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The Biology of Love

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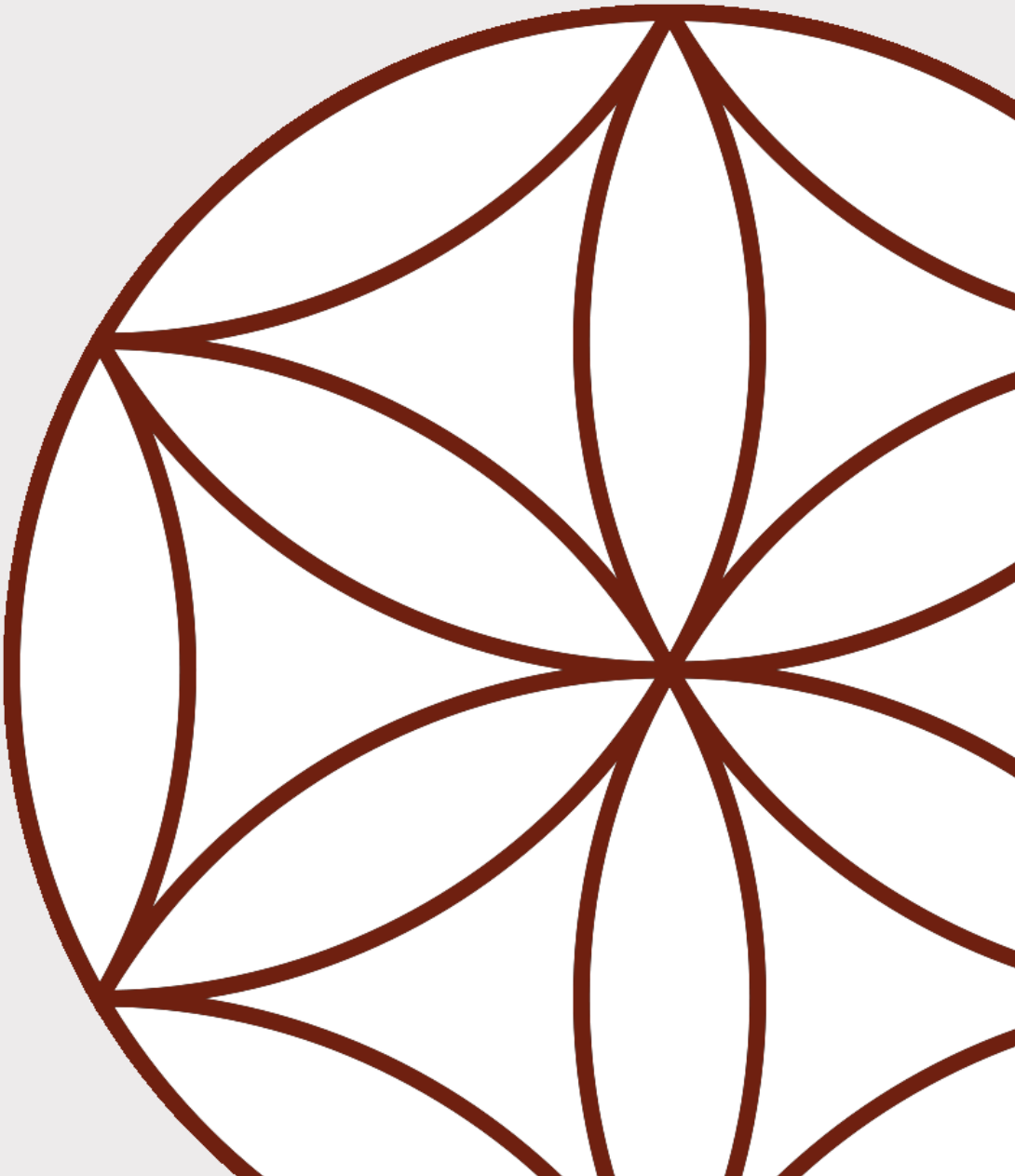


The healing power of love

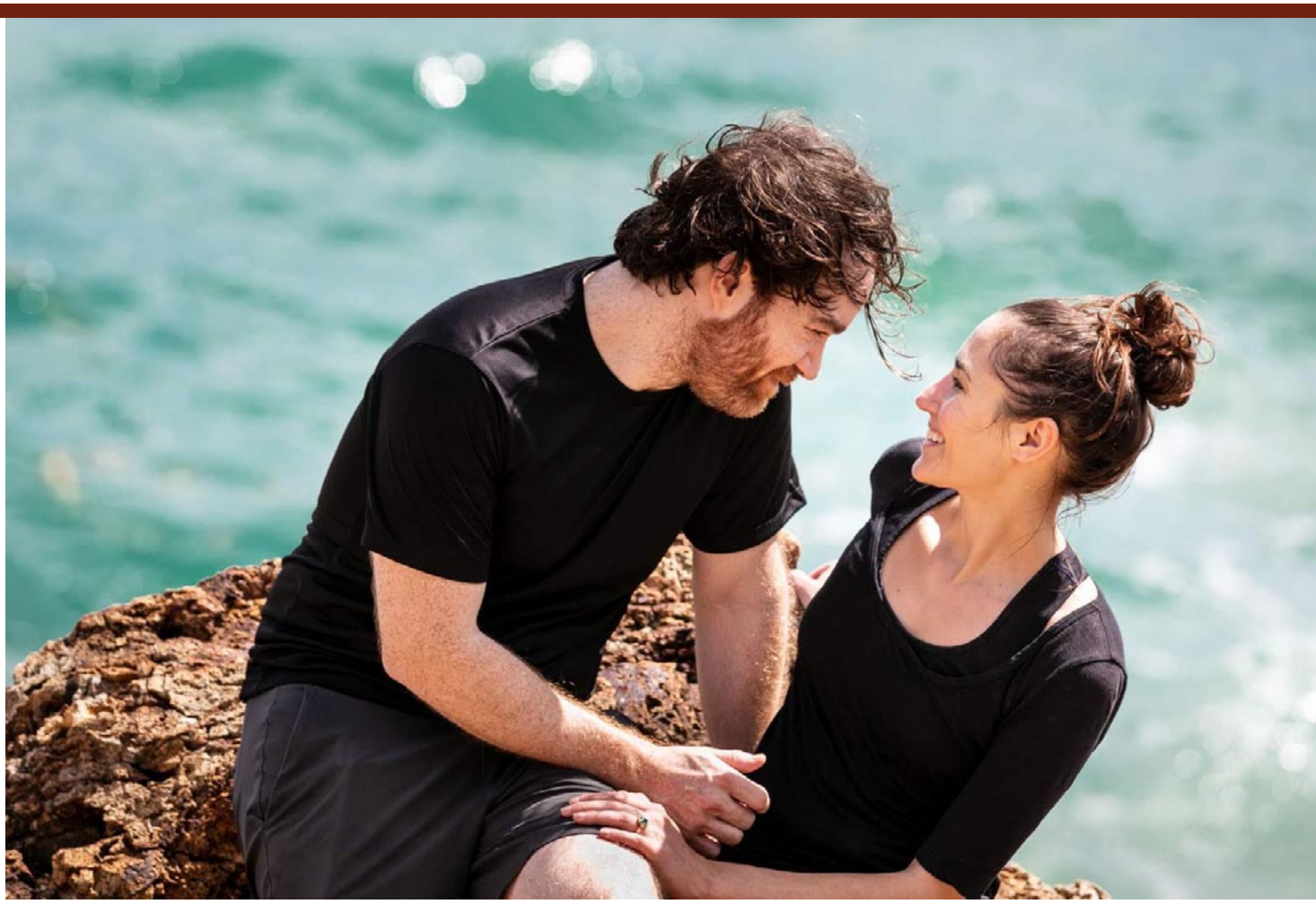
An expert insight into an aspect of biology that concerns the healing power of "love"

Love is intrinsically beautiful, but also complex and mysterious. Although love can be difficult to define, the list of love's functions is long. Love influences all aspects of human existence. Love is powerful medicine. Healthy relationships can protect against disease and restore the body in the face of illness.

Without loving relationships, humans fail to flourish, even if all of their basic needs are met. "Love lost" is one of the most powerful forms of stress and trauma. We now understand that the causes and consequences of love or its absence are grounded in a biology that operates largely below the level of human consciousness.

Remarkably, the origins of this knowledge began in research conducted in a small field mouse known as the prairie vole. In the 1980s, working at the University of Illinois, my colleague Lowell Getz and I uncovered evidence that both in nature and in the laboratory, prairie voles were capable of forming life-long pair bonds. In this species, both parents nurtured the young, with fathers sharing all aspects of infant care except nursing. Older siblings also cared for younger babies. Juvenile prairie voles left the family to find mates and scrupulously avoided incest. Prairie voles exhibited the traits of the mating system that humans associated with monogamy.

As in humans, the core of the prairie vole monogamy was based on social bonds, not simply defined by sexual exclusivity. The capacity for pair bond formation was regulated physiological and emotional states, based on neural systems also found in humans. We also found that prairie voles have high levels of oxytocin,



a human-like autonomic nervous system, and they are exquisitely sensitive to the neural and epigenetic effects of early nurture. Thus, by studying pair bonding in voles, we had created a laboratory model allowing us to examine the neurobiology of what humans' call "love."

The evolutionary and biochemical prototype for love and social bonds is the mother-child interaction. The physiological pathways that permit social bonds are shared with parental behaviour, as well as birth and lactation. Our research in prairie voles revealed that two ancient neuropeptides and their receptors are foundational to the capacity to form pair bonds and also show defensive aggression. Those molecules are oxytocin and vasopressin. Both oxytocin and vasopressin are important to the social bond formation, but their functions are strikingly different.

Vasopressin is the more primitive of the two and is associated with adaptive functions that protect humans against dehydration and regulate blood pressure. Vasopressin has been associated with the neurobiology of anxiety, fear and avoidance learning. Both males and females synthesise vasopressin. However, in areas of the brain implicated in defensiveness and territorial aggression, vasopressin production is increased by androgens, and may play a central role in sex differences in the expression of aggression.

Oxytocin, in contrast, is associated with

prosocial behaviours, including social engagement and the formation of social bonds. Oxytocin also may induce a sense of safety, reduce reactivity to stressors, block fear and increase trust. Processes that help to define mammals, including lactation and maternal behaviour are facilitated by oxytocin. Although both sexes synthesise oxytocin, in some cases estrogen increases sensitivity to the actions of oxytocin, favouring this peptide in females. Oxytocin was essential to human evolution, facilitating the birth, growth and nurture of our immature babies.

Oxytocin helps, directly and indirectly, to promote healing and restoration. For example, oxytocin has anti-oxidant and anti-inflammatory properties. Oxytocin also regulates the immune system and the highly protective parasympathetic, vagal branch of the autonomic nervous system. Vagal pathways, regulated by oxytocin, are necessary for social communication and engagement through actions on the muscles of the face and head.

Furthermore, the autonomic nervous system regulates all of our internal organs, as well as the distribution of blood and nutrients throughout the body. Through effects on the autonomic nervous system, oxytocin regulates blood flow and oxygen to the brain, thus further supporting human cognition, culture and eventually civilisation.

Thus oxytocin-vasopressin effects on the

autonomic nervous system are likely a critical component of the healing power of love. The autonomic nervous system is one portal through which the peptide systems and love may be accessed and influenced.
Oxytocin and vasopressin evolved from a common ancestral peptide. Oxytocin and vasopressin are similar in structure and interact dynamically with each other's receptors. However, for several reasons, these molecules are difficult to study. Their actions are adaptive, quickly changing and also strongly affected by emotional context. Under conditions of safety, oxytocin promotes social engagement. But in a context of anxiety or fear, oxytocin may function like vasopressin, possibly by binding to vasopressin receptors.

Generally, oxytocin tempers fear and increase both trust and social behaviour. But in individuals who have a history of trauma or extreme stress, oxytocin may trigger the vasopressin system, enhancing fear and protective responses. The unique properties of the oxytocin and vasopressin systems allow these two molecules to be highly adaptive and support emotions such as love, but also jealousy and defensive aggression. The same novel properties that give oxytocin and vasopressin great power, also create serious challenges for understanding their functions.

The oxytocin-vasopressin system is constantly changing across the life cycle. Oxytocin affects the development of the brain, cardiovascular and immune systems. Recently, my colleagues and I have demonstrated that the expression of the gene for the oxytocin receptor in voles is epigenetically tuned by early experience. Loving relationships, especially in early life can influence behaviour and physiology across the lifespan, in part through changes in the sensitivity of the oxytocin system. The absence of nurture may create a pattern of self-defensive and a sense of threat that could inhibit the capacity for love in later life.

The mechanisms through which love protects and heals are only now being discovered. Oxytocin influences sociality and social experiences influence oxytocin. Knowledge of the neurobiology of love helps to explain the exceptional reproductive success of humans and also our resilience in the face of fear and aggression. The emotional and physical health and longevity of our species, and perhaps our planet, depends on our capacity to understand and apply our knowledge of the biology of the love, especially in this time of trauma.

The biology of love: Lessons from prairie voles

Discussing the fascinating nature of prairie voles and how they can teach us about the biology of "love"

In both nature and in the laboratory small field mice, called prairie voles form life-long social bonds. Males of this species are amazing parents involved in all aspects of care of the young except nursing. Males even help to "midwife" their partner's labour and help her cut the umbilical cord at birth. Extended families form around the original pair, as prairie vole fathers and then older offspring remain in the natal nest, scrupulously avoiding incest. Males and females are about the same size and they jointly defend their family and resources. Taken together biologists have called this set of behavioural and physical traits "monogamy."

The monogamy paradox

Because prairie vole pairs were sharing a nest and raising babies together, we initially assumed that they also were sexually monogamous. But when we tried to test this assumption, voles of both sexes did not cooperate - often mating with strangers. As DNA fingerprints became available, many prairie voles again failed the genetic tests for sexual monogamy. Similar findings emerged in other apparently monogamous mammals including humans, and most species of birds. Some individuals were sexually monogamous, but when viewed at the level of a species, sexual monogamy was rare or non-existent.

Given the opportunity, both male and female prairie voles were willing to have sex outside of the pair bond. However, once mating was complete, strangers or nonfamily members were often attacked. Like a reality TV show gone wrong, we discovered that male prairie voles were

raising, as their own, babies fathered by other males. We slowly began to accept the notion that social attachments are real and have causes and consequences similar to what humans call “love.”

“I hope we don’t lose sight of one thing. It was all started by a mouse”

- Walt Disney

The term monogamy is derived from the Greek for a single wedding or ritual, and does not speak to sexual choices. Considered across the lifespan, many humans have more than one sexual partner. None of this is shocking. But we now understand that the traits of social monogamy are a kind of syndrome with shared neurobiological underpinnings. Our terminology had to be adjusted to admit that what we were observing was more accurately termed “social monogamy.”

Hormonal ties that bind

Prairie vole families are bound together by invisible social bonds. As we searched for a mechanism for social monogamy, we found in both male and female voles that pair bonds were cemented by powerful molecules synthesized in the brain. These hormones were released by social experiences, including sexual interactions and even the presence of a baby. In turn these brain-derived chemicals regulate social engagement, pair bond formation and parental behaviour. In addition, following mating, aggression toward strangers increased, and behaviours that looked suspiciously like “jealousy” emerged. However, as might be expected

protective aggression toward intruders is based on a somewhat different cocktail of hormones than those needed to create loving relationships between pairs or directed toward a baby.

Two molecules, oxytocin and vasopressin, made primarily in the brain are at the epicentre social monogamy. However, it has taken decades and the help of prairie voles to untangle these relationships. These deceptively simple molecules are capable of binding to each other's receptors, creating various emotional states that support many behavioural permutations. In addition, oxytocin and vasopressin and their receptors are exquisitely sensitive to experience.

In fact, prairie voles are teaching us that the genes regulating receptors for oxytocin and vasopressin can be switched off or on across the life cycle. Life's most important experiences - sexual experiences, birth, the presence or absence of sensitive parenting, exposure to hormones in early life, extreme stress and traumas - are all "epigenetic" events regulated by molecular changes with long lasting effects on the genome. This is one of several mechanisms through which the consequences of love protect us across our lifespans, and through which the absence of love leaves us vulnerable.

Love heals and allows us to be human
Studies of prairie voles, and comparisons to nonmonogamous mammals forced us to re-imagine concepts like monogamy and love. Selective attachments, and well as parenting, are supported by a

comparatively simple brain and ancient neural and endocrine pathways. Human cognition, a complex nervous system or even gonadal hormones are not essential to allow pair bonds to form or infant nurture to emerge. However, in voles - as in humans – these are influenced by social context including fear, safety, and the emotional history of the individual.

Social behaviours, such as pair bonding and parenting, are hormonally-supported and interact with emotions that facilitate good health, a sense of safety and eventually health and survival. Furthermore, nature is conservative and the same hormones are used over and over again across the life cycle and in different species of mammals, where they support variations in social behaviour and aggression across species and individuals, as well as sex differences in behaviour.

Brain regions involved in pair bond formation and parenting also are shared with other forms of rewarding experiences, and with the neural pathways involved in drug addiction. The absence or loss of love creates vulnerability to substance abuse, depression and other forms of mental and physical illness. Knowledge of these relationships helps to explain why love is rewarding, but also can be addictive, and why the loss of a partner or loved one may be experienced as physical pain or illness.

The biology of “love” is intertwined with the biology of reproduction and basic survival in a dangerous world. This is true of both voles and humans. Love and its consequences operate largely below the level of human consciousness. However, prairie voles have taught us that love is constructed from biological mechanisms that are shared with other mammals. Using insights from prairie voles, we are discovering that the same molecules that support love facilitated human evolution, now allow us to survive and thrive, helps create culture, and may even help to explain how and why “love is good medicine.”

Oxytocin in birth, lactation and maternal behaviour

Discussing the critical role of oxytocin in birth, lactation, maternal behaviour and in tuning the baby's developing endocrine and nervous system

Like little scuba divers, most mammals begin their lives swimming in an intrauterine pool of amniotic fluid. Through a two-way tether, the umbilical cord, babies receive oxygen, nourishment and hormones, and transmit chemical signals to their mother. The mammalian infant also is being pre-programmed during pregnancy and by birth for life on "dry land." After birth, this programming continues in the form of hormones in milk and styles of parenting.
We now understand that one neuropeptide oxytocin, plays a critical role not only in birth, lactation and maternal behaviour - but also in tuning the baby's developing endocrine and nervous system. Oxytocin works in conjunction with an even more ancient chemical, known as vasopressin. Together these molecules are essential elements in adaptations to perinatal life and in the events surrounding birth.

Birth and birth interventions

Birth presents one of life's most important challenges. Embedded in the perinatal period and birth experiences are biochemical messages that can help the infant feel safe, or alternatively prepare it for life in a threatening world. Yet, remarkably, the specific consequences of the birth experience itself for either mother or child's physiology and behaviour have received little attention.

Although a basic biological process, the birth transition is often subject to medical and cultural modification. Hormonal treatments, including synthetic oxytocin (also known as Syntocinon or Pitocin) are widely used to induce or augment labour and protect against postpartum bleeding.

Initially it was assumed that oxytocin produced by or given to a mother did not reach the infant in amounts sufficient to affect the child. The effects of oxytocin were believed to be transient, disappearing as soon as the hormone was cleared from the system.

However, studies in animals and humans indicate that oxytocin can cross the placenta around the time of birth and may be transmitted in mother's milk. We also now understand that endogenous oxytocin is an important factor in normal development, with long-term effects on brain maturation as well as in the capacity to manage stress, the autonomic nervous system and immune system.

In a search to better understand the developmental role of oxytocin, we have experimentally administered extra hormone, or in some cases injected agents that block the oxytocin receptors. Treatments were given just before birth via the mother or directly to the infant just after birth. These studies were conducted in the highly social prairie vole, a rodent species that shares with humans, "social monogamy " – a lifestyle characterised by a high level of sociality and the tendency to form families constructed around a mother, father and sometimes several generations of offspring. In prairie voles, and likely in humans, patterns of parenting play a role in sculpting expression of later behaviours, including later tendencies to form social attachments or care for infants.

Oxytocin plays a central role in many

features of maternity, including synchronising social interactions and attachment between mothers and infants. Oxytocin has a wide breadth of functions including effects on social behaviour, metabolism, cardiovascular function, immunity, and the autonomic nervous stress. Oxytocin through its effects on birth and lactation, allowed the development of large primate brains and eventually supported human evolution and cognition.

Vasopressin is a more primitive hormone, related to oxytocin and like oxytocin, is designed for change. Our work in prairie voles revealed that a single exposure to oxytocin on the first day of life could down-regulate the vasopressin receptor in brain regions involved in aggression. The one brain area in which oxytocin increased the availability of the vasopressin receptor was a region associated with pair bonding and reward. Such changes seemed to produce a more social male, better prepared to form social bonds and give sensitive care to his own offspring or siblings.

The Goldilocks Principle

However, like the desired temperature of porridge in the children's tale, Goldilocks and the Three Bears, there is a "just right" range of experiences and hormones in early life that promote survival and reproduction. In our studies of prairie voles, we discovered that even apparently small events, such as a momentary disturbance of the family within the first day of life created life-long differences in brain development and the genes for the oxytocin receptor.

As one example, young prairie voles exposed to moderate social stimulation in early life are gregarious. In comparison to less social species of rodents, prairie voles begin life with more oxytocin, both in their blood and brain, and more oxytocin receptors in brain regions necessary for social awareness and attachment. Prairie voles exposed to a single oxytocin treatment around the time of birth also showed - in later life - an even friendlier behavioural pattern with less anxiety and fear of novelty.
In some cases, neonatally oxytocin-treated voles also formed adult pair bonds more quickly. Especially in males, increases were seen in the oxytocin receptor after receiving small amounts of exogenous oxytocin, possibly allowing these males to be more sensitive to the benefits of oxytocin. The biological basis of the "Goldilocks principle" includes re-programming of neural pathways that rely on oxytocin and vasopressin.

Should we mess with mother nature?

Prenatal and postnatal experiences differ among species and within a species among individuals and between the sexes. Variations in early stimulation and hormones, such as oxytocin contribute to these differences.

Moreover, oxytocin and perinatal social experiences also are widely manipulated.

Image: © Jessie Williams

Among these manipulations are different styles of parenting, and birth interventions, such as Caesarean-sections, applications of extra oxytocin to hasten birth, or blocking oxytocin receptors (sometimes used to prevent premature labour). All of these hold the potential to influence a broad range of processes relevant to the health of both the mother and baby.

Perhaps even more remarkably, the genes that control the oxytocin receptor can be epigenetically “tuned” by either experience or hormones, including oxytocin itself. Birth and oxytocin both sculpt the brain and body. During the perinatal period infants receive behavioural and physiological messages that help the new born adapt to and cope with an everchanging environment.

However, these properties also give birth, parenting and natural and medically-manipulated oxytocin the power to alter physiology and behaviour for both the present generation and into the future. Studies of oxytocin-vasopressin pathways are offering new insights into the pervasive health benefits of optimal early experiences. This research also provides warnings that manipulations of these systems hold the potential for unexpected outcomes.

A focus on biology: Peptide pathways to human evolution

An insight into emotionally powerful social behaviours that are built upon primal functions, specifically regarding peptide pathways to human evolution

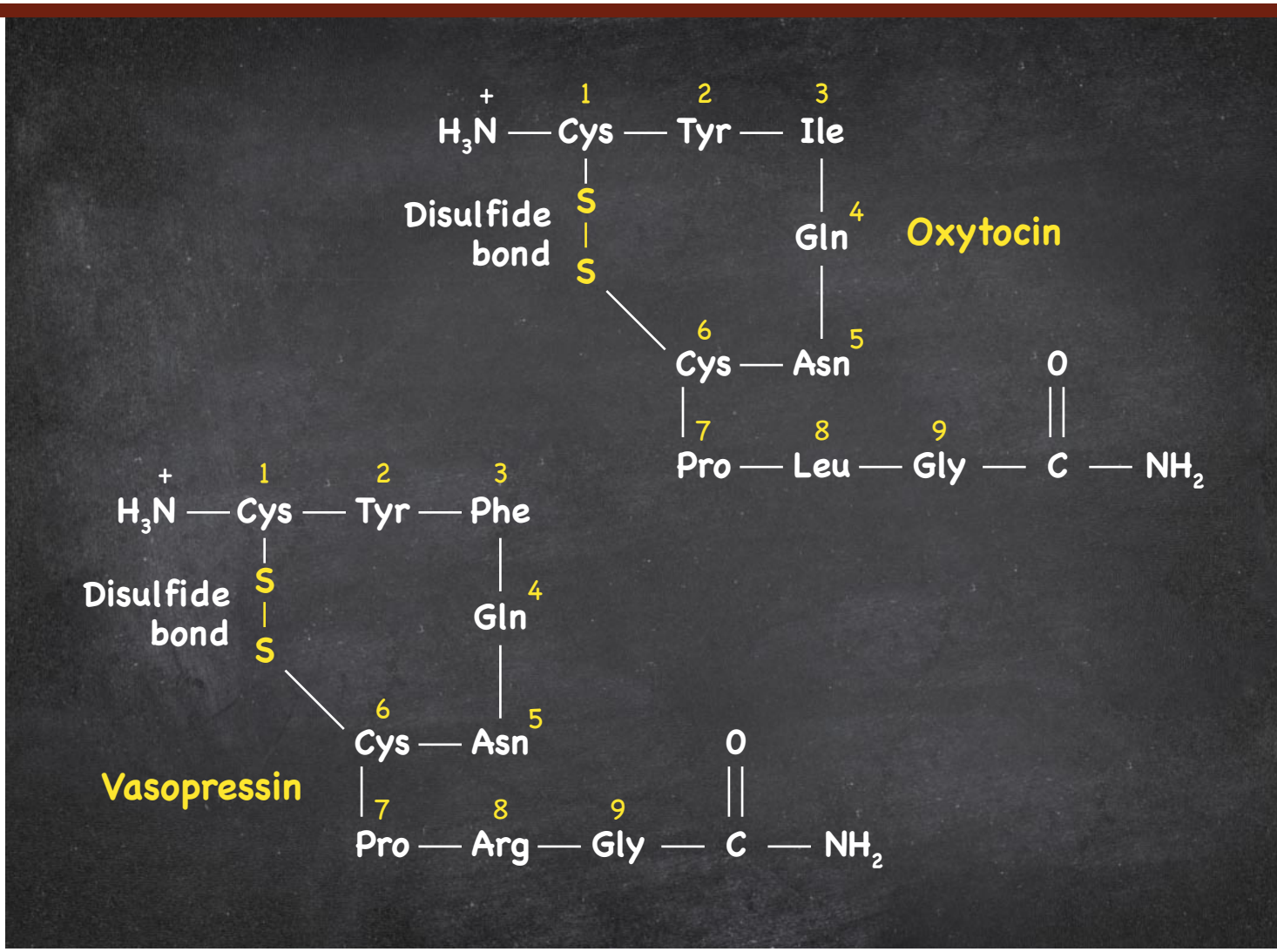
Human evolution and unique features of the human brain, can be traced to archaic chemical processes that began to appear over 600 million years ago. Amino-acid based molecules known as peptides, capable of reducing dehydration, allowed animals to move from aquatic environments to dry land. Particularly relevant to the evolution of modern mammals are two small peptides, oxytocin and vasopressin. Of these, vasopressin is more ancient. Oxytocin appeared much more recently and is central to the traits that define modern mammals.

Both oxytocin and vasopressin tune the central nervous system, setting the neurobiological stage for adaptive patterns of physiology and behaviour. Vasopressin is associated with anxiety and defensive behaviours, increases blood pressure and allows mobilisation in the face of danger. Oxytocin permits mammals to overcome the fear of others and use social relationships and cognition to cope with challenges and trauma.

These biochemical building blocks and their receptors are foundations for mammalian sexuality, birth, lactation and the capacity to adapt in an ever-changing environment. The same molecules that protect our bodies and allow reproduction, also facilitate our capacity to form social bonds and defend ourselves and those for whom we care.

Chemistry and bonding

Oxytocin and vasopressin are partners in a dynamic biochemical dance. Both consist of nine amino acids with 6 amino acid rings that are held together by



disulfide bonds. Oxytocin influences the functions of vasopressin and vice versa, in part because these peptides are capable of binding to each other's receptors. Most of the oxytocin and vasopressin in the body is synthesised in the brain. However, receptors sensitive to these peptides are found throughout the body giving these molecules a central role in coordinating many physiological functions. Other hormones including gonadal and adrenal steroids also regulate both peptides and their receptors. When better understood, the interactions among these will likely help explain much of their biological versatility, ranging from the bonds formed between molecules to the selective relationships found in society.

Do oxytocin and vasopressin help to explain human nature?

Oxytocin played a central role in the evolution of the mammalian nervous system and may lie beneath the surface of several mysteries associated with human existence. Both the birth of a baby and releasing milk are facilitated by oxytocin's effects on muscles. In the postnatal period mothers (or comparable caretaker) provides milk and nurture to the dependent newborn. Falling in love with a baby also appears to be facilitated by oxytocin in both males and females. Bonding to an infant can occur in the absence of birth or lactation, providing several layers of physical and emotional

support for the newborn. The human experiences of orgasm and, in males, ejaculation also are facilitated by oxytocin, possibly reinforcing adult social bonds.

Unique human traits including complex social cognition and language rely on the functions of the human cortex. The cortex requires a sophisticated autonomic nervous system and high levels of oxygen. The autonomic nervous system is dynamically regulated by both oxytocin and vasopressin, with abundant peptide receptors in the brainstem.

Vasopressin is a stress hormone, while oxytocin is of particular importance in "stress-coping," encouraging a sense of safety that allows positive social interactions even during periods of adversity and trauma. Across the lifespan, oxytocin may modulate emotional reactivity and increase social sensitivity.

During mammalian development, variations on these same molecules help physically sculpt the brain, heart and other tissues. Oxytocin can heal wounds and has therapeutic consequences throughout the body. For example, oxytocin appears to be a protective factor against cardiovascular disease, possibly by reducing inflammation and blood pressure, while vasopressin generally has opposite effects.

A mother's body is physically remodelled in part by oxytocin, eventually allowing birth. Oxytocin stimulates smooth muscles, such as those in the uterus, creating rhythmic contractions that are associated with sex and birth. Oxytocin is of special importance to humans, in which infants have comparatively large heads and communicative faces. Oxytocin plays a major role in the innervation of the face and facilitates social communication. Oxytocin physically and functionally shapes the neocortex, allowing a nervous system capable of language and social cognition. Oxytocin also is analgesic and protects both mother and infant from pain and the memory of pain associated with childbirth. Oxytocin functions in conjunction with other molecules, including dopamine and opioids, to transform experiences from pain to pleasure and to reduce the consequences of traumatic stress.

Although characterised initially as a "female reproductive hormone," it is now clear that oxytocin acts in both sexes. In contrast, vasopressin, especially in brain regions associated with defence, is regulated by androgens and of particular importance in males. Both sexes use changes in the vasopressin system to adapt to threatening experiences, but there is increasing evidence that males are more sensitive to vasopressin than females. Males may show a more mobilised response to danger, while females tend to respond to apparently similar stressors with immobilisation or anxiety. Depression and a tendency to emotionally shutting-down after a traumatic experience is two to four times more likely in females than males. Vasopressin can support active defensive

behaviours and lowers thresholds to aggression. It is also possible that sex differences in aggression and reactions to infants are at least partially due to sex differences in sensitivity to vasopressin and oxytocin.

Pathways to peace

In a world torn by fear and violence, it is easy to forget that humans are the primate species that rely most strongly for its survival on social relationships. Knowledge of the roots of both peace and war are critical to our future as a species. The deeply-buried secrets at the core of human evolution are only now being uncovered.

Understanding the actions of peptides and especially oxytocin is offering new perspectives into the physiological and evolutionary origins of what it means to be human. This knowledge also suggests pathways through which we may optimise human health and wellbeing.

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Is birth essential? and if so, why?

Discussing the burning existential and biological questions about birth

Brave New World, Aldous Huxley's 1932 dystopian novel, predicted a future in which humans would be created in test tubes, gestated in jars and "decanted" into independent existence. However, in the 21st-century foetuses created either in vivo or in vitro still must grow in utero, and be "delivered" through the process known as "birth."

To this day birth remains both essential and mysterious. As Western medicine emerged over the last century, there has been interest in improving on "mother nature." In the short-term, medically-managed births seemed more predictable and less dangerous. However, science is gradually discovering that avoiding or manipulating birth holds hidden risks for both mother and child.

Epidemiological studies show that surgical births are statistically associated with a host of maternal health risks, including maternal death and later sub-fertility in some women [1, 2]. Postpartum depression and anxiety, which can occur in 15 to 20% or more of new mothers, is significantly more likely after a caesarean birth [3]. It is estimated that the benefits of caesarean section outweigh the risks only in roughly 10 to 19% of births [4, 5]. Despite recognition of the health advantages of vaginal births, caesarean section rates have almost tripled in the last three decades. In the United States, roughly one in three babies are born by caesarean section with rates around 27% in the UK and Canada. Even higher rates are reported in China and Latin America. In private hospitals in Brazil, the rates of surgical birth reached a staggering 80-90%. What was intended as a method for dealing with birth emergencies, became increasingly "elective," with consequences that are only now being appreciated.

Benefits of birth

Uterine contractions are facilitated by hormones, including the neuropeptide oxytocin. These contractions clear the infant's lungs of amniotic fluid and facilitate breathing. Children born by caesarean section also are at risk for asthma and obesity, two epidemic disorders in modern life [6]. The digestive system of a newborn mammal is sterile and requires colonization by friendly bacteria. Bacteria are acquired from the mother during passage through the vagina. Healthy bacteria also can be transmitted in colostrum and maternal milk, helping to prepare the baby to deal with the microbial environment it encounters at the time of birth. As one example, Lactobacillus reutter, a powerful probiotic bacteria found in human milk, has a variety of beneficial effects, including facilitating normal digestive function, wound healing and sociality. The health benefits of probiotic bacteria involve several systems, including the autonomic nervous system (vagus nerve), and are mediated in part by the neurohormone, oxytocin [7].

Cocktails for birth

Other interventions often accompany birth. Synthetic oxytocin (Pitocin or Syntocinon), may be used to induce or augment labour. However, these treatments, which increase the intensity of uterine contractions, also lead to increased pain. Pain medications, in turn, can inhibit the release of endogenous oxytocin and delay labour, eventually requiring more interventions, including additional exogenous oxytocin, and eventually a caesarean section. Opiates given to the mother can be detected in the infant's urine 24 hours after birth. Some mothers given opiates during birth become drug-dependent. Furthermore, often added to the maternal cocktail are commercial antibiotics, which may disrupt healthy bacteria in the mother and child.

Oxytocin

Oxytocin is a molecule best known for its role in female reproduction, as well as

social behaviour and stress-coping. This same hormone stimulates oxytocin receptors in the intestine with direct consequences for neonatal digestion. In mouse models considered to be relevant to autism, animals genetically predisposed to show low levels of social behaviour and deficits in oxytocin pathways also have abnormal gut functions. These mice are especially vulnerable to disruptions in the microbiome, although normal behavioural and digestive functions can be restored with oxytocin [8].

The oxytocin system and the digestive biome may be especially important in explaining the benefits for the child of vaginal versus caesarean birth. Healthy bacteria and oxytocin can spare the baby from detrimental effects of birth-related hypoxia, reduce pain and stimulate maturation of the developing nervous system and lungs [9,10]. Oxytocin also primes oxytocin receptors and facilitates social behaviour, especially in the face of stress.

Although most often studied in the context of birth and lactation, there is increasing evidence that oxytocin is a powerful anti-inflammatory and anti-oxidant [11], with the capacity to “educate” the developing immune system, protect against cancer, and support the functions of the microbiome. Under optimal conditions, oxytocin benefits virtually every tissue in the body. When oxytocin is absent, or when given in excess, these functions are disrupted, with effects that are not yet well understood.

“Now is the time to understand more”

Under conditions when a caesarean section is necessary, breastfeeding may be one natural way to partially compensate for the effects of surgery. Human milk supplies ideal nutrition, healthy bacteria, direct transfer of oxytocin and other vital hormones. For the mother, lactation encourages mother-infant interactions, helps protect against over-reactivity to the stress of child-rearing, and reduces the later risk of maternal breast cancer. Although the benefits are well accepted, lactation is more difficult after a surgical birth, and all postpartum mothers, and especially those who are nursing need support and knowledge.

An increasingly medicalised perspective on human life and especially fear of birth have encouraged the use of elective caesarean sections and other invasive birth interventions. Caesarean sections, in particular, can save lives, can appear to reduce uncertainty and may be financially profitable to health providers. However, there is also increasing evidence that vaginal birth has direct benefits for later physical and mental health in mother and child.

To quote the twice-honoured Nobel Laurate, Madam Marie Curie, “Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less.” A deeper understanding of the biology of birth is necessary if we are to adequately evaluate alternatives, avoid mistakes and reduce fear.

Acknowledgement

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