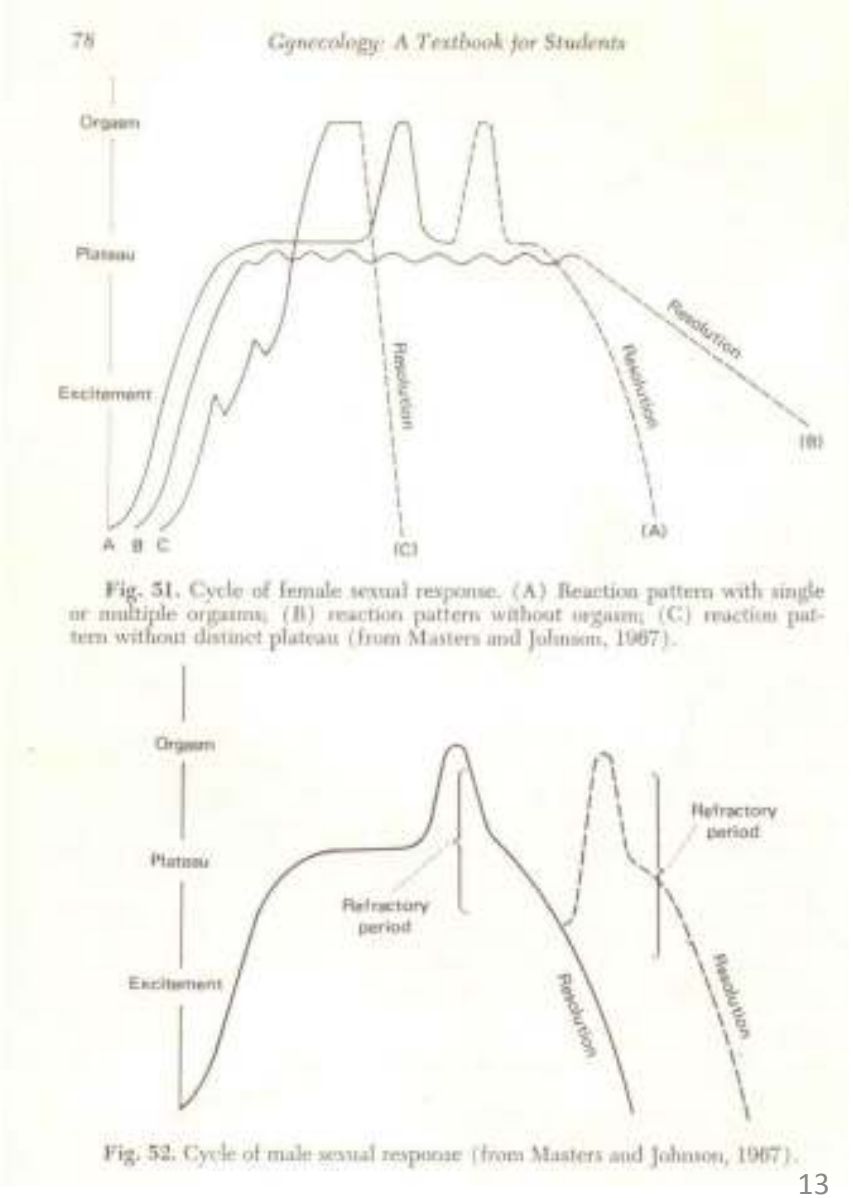


Fig. 52. Cycle of male sexual response (from Masters and Johnson, 1967).

Addiction to Unnatural Stimuli like Drugs

- Build up appetance not released completely or only for a short while after consumption
- Motivational Toxicity (Even more appetence)



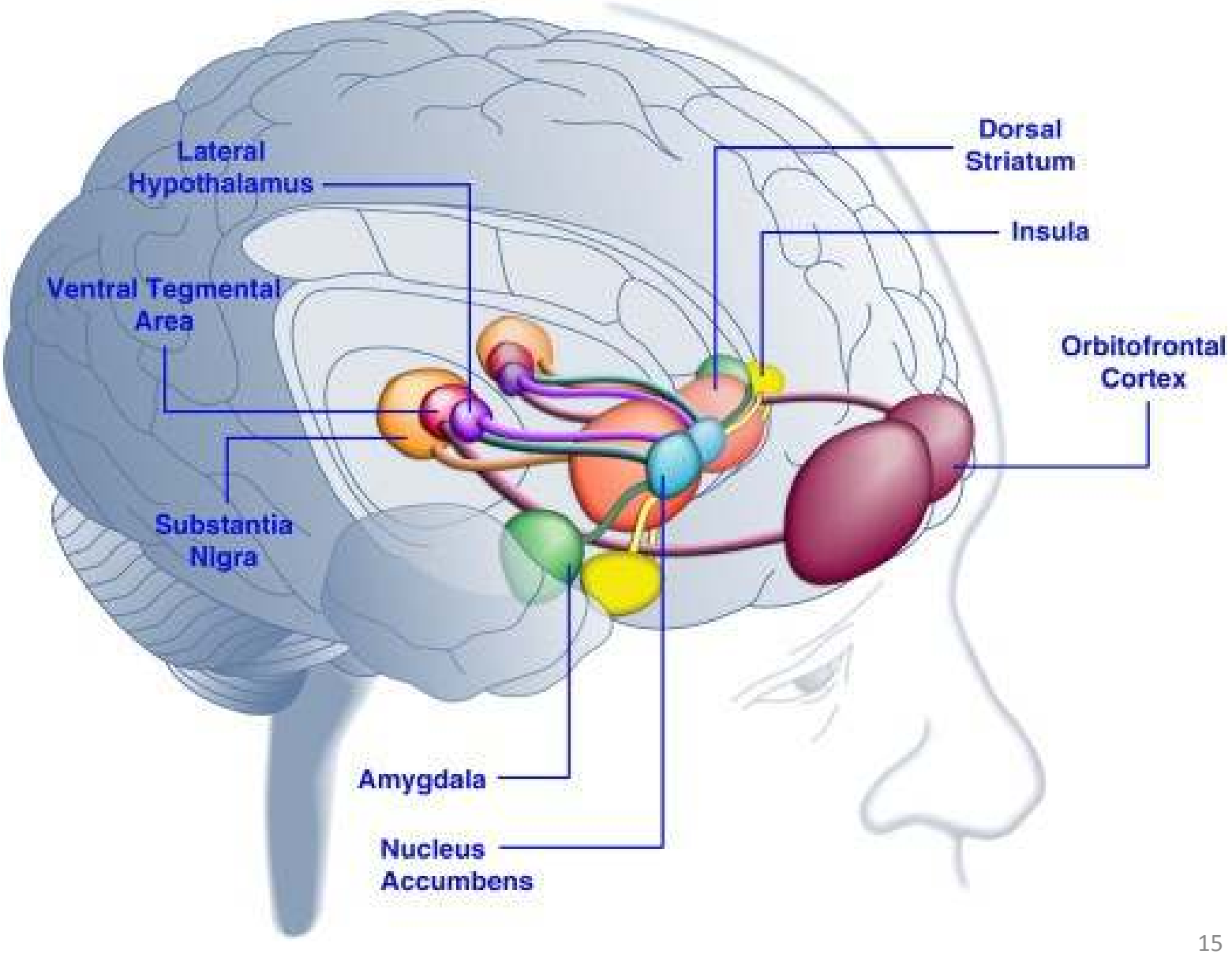
Components of Love

- Falling in Love / Attraction

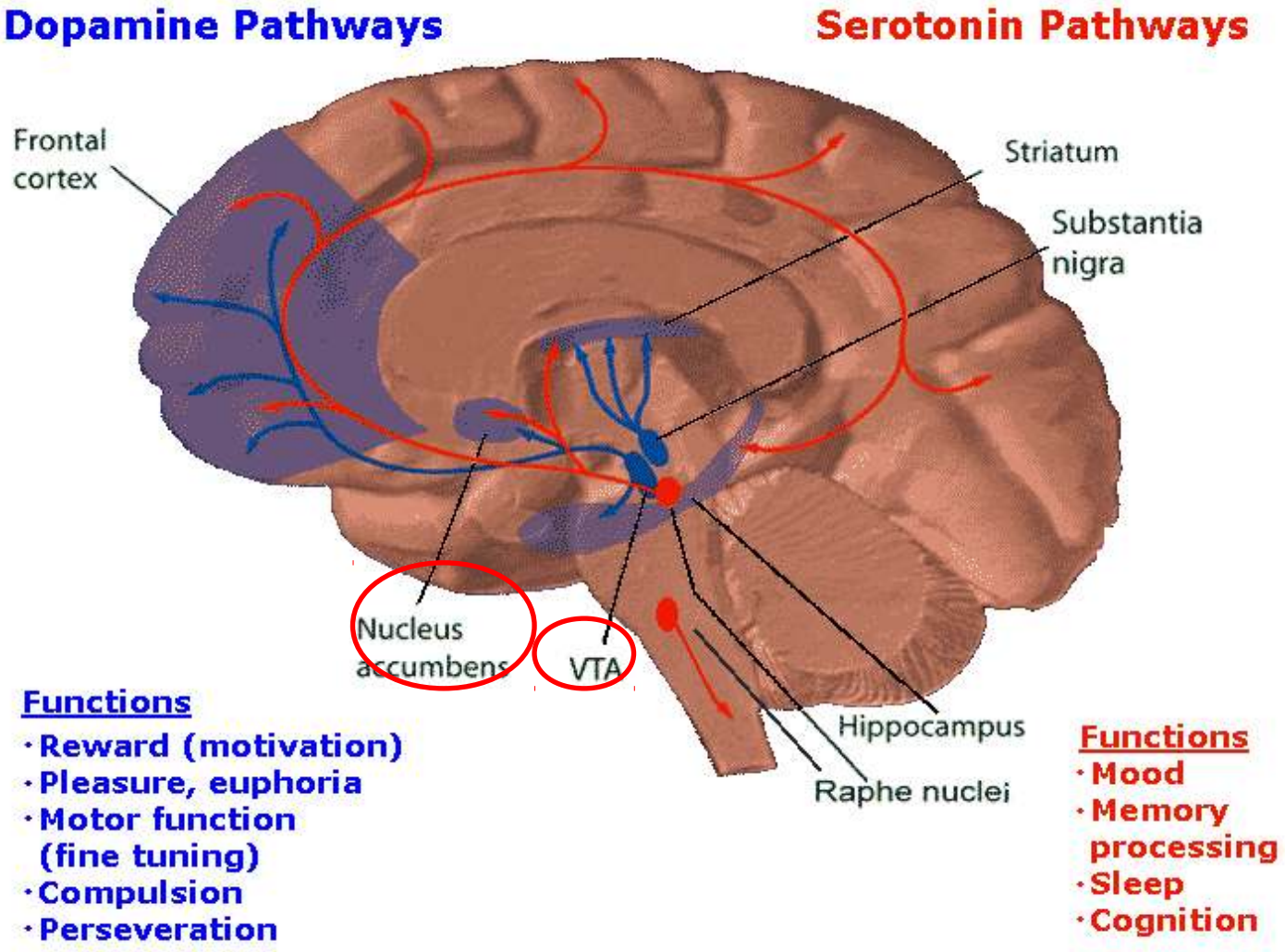
- Attachment Process (pair bonding): may last for ever in some cases e.g., mother's love,

  provides support and protection under challenging circumstances.

Brain Reward Areas



Interaction of Dopaminergic and Serotonergic system



VTA & Nacc are brain areas where dopamine & serotonin neurons interact with each other in reward processing

http://3.bp.blogspot.com/UPZ7fp0iKtQ/T6wb8JBoeyI/AAAAAAAAA0E/IGSZGNs3_g/s1600/Dopamine+seratonin+system.png

Brain Areas Involved in Love -- 1

- Activation of Reward-Dopaminergic Areas: Medial insula, anterior cingulate gyrus, hippocampus, straitum, nucleus accumbens.

- Deactivation of Right sided Amygdala, frontal cortex, prefrontal cortex, temporal poles, and parietotemporal junctions.

Brain Areas Involved in Love -- 2

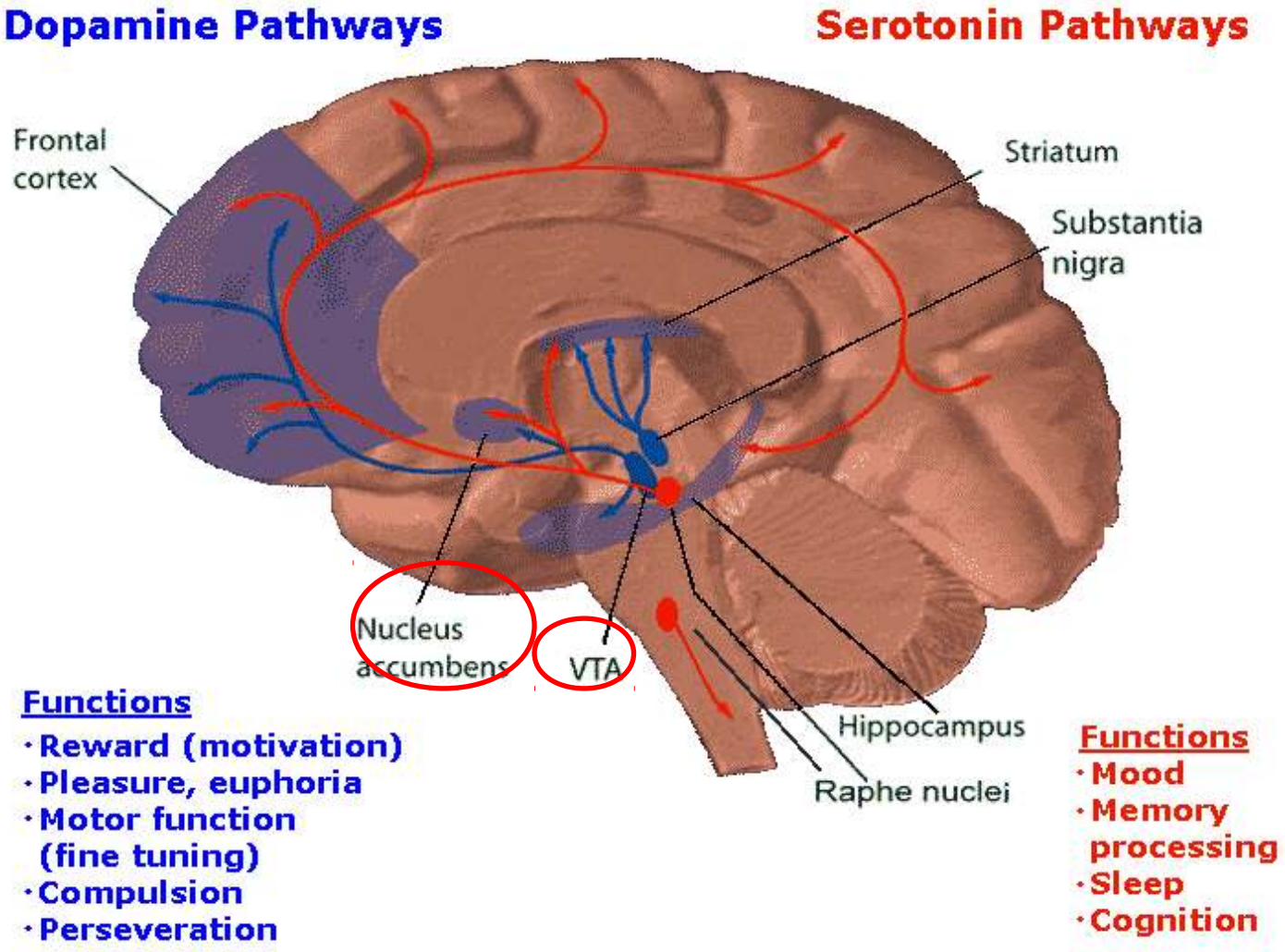
- Frontal cortex is for negative emotions and judgment: It is suppressed, and lover's character is not judged.

- Prefrontal cortex, temporal poles and parieto temporal junctions which, mentalise, evaluate feelings and intentions are also implicated.

Dopamine

Oxytocin and Vasopressin interact with the dopamine making love a rewarding experience

Interaction of Dopaminergic and Serotonergic system



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Dopamine and Love

The dopamine – innervated regions contain a high density of oxytocin and vasopressin receptors.

Nucleus accunbens, ventral tegmental area, paraventricular hypothalamic nucleus, prefrontal cortex are dopamine innervated regions.

Dopamine receptors & love

D1 receptor (in NA)– blocks the formation of new pair-bonds after formation of one by inducing aggression to a stranger female.

D2 receptor neurons (project to Ventral Pallidum rich in VP-R) – facilitates formation of new pair-bonds. D2 R also stimulates cocaine addiction.

After formation of pair-bond, D1 receptor density upregulates preventing formation of newer pair bonds.

the prairie vole model

Nucleus accumbens, ventral tegmental area, paraventricular hypothalamic nucleus, prefrontal cortex are dopamine innervated regions

High desity of OT & VP receptors

Release of Dopamine in Nucleus Accumbens is central to monogamous pair formation in praire voles

Other endocrine factors and neurotransmitters in love -- 1

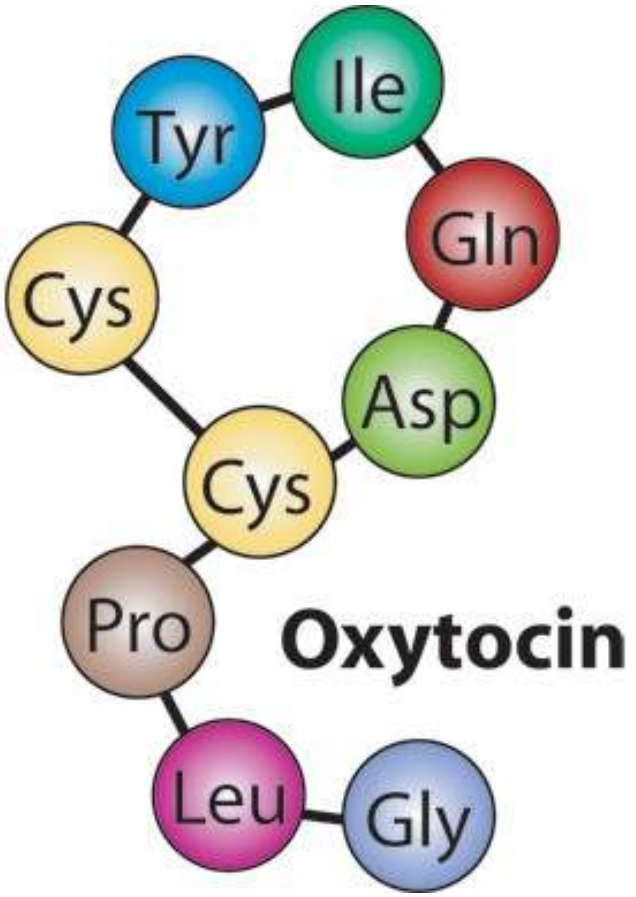
- Oxytocin (OT)
- Vasopressin (VP)
- Adrenal cortisol and other stress molecules of Hypothalamo-Pituitary-Adrenal axis.
- Serotonin
- Hypocretin/Orexin
- Nerve Growth Factor

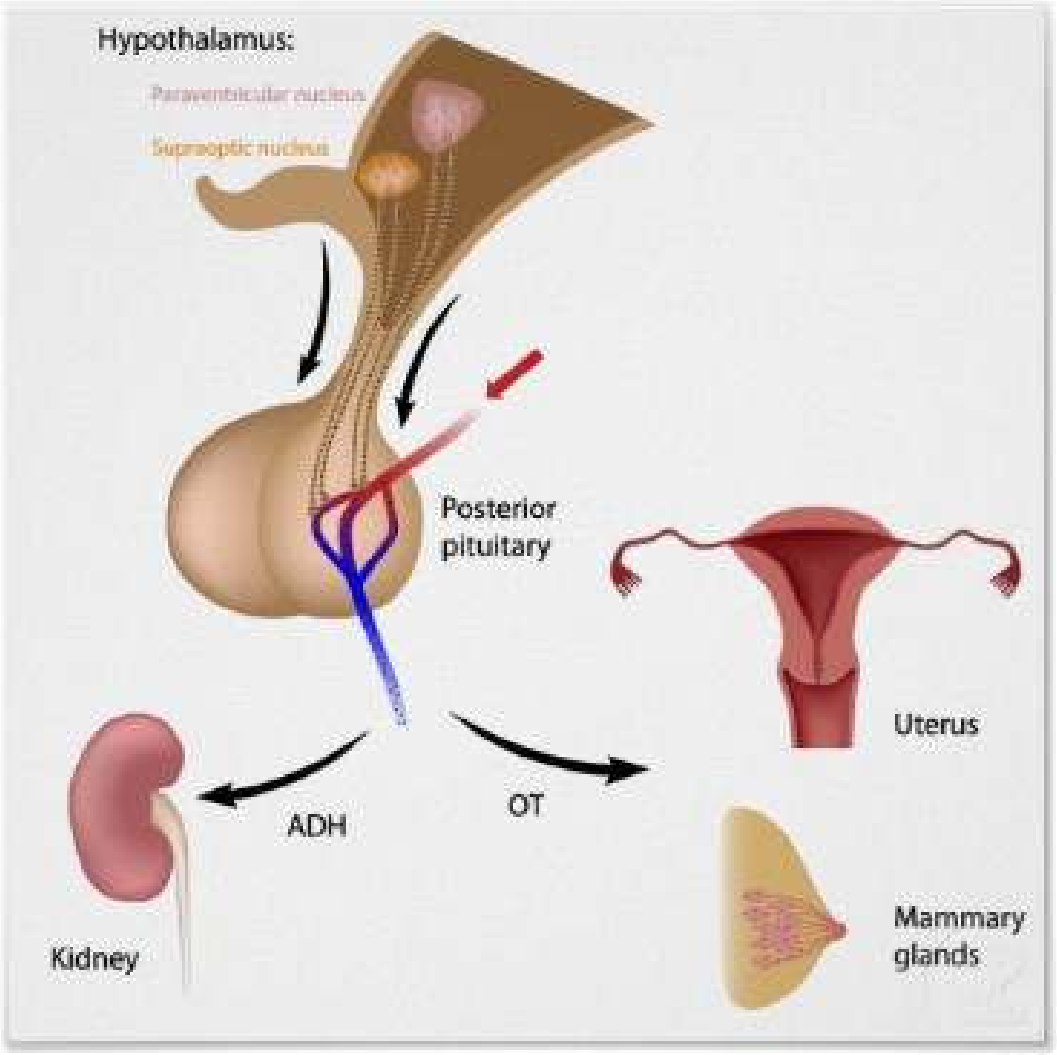
Other endocrine factors and neurotransmitters in love -- 2

- **Testosterone**
- **Endogenous morphine like chemicals: enkephalins and endorphins**

Oxytocin

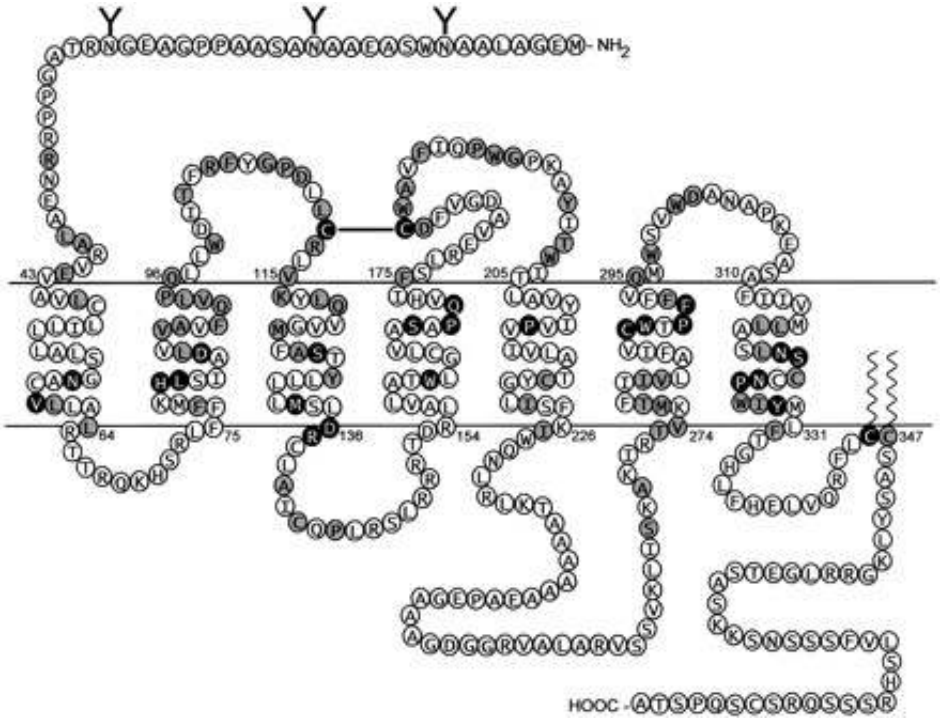
‘love drug’
‘cuddle chemical’



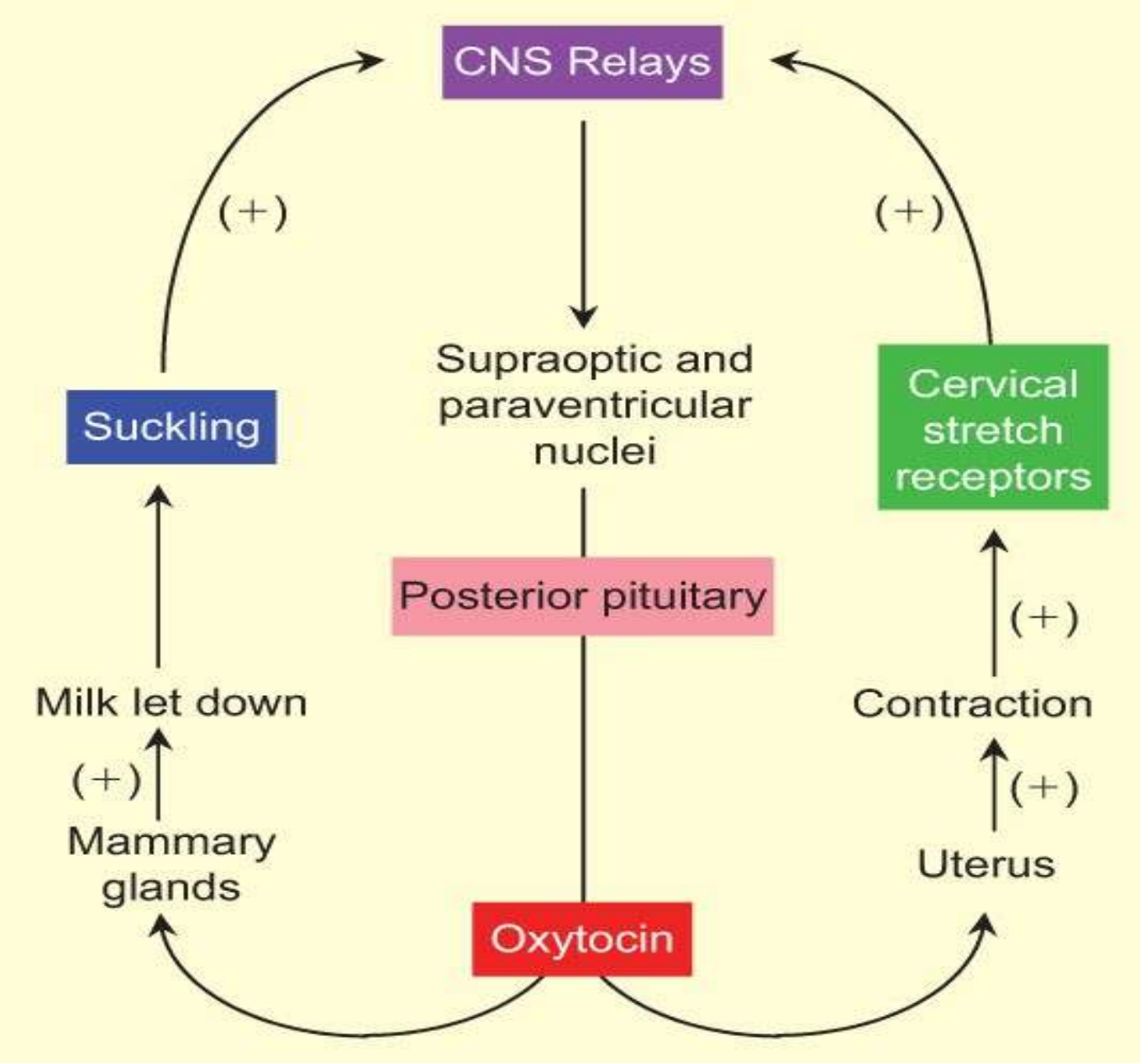

Hypothalamus:
Paraventricular nucleus
Supraoptic nucleus
Posterior pituitary
Uterus
ADH
OT
Kidney
Mammary glands

Oxytocin Receptor

- G-protein coupled receptor
- Brain Location: amygdala, ventromedial nucleus of the hypothalamus
- Peripheral tissues: reproductive organs, thymus, heart



Schematic model of human oxytocin receptor *(Gimpl & Fahrenholz, Physiol Rev, 2001)*


CNS Relays
(+)
(+)
Supraoptic and paraventricular nuclei
Suckling
Cervical stretch receptors
Posterior pituitary
(+)
Milk let down
Contraction
(+)
(+)
Mammary glands
Uterus
Oxytocin

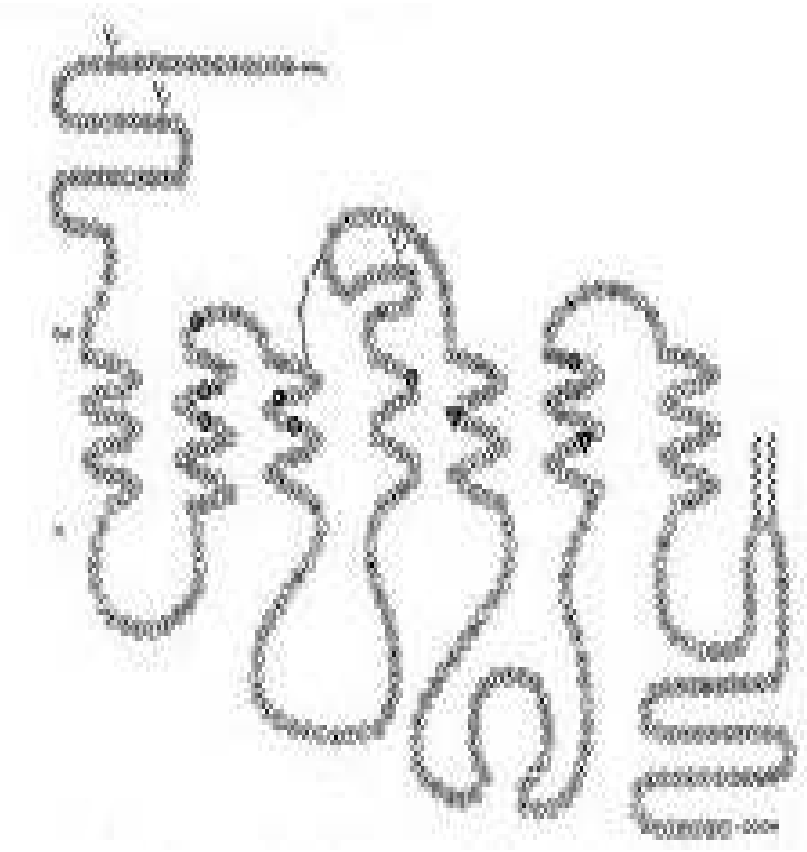
Vasopressin

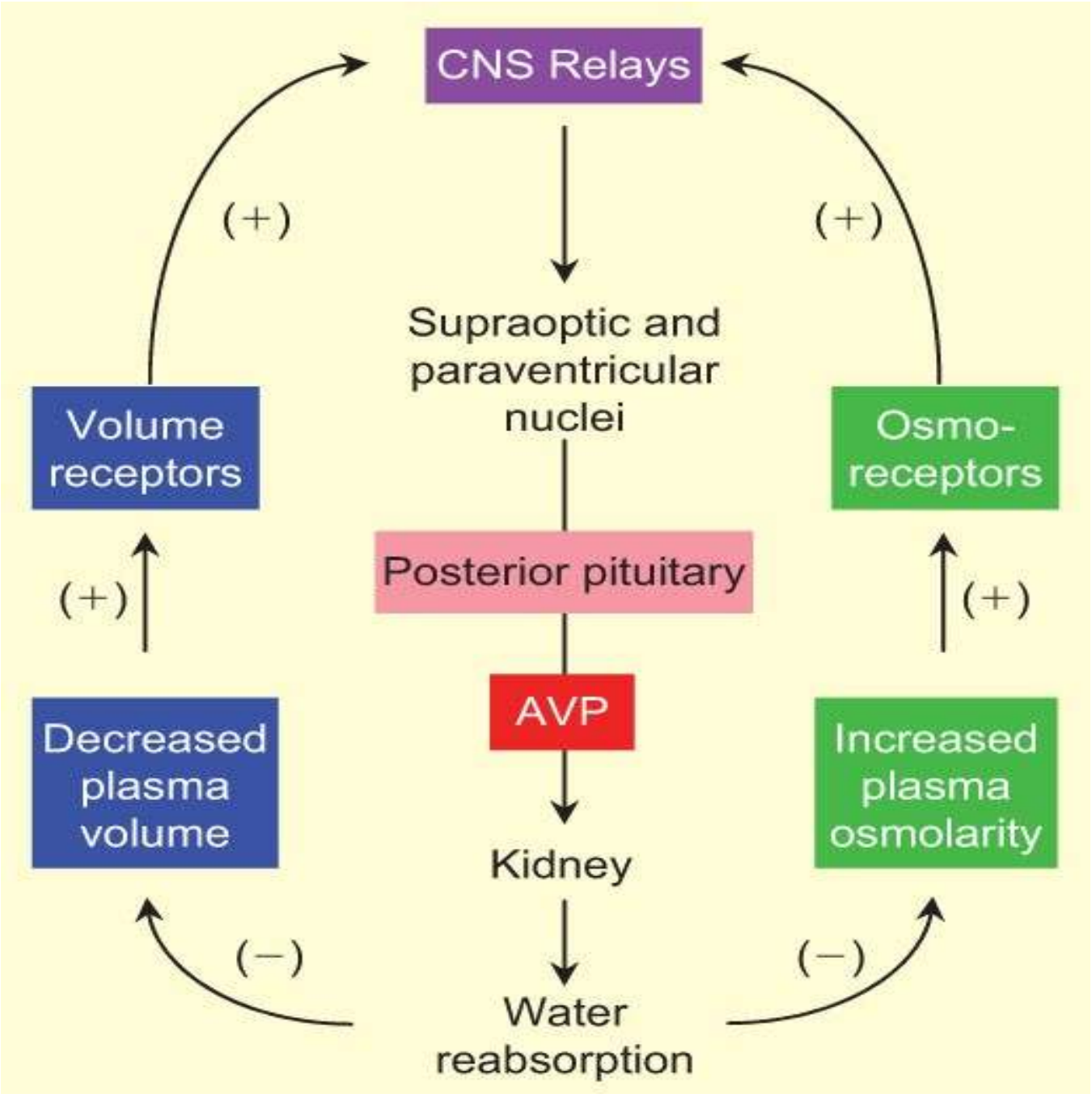
Argipressin

Antidiuretic hormone (ADH)

Vasopressin Receptor

- 3 receptors - V1a, V1b, V3
- V1a – cardiovascular system , prefrontal, cingulate, pyriform, entorhinal cortex, mamillary bodies
- V1b - pituitary
- V2 - kidney




CNS Relays
(+)
(+)
Supraoptic and paraventricular nuclei
Volume receptors
Osmo-receptors
Posterior pituitary
(+)
(+)
AVP
Decreased plasma volume
Increased plasma osmolarity
Kidney
(−)
(−)
Water reabsorption

Differences in oxytocin & vasopressin in pair-bonding

	Vasopressin	Oxytocin
Central infusion into ventral pallidum	Partner preference in male prairie voles	Partner preference in female prairie voles
	Increases fear and stress response	Anxiolytic and stress-reducing effects
	Activates Rt amygdala	Deactivates Rt amygdala

- OT-Rs in lateral parts of central nucleus of amygdala.
-
- OT activates GABA neurons there.

- GABA inhibits Amygdala output, arouses trust.

- VP activates Amygdalar output, arouses fear.

- In both, males and females, during romantic love the effect of Oxytocin is stronger than Vasopressin on the decrease in amygdalar activity (fear reduction).

- Vasopressin is more active in male binding and OT is more active in female binding.

Hypothalamic pituitary adrenal axis (HPA) and cortisol

- HPA activity increases only in early stage romantic love.

- Increased stress levels observed during early romantic love is due to raised cortisol levels required to trigger bond formation and overcome initial neophobia.

- Vasopressin increases HPA axis activity in early stage romantic love while oxytocin reduces stress and HPA axis activity in long-term relationships.

Love and Stress

- Moderate stress or Acute Stress promotes attachment.

Rodent population increases. Improved immune system

- Chronic or Excessive stress, e.g., grief may promote breakdown of attachment, promote isolation and ill health.

Social Stress & Aggression in Rodents & Primates:

Infertility, infections, atherosclerosis, hypertension, neural, cardiovascular and renal damage and death.

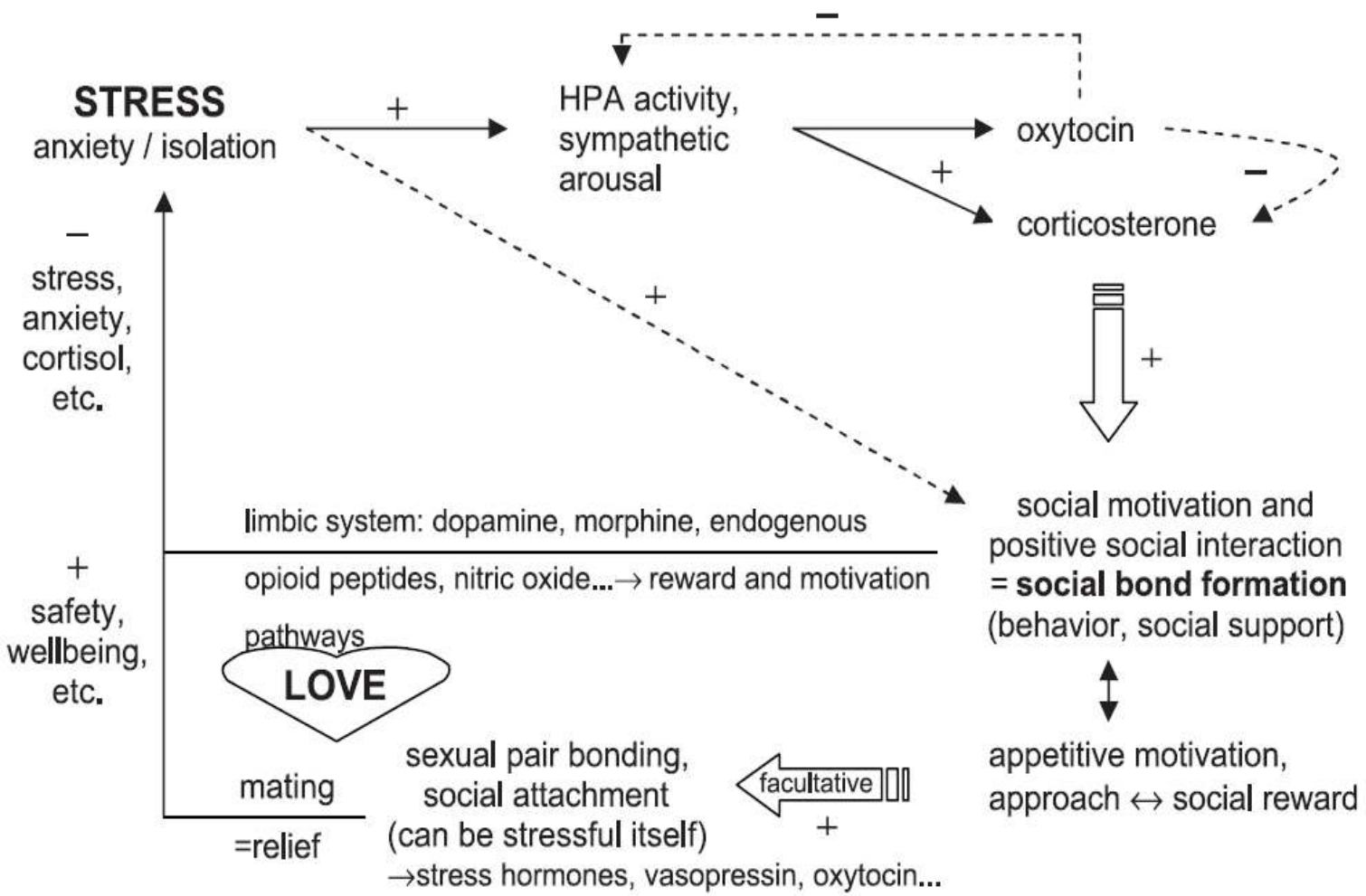
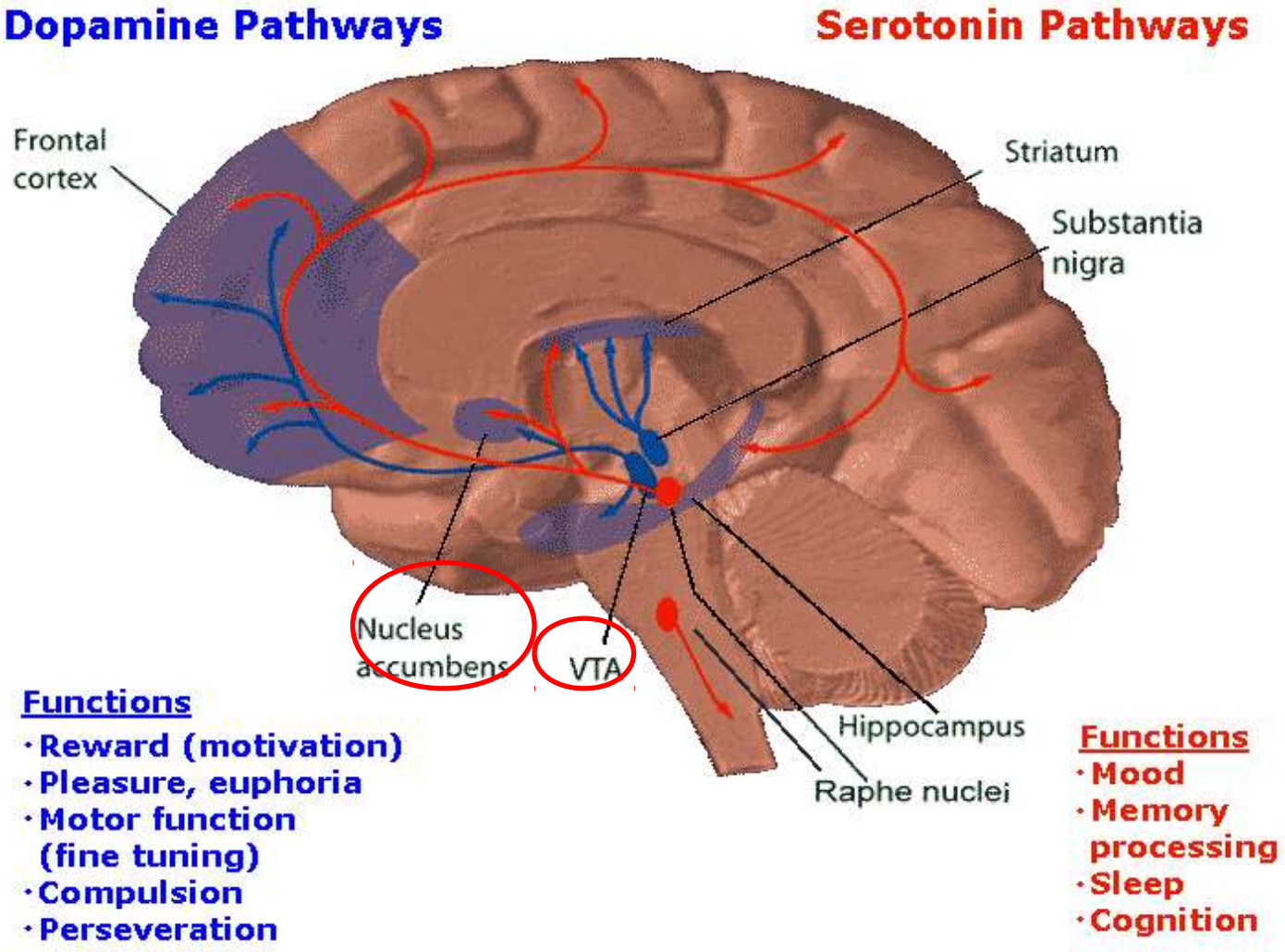


Figure 1. *Stress and its relation to social bond formation and love.*
References see text. HPA – hypothalamic-pituitary-adrenal (axis).

Serotonin

Interaction of Dopaminergic and Serotonergic system



VTA & Nacc are brain areas where dopamine & serotonin neurons interact with each other in reward processing

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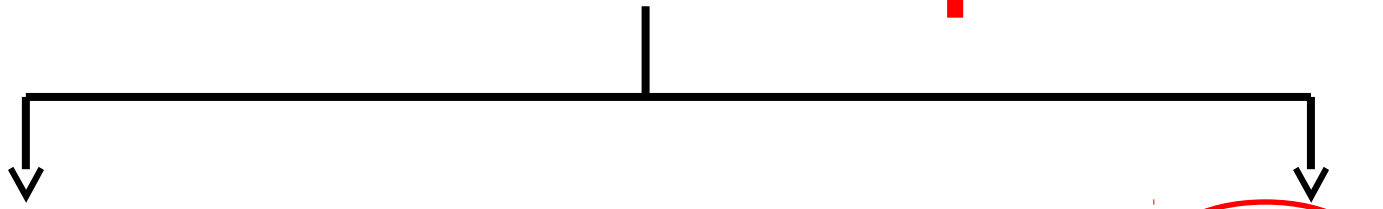
Serotonin receptors



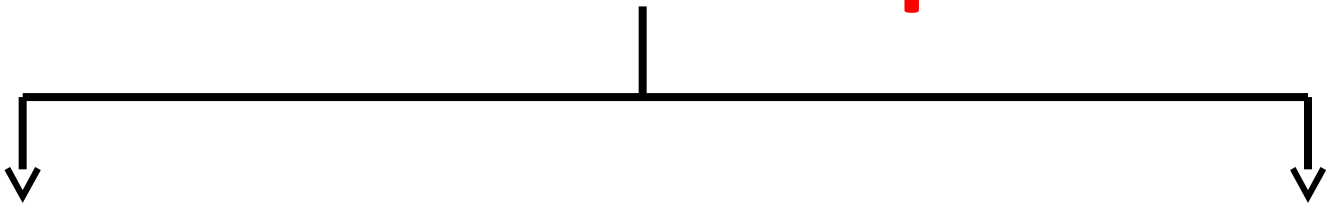
Inhibitory receptor, 5-HT_{1A}

High in raphe nuclei, OFC, ACC
Low in VTA, striatum, amygdala

Excitatory receptor, 5-HT_{2A}

High in OFC, ACC
Low in raphe nuclei, VTA, hypothalamus, lateral habenula

Serotonin transporter



High in raphe nuclei, OFC, ACC

Low in NAcc, ACC, striatum, OFC

- Antidepressants: Synaptic Serotonin Reuptake Inhibitors Raise Brain Serotonin.

- Alleviate depression in 53-64 % cases

- However decrease liking (desire, anhedonia) and wanting (motivation) pleasure, including libido.
- This effect is mediated by **H_{2A}** receptors in dopaminergic areas.

Hypocretin/Orexin (?)

- Secreted by neuronal bodies in the dorsal & lateral hypothalamus, thalamus and brainstem

- Single neurotransmitter that regulates sleep, appetite, metabolism and reward-seeking behaviours

Nerve Growth Factor

- Neurotrophin
- Inflammatory mediator in Chronic Airway diseases
- Determines dominant and submissive behavior
- Reduces stress by inhibiting HPA axis
- Elevated in plasma of after new love
- May facilitate pair bonding (?)

Testosterone

- Reduced levels in males but elevated levels in females during first 12-24 months of new relationship.
- Partnered men and women have lower T than singles.
- Women in long distance relationship have higher T levels than women who are in a relationship with a man in the same city

Endogenous Morphine

- Enkephalins ⬇ the release of OT and VP in the posterior pituitary
- Enkephalin ⬇ OT & VP in related memory and learning stimulation

Endogenous Morphine

- Endogenous morphine in neurons containing VP-R & OT-R eg amygdala, nucleus accumbens, raphe nucleus, VTA, hipocampus

- An opiate receptor, mu3, is critical for lust and reward. This receptor also important for infant-mother bonding.

- Opiate signaling erase negative memories and enhance positive memories.

Gender differences in love

- Females: Brain areas associated with attention, emotion and memory are activated.

- Males: Areas associated with viewing beautiful faces and integration of visual stimuli are activated. This signals a woman's youth and beauty, indicators of her fertility to a man's mind.

- Bonding is both, estrogen + OT dependent in women.

Romantic vs Parental Love

- Hypothalamus is activated in sexual arousal and romantic love, but not in maternal love

- In maternal love areas involved in face recognition and facial expression are activated.

Romantic vs Parental Love

- Maternal love is one of the most powerful motivations for human love is well known.
- Sexual behaviour is related to attachment but the two are not always associated.
- Both loves share a common evolutionary purpose, namely maintenance and propagation of the species.

Romantic vs Parental Love

- Paternal Love and Other kind of Loves not yet investigated.

Break up of a Relationship

- Increase in stress hormones
- Increased activity in ventral tegmental area, ventral straitum, pallidum and putamen and orbitofrontal cortex
- Rejected individuals had decreased activity in brain network and depression.
- Women have stress related diseases
- Men are prone to drug abuse
- Social support system alleviates health hazards

Human Monogamy

- Most relationships break up sooner or later.
- 1/3 of all marriages in the West end in divorce.
- Marital satisfaction is inversely related with the duration of marriage.
- Humans are not biologically monogamous, though they so pair bonding and cooperation in raising offspring.
- Ongoing studies on OT, VP and Receptor polymorphism, & dopamine D-2 receptor.

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THANK
YOU