

THE HEALING POWER OF LOVE: AN OXYTOCIN HYPOTHESIS

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Dedicated to a deeper understanding of the neurobiological basis
of love, sexuality, and wellness



CONTEXT - THE WORLD HAS ALWAYS HELD DANGER, TRAUMA & PAIN



The Wave Off Kanagawa. By Hokusai 1829-1833



Human existence required THE EVOLUTION OF A SOCIAL SOLUTION for dealing with Stress, Trauma and Pain in a complex world.

PURPOSE of this presentation is to EXPLORE THE EVOLUTION AND BIOLOGY OF LOVE AND OXYTOCIN, to begin to understand WHAT MAKES US “HUMAN” AND HOW “LOVE PROTECTS AND HEALS”

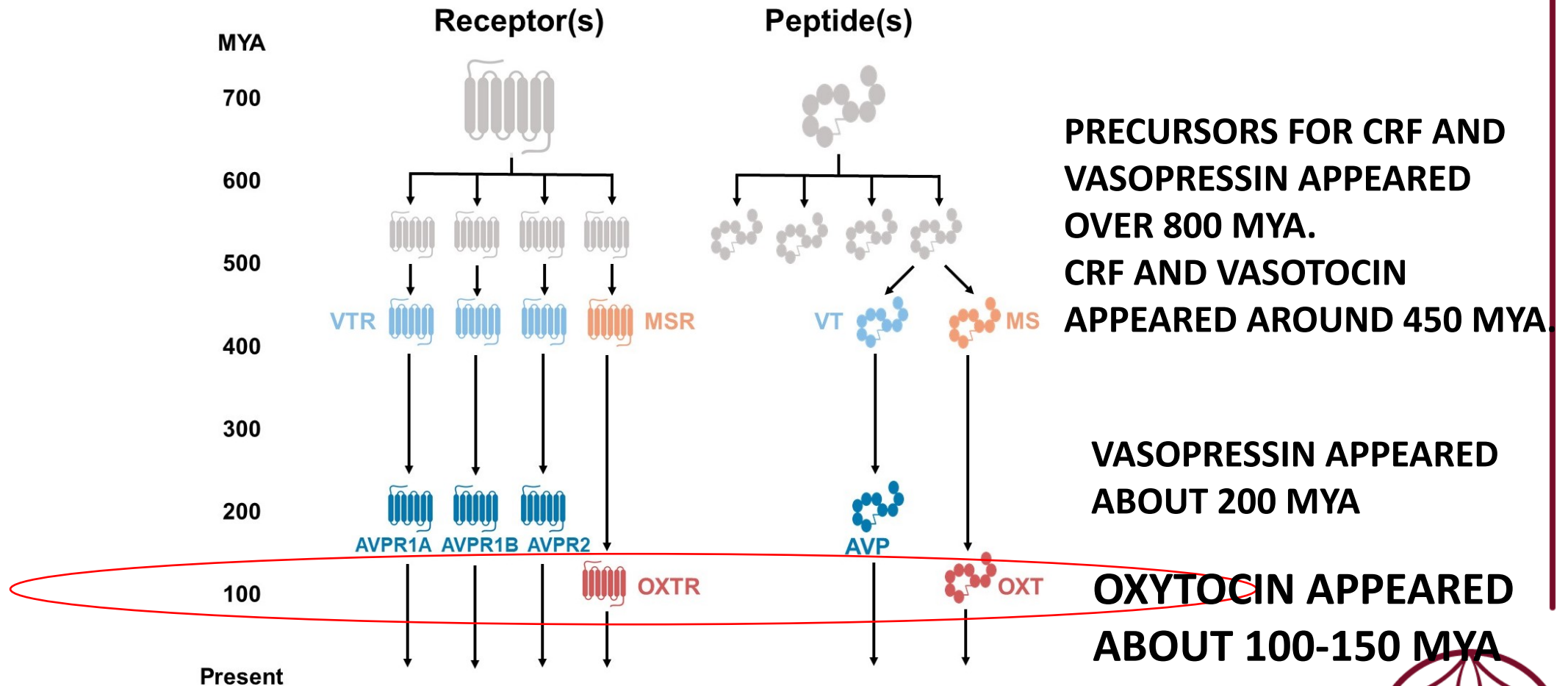
This solution depended on the comparatively recent evolution of -

- 1. OXYTOCIN (a mammalian hormone)**
- 2. SOCIAL COGNITION**
- 3. SELECTIVE SOCIAL BONDS and other ADAPTIVE RELATIONSHIPS**
- 4. CAPACITY for a PERCEIVED SENSE OF SAFETY (Social cues) to PROTECT AND HEAL even in the face of FEAR, THREAT AND TRAUMA**

HIGH LEVELS OF SOCIALITY and DEPENDENCE ON OTHERS is central to being a MAMMAL, and especially to being HUMAN.



THE EVOLUTION OF MAMMALIAN OXYTOCIN AND ITS RECEPTORS STARTED ABOUT 150-100 MILLION YEARS AGO (MYA) -



Arginine Vasopressin (AVP) evolved about 200 million years ago associated with the transition to terrestrial life – from VASOTOCIN (VT) - a more ANCIENT peptide), associated with aquatic life.

Oxytocin (OT) is more MODERN... appearing about 100-150 million years ago, associated with the evolution of mammals (SOCIAL BONDS, BIRTH, LACTATION AND SOCIAL COGNITION).



LOVE and FEAR, TRAUMA, and CHRONIC PAIN are most easily understood in the context of EVOLUTION and DEVELOPMENT.

BOTH LOVE and FEAR directly or indirectly support:

SURVIVAL

SOCIAL SUPPORT AND PERCEIVED SAFETY

DEFENSE AND AGGRESSION

REPRODUCTION

ACCESS TO MATES

CARE OF OFFSPRING

GENETIC SURVIVAL



What is love?

**LOVE is usually defined by
ATTACHMENTS AND
SOCIAL BONDS AND A
NEED TO PROTECT THOSE
THAT WE LOVE.**

**Here I define LOVE as a
complex of neurobiological
processes that facilitates
health, wellness,
reproductive fitness &
biological optimality.**



SOCIAL BONDS and SECURE ATTACHMENTS are essential to all definitions of LOVE.

The capacity for SELECTIVE & SECURE social relationships, as well as the emotions and chemistry associated with SOCIAL BONDS, are not unique to humans or other primates. This has allowed a deeper understanding of the biological basis LOVE, SAFETY and FEAR and perhaps CHRONIC PAIN?



Photo by Jessie Williams





**CONTEXT: Survival is the first law of nature.
It is biologically important that we are not alone.**





CONTEXT: Sociality has survival benefits.
There is safety in numbers.



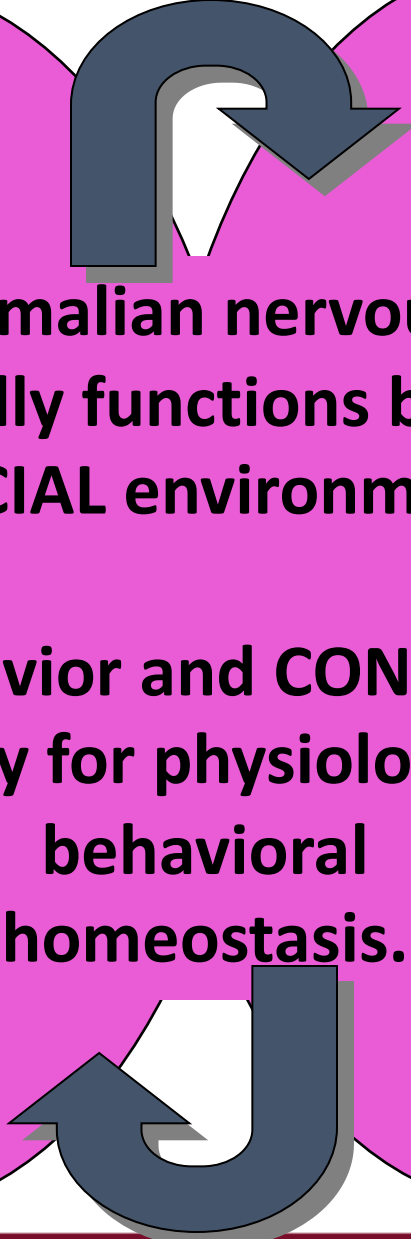
**SOCIAL BEHAVIOR, SOCIAL BONDS AND LOVE -
BUT ALSO FEAR, TRAUMA AND PAIN
EXIST IN THE CONTEXT OF EVOLUTION**

**The most common
unit of analysis in
Psychology and Biology
and
especially in
Physiology
is the
INDIVIDUAL.**



**However,
Most living organisms can
NOT SURVIVE
OR REPRODUCE ALONE.**





**The mammalian nervous system
especially functions best in a
SOCIAL environment.**

**Social behavior and CONNECTION is
necessary for physiological and
behavioral
homeostasis.**

**What
Myron Hofer
called
“Hidden regulators”**



**In the ABSENCE
of appropriate
social interactions
& social bonds
(i.e. ISOLATION)**

-

**Substitutions
May occur**

**Abuse of
Drugs
Food,
Mental
Dysfunction,
CHRONIC
PAIN??**

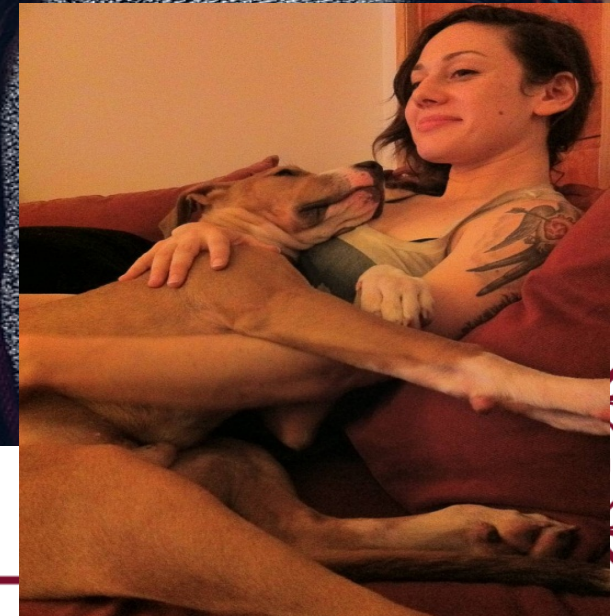




**WHAT IS
LOVE?**

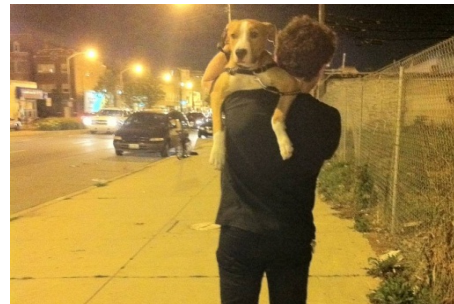


LOVING RELATIONSHIPS CAN COME IN MANY FORMS



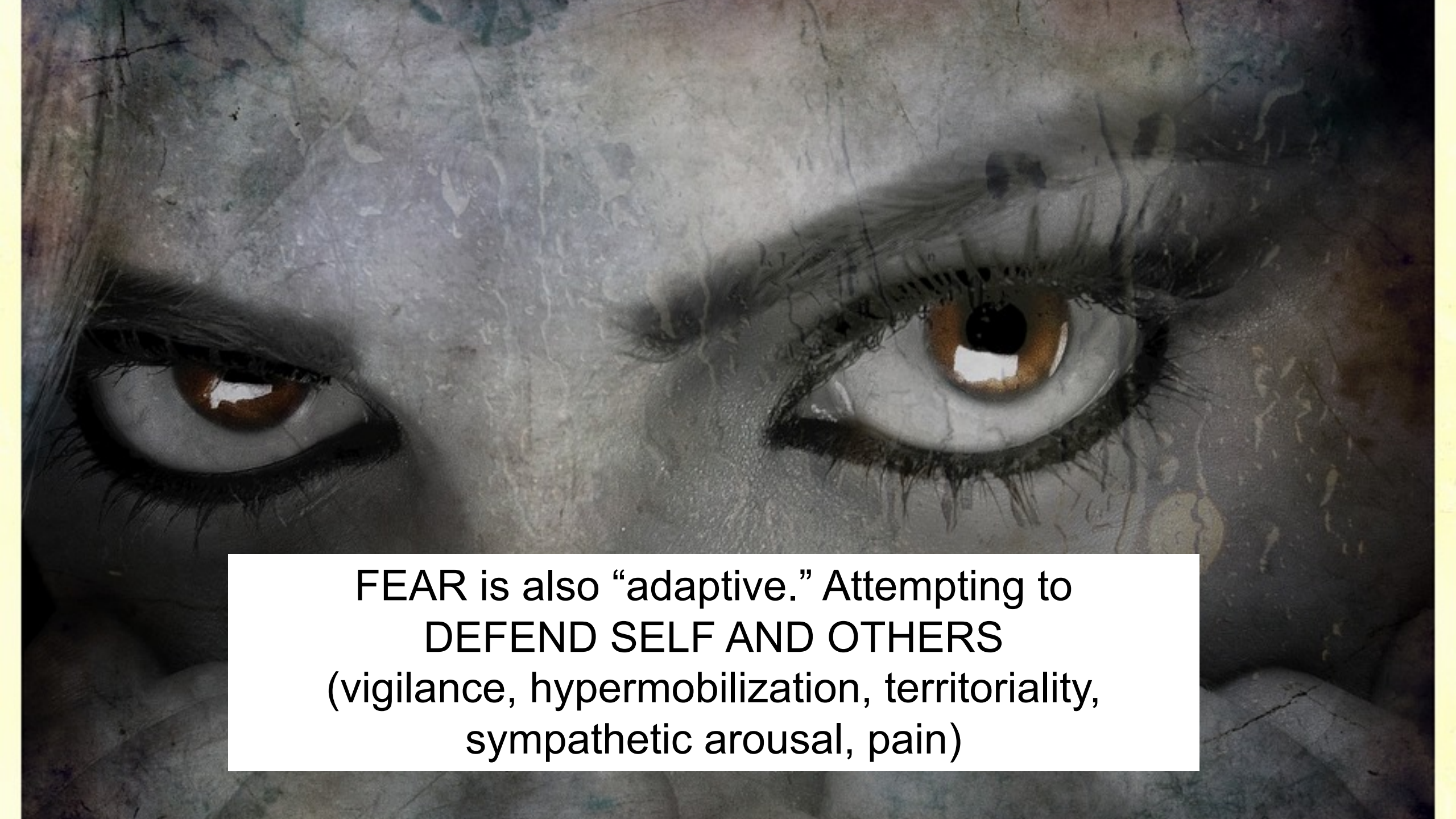


Social stimuli and support can come from various sources including partners, family and pets.



**Social bonds and LOVE are not “one-way streets”.
The best relationships are both secure and reciprocal.**



A close-up, high-contrast photograph of a person's face, focusing on the eyes and forehead. The person has light-colored, wide-open eyes with dark pupils, and their eyebrows are heavily furrowed, creating deep lines on the forehead. The skin appears pale and somewhat textured, with some visible creases and shadows. The overall mood is one of intense fear, anxiety, or distress.

FEAR is also “adaptive.” Attempting to
DEFEND SELF AND OTHERS
(vigilance, hypermobilization, territoriality,
sympathetic arousal, pain)

FEAR AND ANXIETY
(PRIMITIVE, ADAPTIVE,
BUT POTENTIALLY
MALADAPTIVE)

There is no
fear in love;
but perfect
love casteth
out fear
1 John 4:18



**Physiological states,
regulated by ancient
hormones and the
autonomic nervous
system are elements in
the dynamic dance
between approach and
avoidance – between
LOVE and FEAR. These
same hormones also may
regulate PAIN?**



**LET'S START FROM
THE BEGINNING**

**BABIES ARE NOT
DELIVERED BY
LARGE BIRDS...**

**THEY MUST BE
“BORN”**



**PREGNANCY AND
BIRTH
ARE THE FIRST BIG
CHALLENGES FOR
HUMAN CHILDREN.**

**HORMONES, including
OXYTOCIN MAKE BIRTH
POSSIBLE IN MAMMALS**



**BIRTH IS ONE OF LIFE'S FIRST BIG CHALLENGES
FOR MOTHER AND CHILD.. HISTORICALLY REQUIRING
OXYTOCIN TO ACCOMMODATE BIG-HEADED HUMANS
AND DEAL WITH THE PAIN OF CHILD BIRTH.**





**THE REWARD
FOR PREGNANCY
AND THE PAIN OF
CHILD BIRTH.**

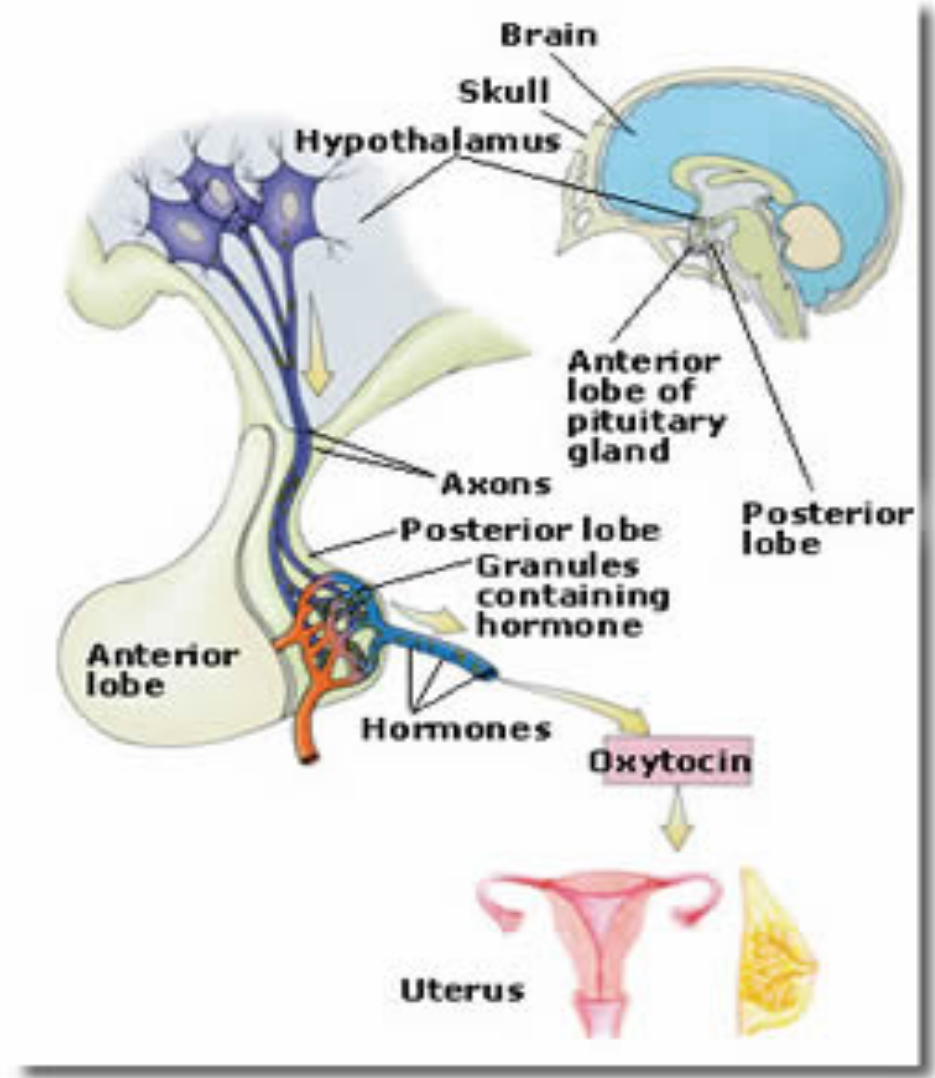
**THE MOST
ATTRACTIVE
OBJECT IN THE
WORLD.**



Oxytocin was classically viewed as a “FEMALE REPRODUCTIVE HORMONE,” acting primarily on the UTERUS and MAMMARY GLAND.

Of course, we now know that this is only part of the story!

OXYTOCIN HAS EFFECTS IN BOTH MALES & FEMALES THROUGHOUT THE BODY & BRAIN





**The EVOLUTIONARY & BIOCHEMICAL prototype for
LOVE and social bonds in mammals is the
mother-child interaction including BIRTH & LACTATION**





**HORMONES - INCLUDING OXYTOCIN -
FACILITATE BIRTH, LACTATION &
BUFFER NEW PARENTS
(FATHERS AND MOTHERS) FROM THE
PAIN AND STRESS ASSOCIATED WITH
CHILD REARING.**



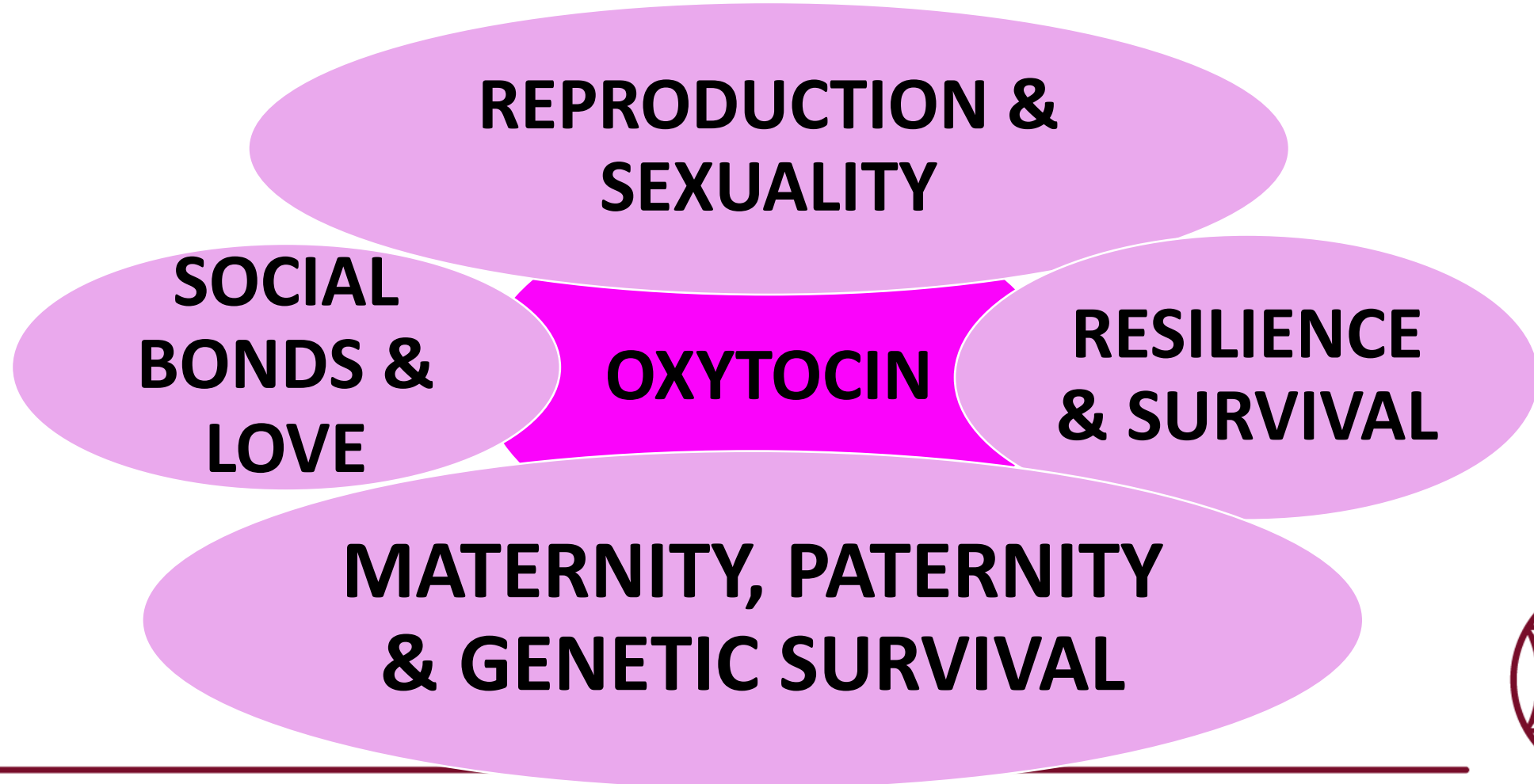
Oxytocin supports or permits:

PREGNANCY
INFANT NUTRITION
MATERNAL BEHAVIOR
PATERNAL BEHAVIOR
ALLOPARENTAL BEHAVIOR
and
EXTENDED NURTURE
of the
immature
human offspring
And

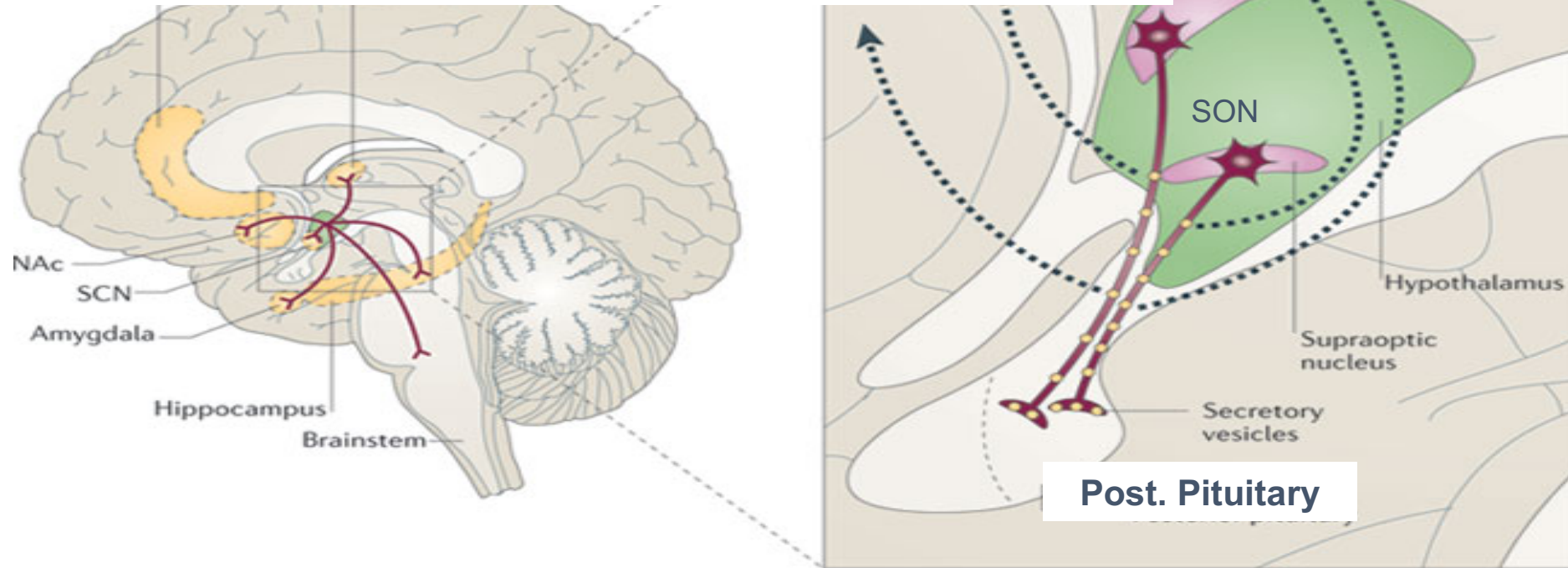
ATTACHMENT and LOVE



**Overview: OXYTOCIN PATHWAYS, CRITICAL TO A SENSE OF SAFETY,
UNDERLIE CENTRAL FEATURES OF SOCIAL BEHAVIOR ASSOCIATED
WITH MAMMALIAN REPRODUCTION AND SURVIVAL**



OXYTOCIN IS A STRESS COPING HORMONE AND A BIOLOGICAL METAPHOR FOR SAFETY

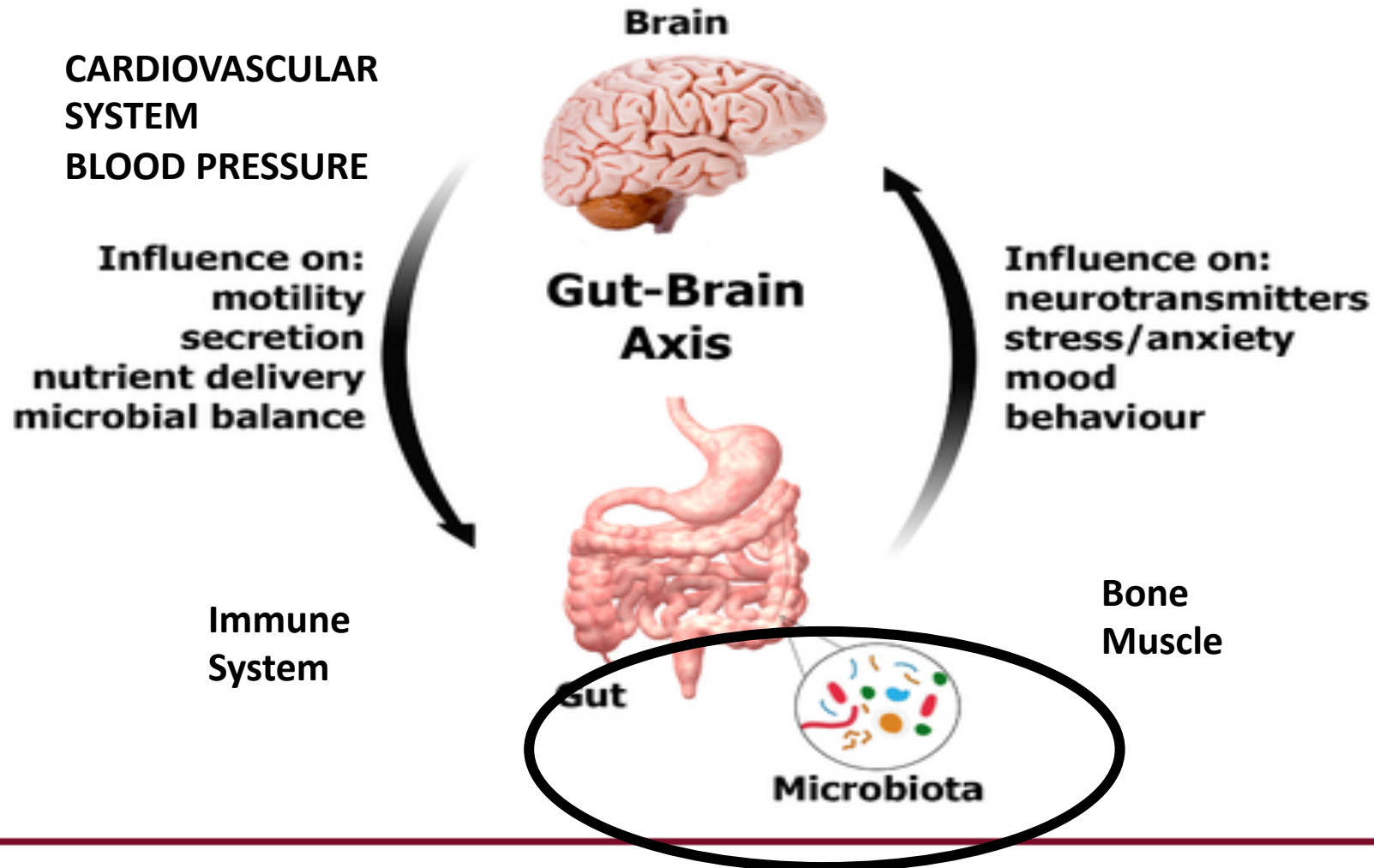


Oxytocin is made primarily in the **BRAIN (HYPOTHALAMUS)**, and released into the blood stream at the Posterior Pituitary, but is also released within the nervous system.

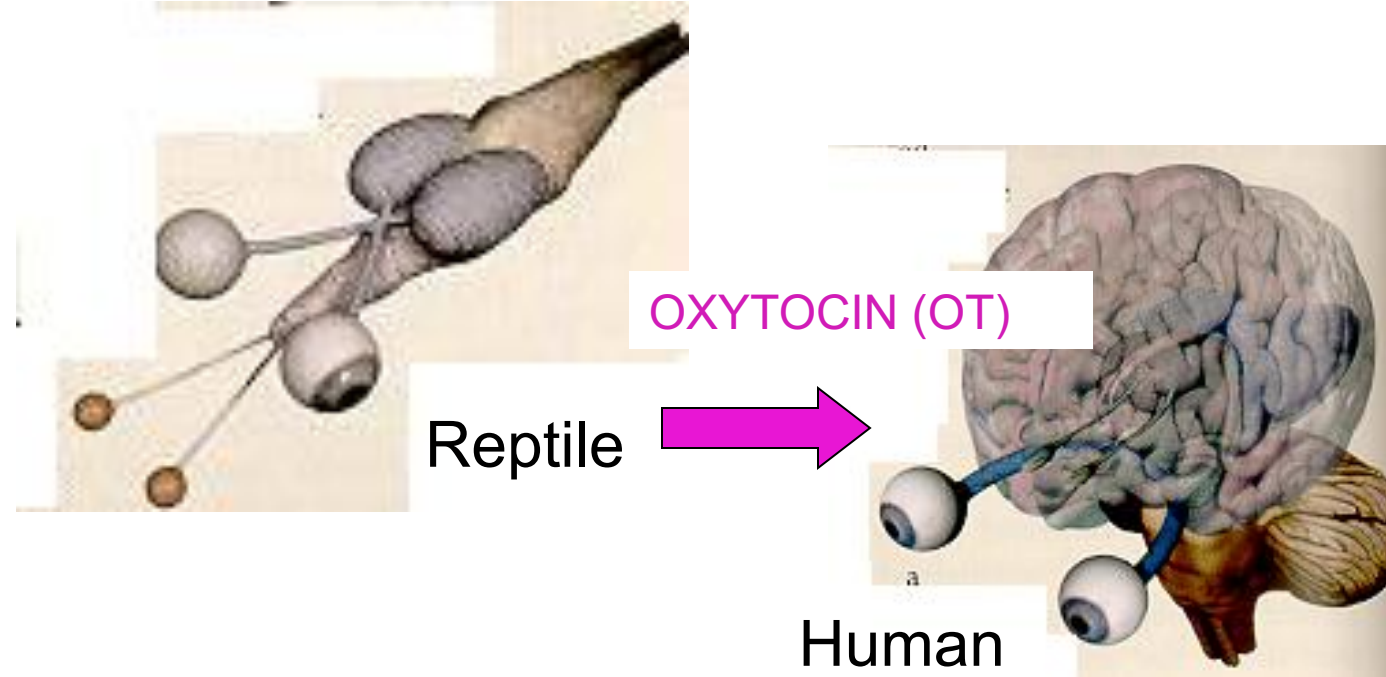
Oxytocin can affect social behavior, the autonomic nervous system, and the immune system, allowing the body to **ADAPT, PROTECT** and **HEAL**, especially in the face of challenge, stress and **PAIN**.



Oxytocin receptors are in the brain, digestive system, immune system, bone and muscle. Oxytocin is needed for the optimal beneficial effects of probiotic bacteria (microbiota) and to balance inflammation.



**The human nervous system is a consequence of evolution.
Compared to reptiles humans have a massive increase in
the size of the cerebral cortex**



OXYTOCIN (OT) allowed the transition from reptile to mammal.

OT permits birth (helps expel the large-brained baby from the uterus)

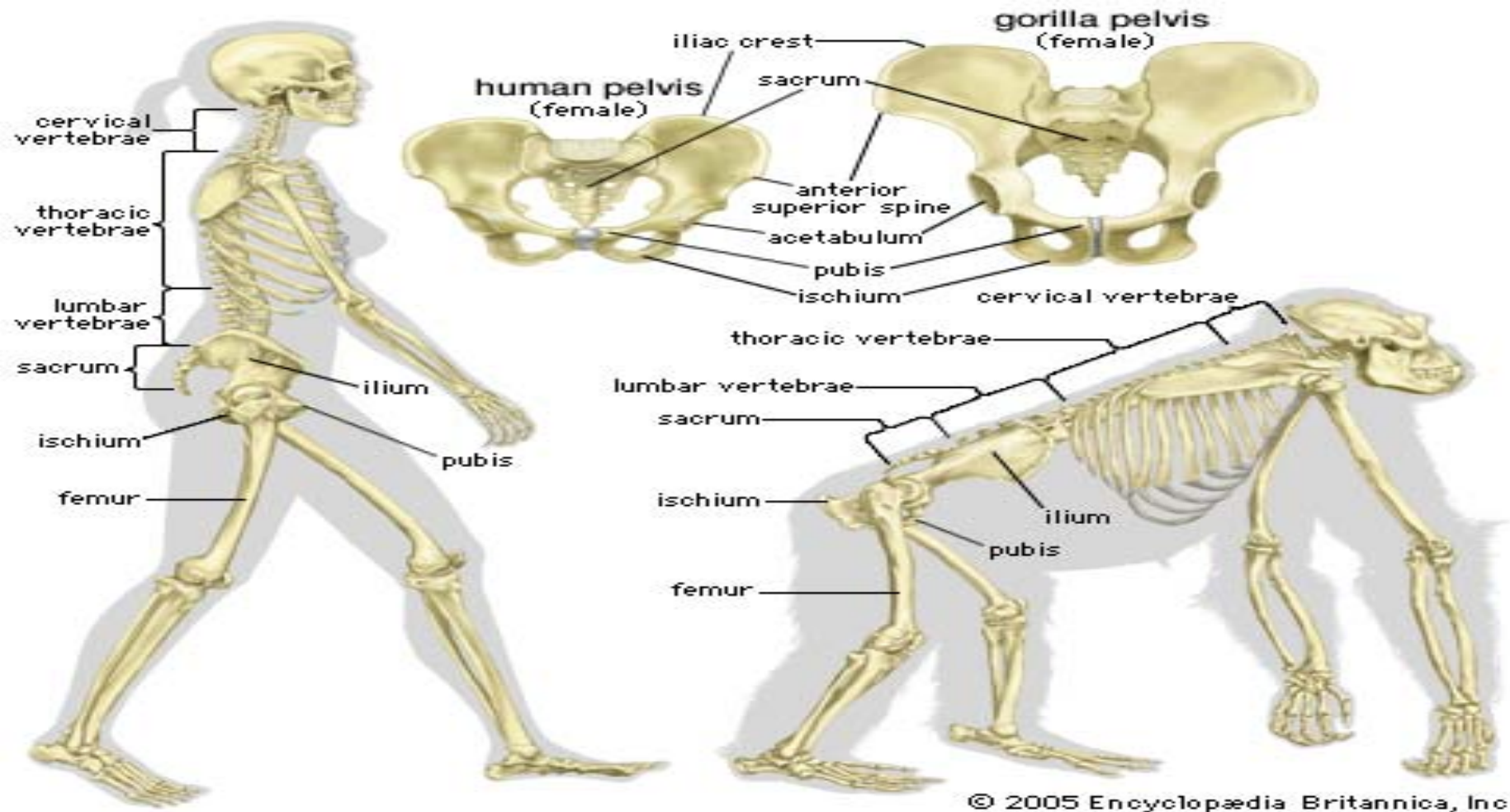
**OT facilitates post-birth nutrition & supports the baby (lactation/maternal
behavior/alloparenting)**

OT facilitates oxygenation of the brain (myelinated vagus).

OT PERMITS HUMAN COGNITION AND SOCIAL BEHAVIOR.

WE ARE HERE TODAY BECAUSE OF OXYTOCIN!





HUMAN BIRTH presents special problems because of our

- **BIG CORTEX** and **SKULL**,
- **BIPEDAL LOCOMOTION** and
- **SMALL, RIGID PELVIC GIRDLE**

OXYTOCIN FACITATES BIRTH by **STRONG UTERINE CONTRACTIONS**



Oxytocin does NOT act alone.
OXYTOCIN (OT) has a sibling hormone –
Arginine VASOPRESSIN (AVP) –
from which it differs by 2 (of 9) amino acids

OXYTOCIN (OT)

Cys-Tyr-Ile-Gln-Asn-Cys-Pro-Leu-Gly-NH₂

Arginine VASOPRESSIN (AVP)

Cys-Tyr-Phe-Gln-Asn-Cys-Pro-Arg-Gly-NH₂



**The EVOLUTION OF SOCIALITY AND LOVE involves:
A dynamic dance between Oxytocin and Vasopressin**

**Oxytocin facilitates a sense of SAFETY & SYNCHRONY,
as well as the capacity to RELAX AND RESTORE.**

Vasopressin permits ACTIVE DEFENSE and MOBILIZATION.



SMALL STRUCTURAL DIFFERENCES IN OXYTOCIN AND VASOPRESSIN ALLOW THEM TO INTERACT WITH EACH OTHERS' RECEPTORS.

STIMULATING OXYTOCIN RECEPTORS IS ASSOCIATED WITH PROSOCIALITY.

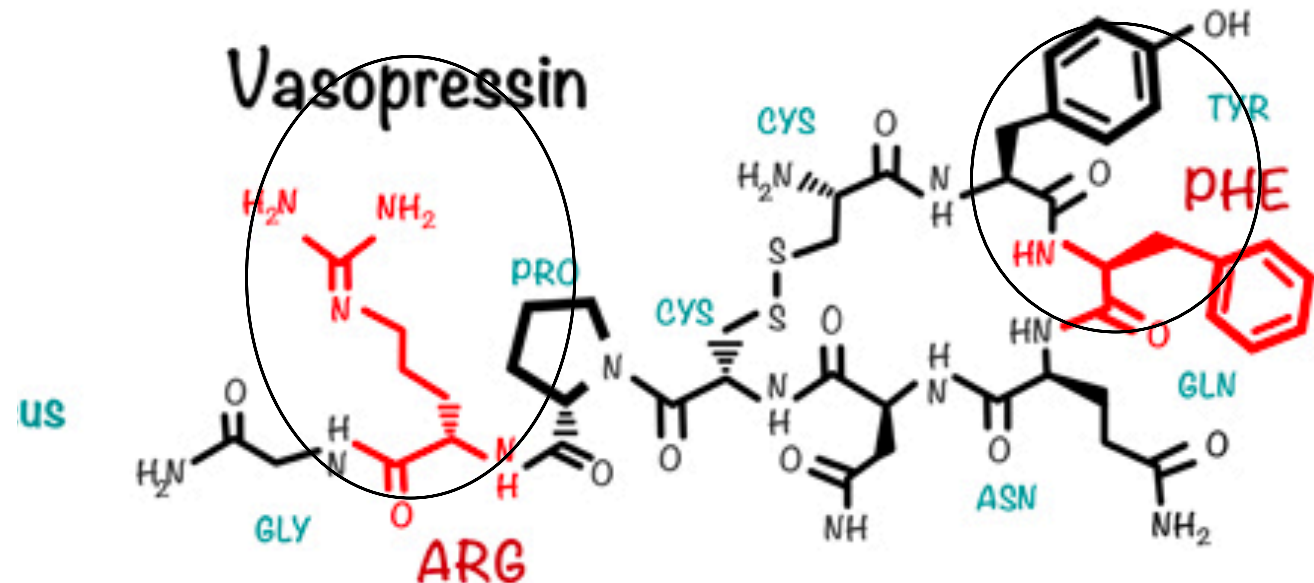
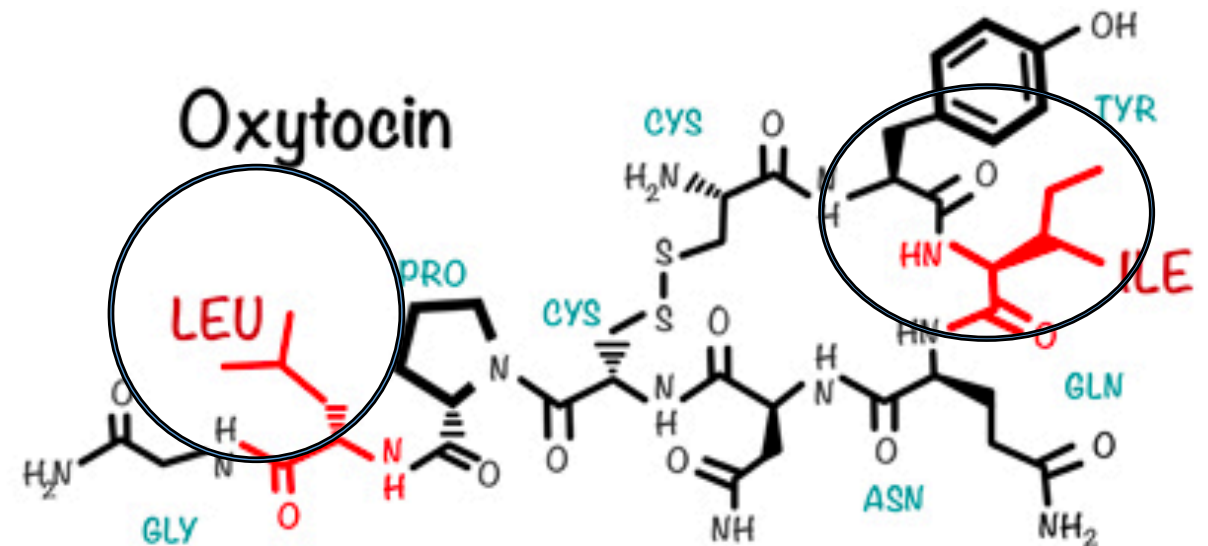
STIMULATING VASOPRESSIN RECEPTORS IS ASSOCIATED WITH DEFENSE.. But

THESE MOLECULES MAY STIMULATE EACH OTHERS' RECEPTORS.

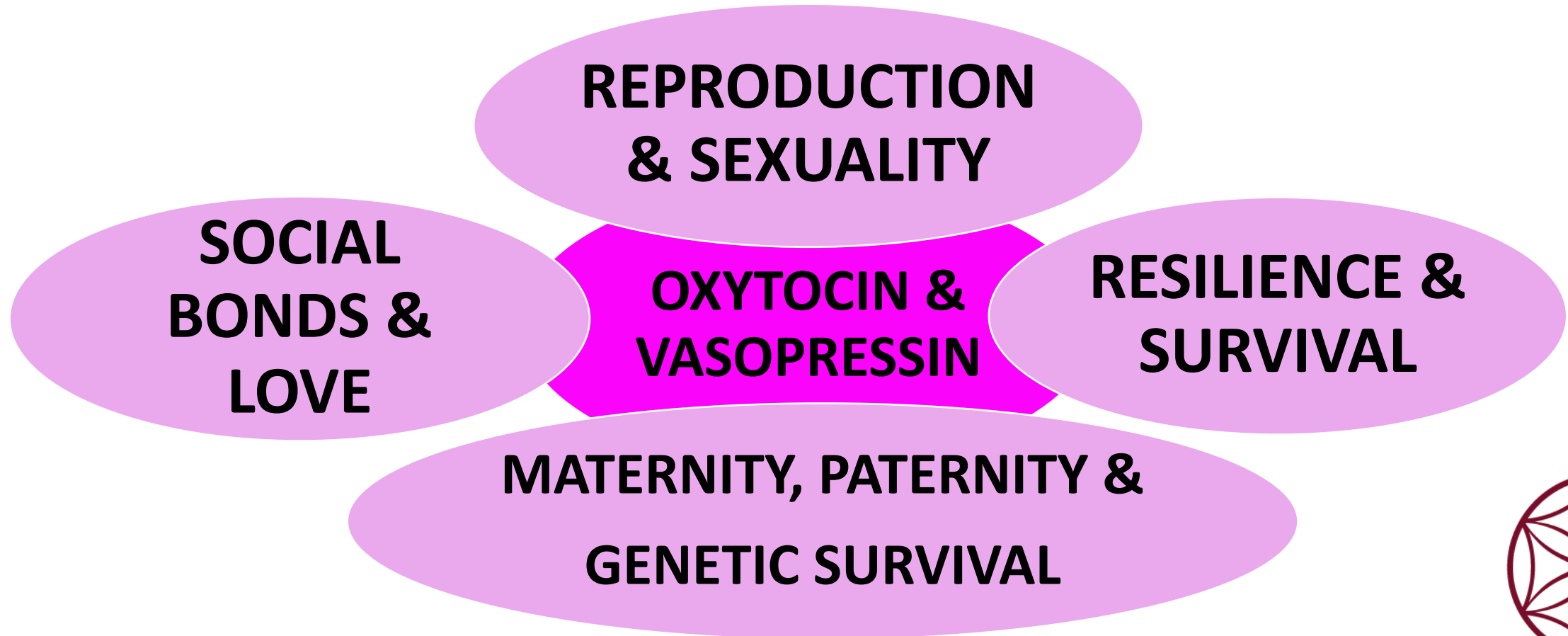
THEY MAY INHIBIT THE ACTIONS OF EACH OTHER.

THEY CAN HAVE DIFFERENT EFFECTS IN DIFFERENT CONTEXTS AND DIFFERENT BRAIN REGIONS, DEPENDING ON THE HISTORY OF THE INDIVIDUAL.

THIS ALLOWS MANY VARIATIONS OF ACTION FROM JUST TWO MOLECULES, AND SUPPORTS THE COMPLEXITY OF MAMMALIAN SURVIVAL AND REPRODUCTION.

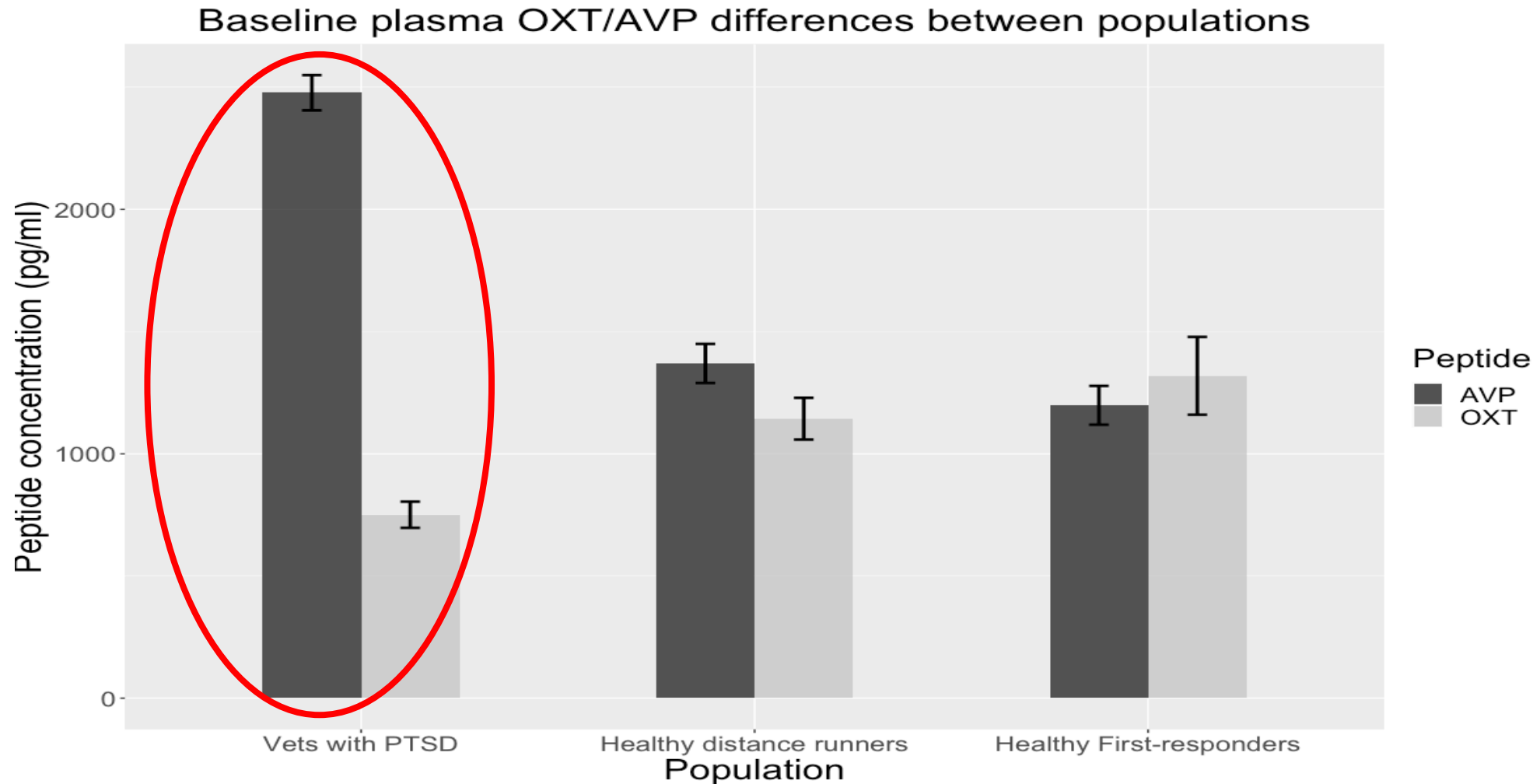


OXYTOCIN DOES NOT ACT ALONE.
**OXYTOCIN PLUS VASOPRESSIN BOTH UNDERLIE CENTRAL FEATURES OF SOCIAL
BEHAVIOR ASSOCIATED WITH MAMMALIAN REPRODUCTION AND SURVIVAL**



PTSD patients (vets) had LOW OXYTOCIN AND HIGH VASOPRESSIN (in plasma).

Non-patients (first responders in SWAT training) or
Healthy runners doing an Ultramarathon did not show this pattern, even under extreme acute stress.



Horn, Nazarloo, Carter, et al., unpublished data 2020



**OXYTOCIN and VASOPRESSIN are similar in structure
but have different functions**

Vasopressin

**Fear/Defense
Territoriality**

**Vigilance, Arousal
Mobilization**

Sympathetic nervous system

**PROTECTIVE
(active strategies)
More "primitive"
Dominant during
Extreme stress/ Trauma**

Oxytocin

**Prosociality/Approach
Sharing**

**Relaxation, Resilience
Immobilization without fear**

**Parasympathetic nervous
system (the vagus nerve)**

**HEALING & RESTORATION
(The healing power
of "love") More modern.
Dominant when there
Is a sense of SAFETY.**



CONTEXT of PERCEIVED -

↑ OXYTOCIN

LOVE and SAFETY



**SOCIAL BONDS & LOVE
SAFETY OR CALM**

↑ VASOPRESSIN

ANXIETY or FEAR

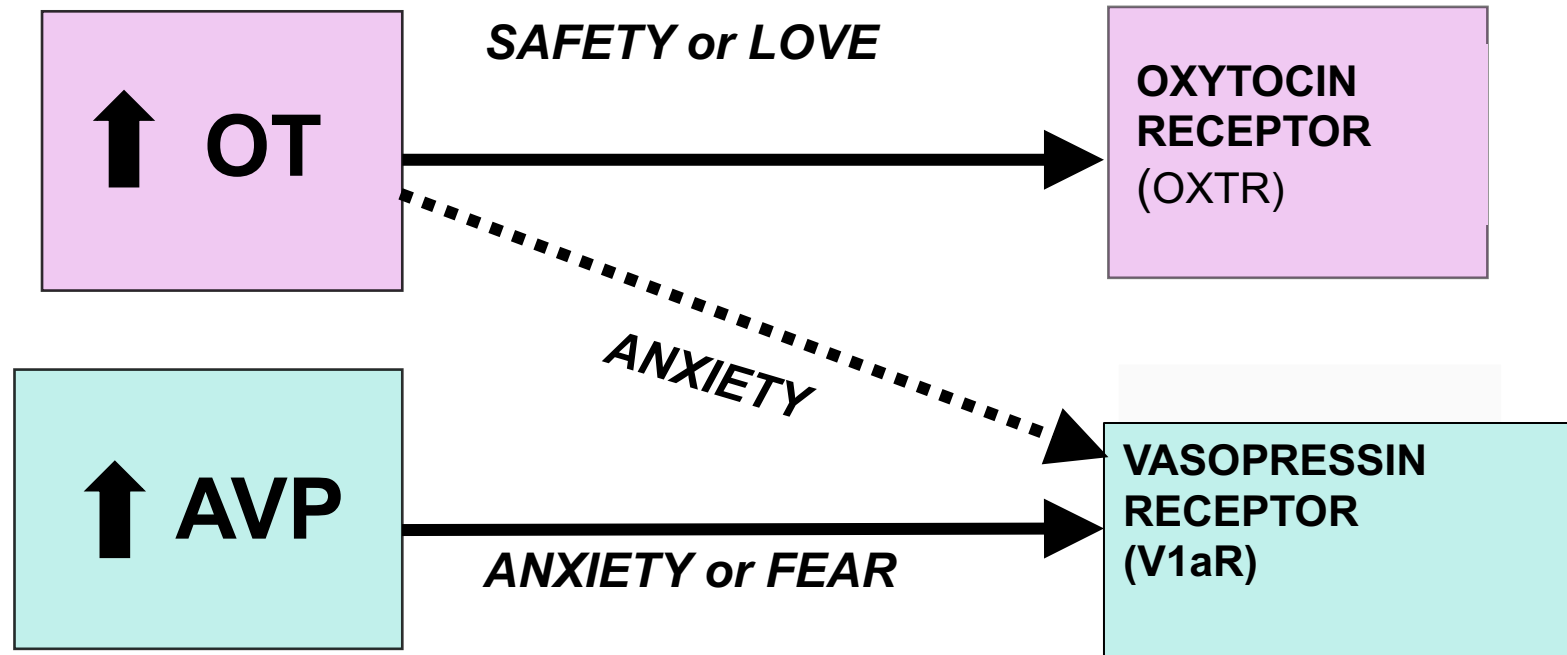


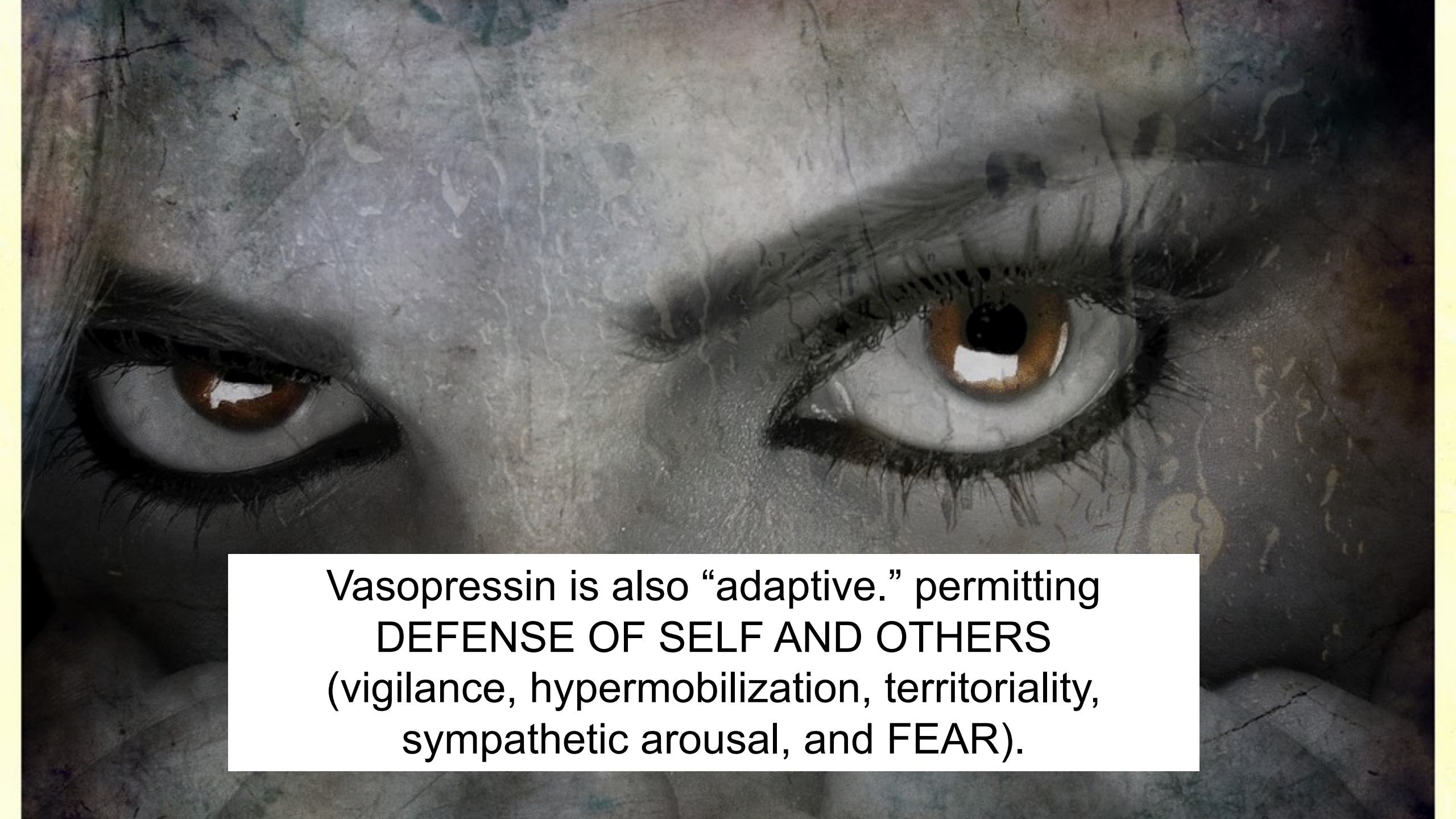
**AVOIDANCE & ANXIETY
DEFENSIVENESS & FEAR
AGGRESSION**



Oxytocin can act through the
VASOPRESSIN RECEPTOR with effects that depend on **CONTEXT**.
High levels of OT may act like AVP.
It is often the **RECEPTOR** that determines the effect –**NOT** the **PEPTIDE** itself.
(Detailed in Carter, 2017 *Frontiers in Endocrinology*)

CONTEXT of PERCEIVED -





Vasopressin is also “adaptive.” permitting
DEFENSE OF SELF AND OTHERS
(vigilance, hypermobilization, territoriality,
sympathetic arousal, and FEAR).

Particularly helpful to our understanding of OXYTOCIN AND VASOPRESSIN have been SOCIALLY MONOGAMOUS RODENTS, which share with humans the capacity to form long-lasting SOCIAL BONDS AND RELATIONSHIPS



*PRAIRIE VOLES,
Microtus ochrogaster*



Prairie voles can be studied in nature



And in the Laboratory



Research in rodents suggests that

**BOTH
OXYTOCIN and
VASOPRESSIN
are involved in:**



**Vasopressin is particularly
important to
DEFENSE of SELF AND FAMILY
Including
Increased Arousal and
Protective Aggression,
through actions on
VASOPRESSIN RECEPTORS**



THE OXYTOCIN PARADOX?

Oxytocin ALSO may be released under conditions that are negative or acutely “stressful,” –

**Inflammation
Disease**

Oxytocin serves as a component of an adaptive, COPING strategy, BUFFERING against stressors.

At high level OXYTOCIN also may act by binding to VASOPRESSIN RECEPTORS.
(reviewed in Carter, 2017 Frontiers in Endocrinology)



**OXYTOCIN IS A STRESS-COPING
HORMONE**



Vasopressin (AVP) and
hormones of the stress axis (HPA AXIS including CRF)
are primarily pro-inflammatory - fast strategies of defense.



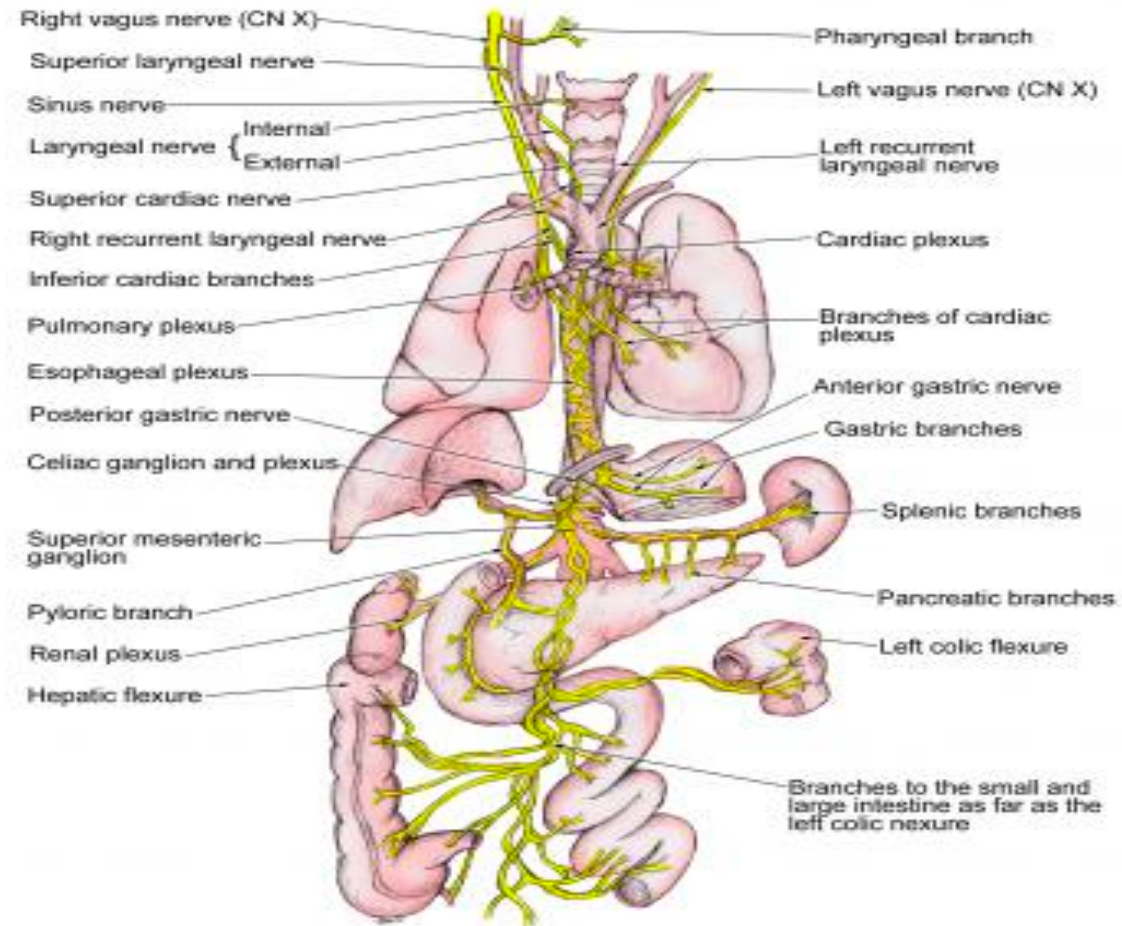
Oxytocin works like a fire extinguisher...
Acting as an anti-inflammatory and anti-oxidant.



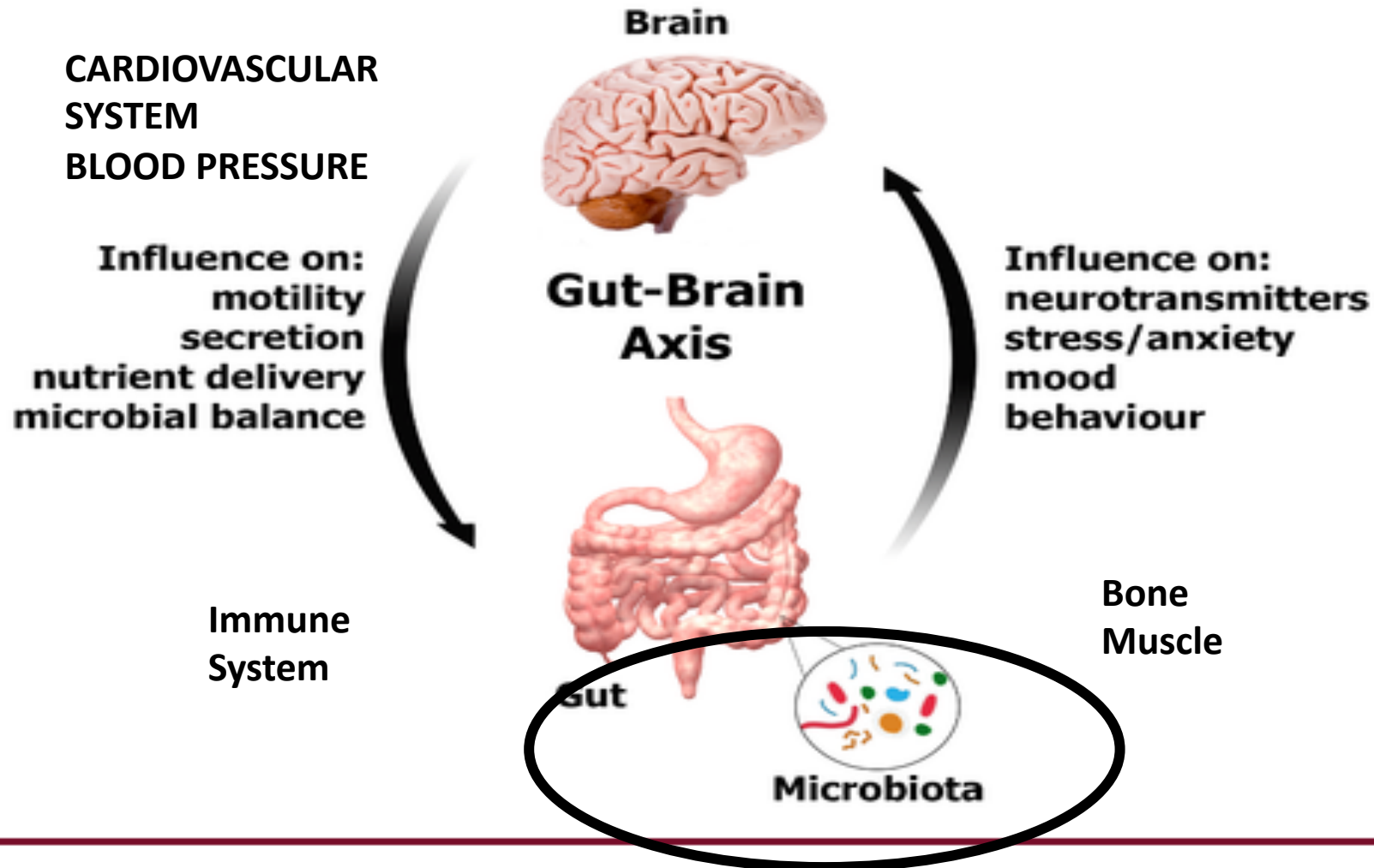
Of particular importance to understanding Oxytocin & Vasopressin - as well as the HEALING POWER OF SOCIAL CONNECTION - is the fact that these hormones act on the AUTONOMIC NERVOUS SYSTEM and regulate the VAGUS NERVE

THE VAGUS (10TH CRANIAL NERVE), SHOWN HERE, LINKS THE BODY TO THE BRAIN, AND IS CRITICAL TO EXPLAINING THE HEALTH BENEFITS OF FEELING SAFE AND THE HEALTH RISKS OF FEAR AND ANXIETY.

OXYTOCIN & VASOPRESSIN BOTH REGULATE THE ADAPTIVE FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM AS WELL AS REGULATING INFLAMMATION AND HEALING.



Oxytocin receptors are in the brain, digestive system, immune system, bone and muscle. Oxytocin is needed for the optimal beneficial effects of probiotic bacteria (microbiota) and to balance inflammation.

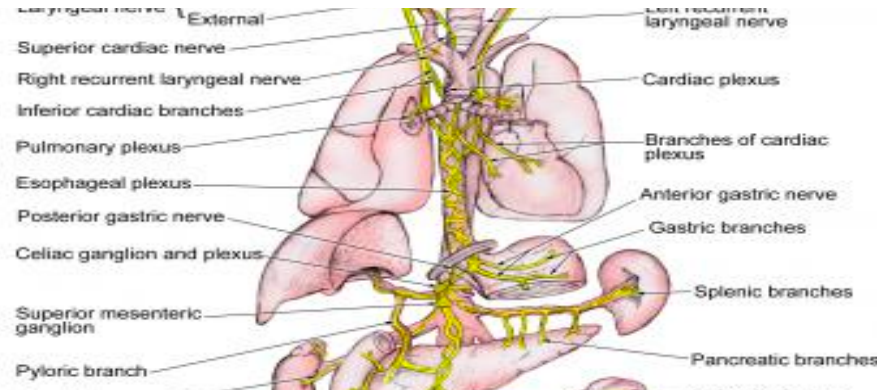


DISORDERS LINKED TO OXYTOCIN DEFICIENCY OR DYSFUNCTION (or ATYPICAL/EXCESS VASOPRESSIN) (Based on both human conditions and animal models)

MENTAL HEALTH

Social & Emotional Dysfunction
Autism Spectrum Disorders
Schizophrenia
Anxiety
Depression (general)
Postpartum depression
Trauma
Prader-Willi Syndrome
Fragile X
Substance Abuse
Williams Syndrome (hi PEPTIDES)

LINKED BY VAGUS/AUTONOMICS and OXYTOCIN – VASOPRESSIN AN INTEGRATED SYSTEM

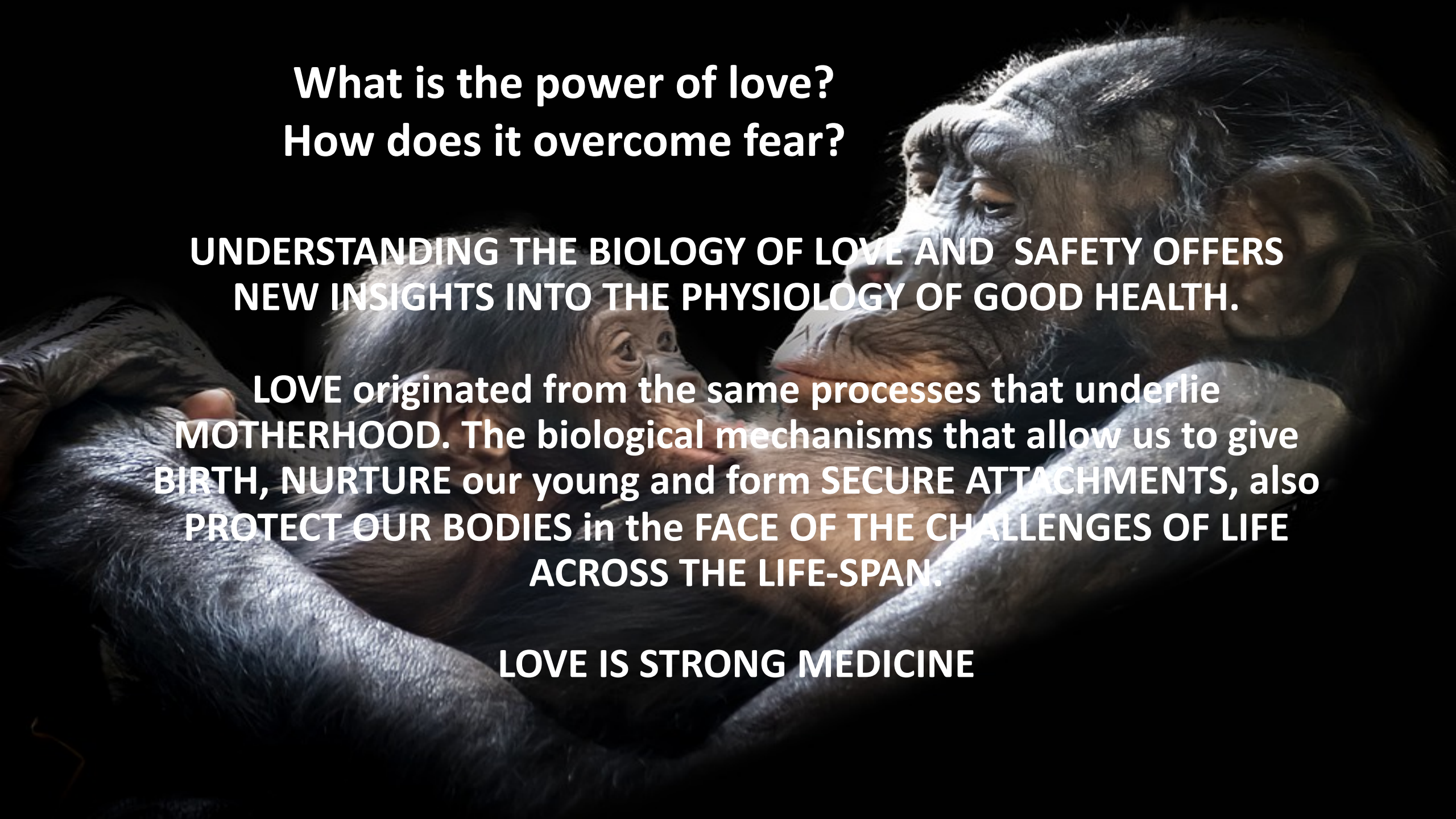


PHYSICAL HEALTH

Stress management
Cardiovascular Devel. & Disease
Obesity & Metabolism
Wound Healing
Bone Health (Osteoporosis)
Muscle Strength (Myopenia)
Chronic Pain
Fibromyalgia
Immune dysfunction (HIV?)
Longevity

INFLAMMATION
OXYTOCIN IS ANTI-INFLAMMATORY
VASOPRESSIN PREDOMINANTLY PRO-INFLAMMATORY





**What is the power of love?
How does it overcome fear?**

**UNDERSTANDING THE BIOLOGY OF LOVE AND SAFETY OFFERS
NEW INSIGHTS INTO THE PHYSIOLOGY OF GOOD HEALTH.**

**LOVE originated from the same processes that underlie
MOTHERHOOD. The biological mechanisms that allow us to give
BIRTH, NURTURE our young and form SECURE ATTACHMENTS, also
PROTECT OUR BODIES in the FACE OF THE CHALLENGES OF LIFE
ACROSS THE LIFE-SPAN.**

LOVE IS STRONG MEDICINE