# Attachment Reviewed from Neurobiology

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**Abstract**

*The optimal mental health developmental is formed in early life, through the bond between the baby and his primary caregiver, which is described by attachment. Attachment in children is a strong bond to find closeness and contact with certain figures, and in certain situations, especially when experiencing fear, fatigue or illness. Maternal sensitivity and physical contact between mother and baby is one of the sensory systems learning, which will be followed by reciprocal processes as adults, and behaviors that decrease from mother to child. There are neurobiological roles such as the oxytocin and dopaminergic systems that contribute to care by the mother, affective conditions in the mother, and growth also mental development in children.*
*Keywords: attachment;neurobiology; oxytocin;dopamine*

## 1. Introduction

(Bowlby used to describe "Attachment" as the affective bond that develops between children and their primary caregiver. The individual's initial experience with caregivers primarily leads to the formation of the internal working model (IWM), that determine the characteristics of his attachment and caregiver expectations, as well as the development of self-perception. Different types of attachments reflect different types of internal working models and can lead to different developmental outcomes in children. Attachment stability from infancy to later childhood influences children's social emotions, cognitive, and behavioral development. Attachment is important to develop especially in the relationship between mother and baby, because secure attachment is the basis for the baby's sense of security to explore the outside world boldly and confidently, to shape the baby's behavior which is then adapted to the environment, and to shape long-term emotions and cognitions (Ding et al. 2014).

The development of attachment in childhood is associated with optimal neurobiological development and pathological emotional development and the origin of personality disorders in adults. Attachment theory states that the brains of both individuals (mother-infant) will exchange information and influence each other. Traumatic experiences that occur during brain development have effects that may last, leading to emotional and cognitive deficits that manifest as psychiatric disorders later in life (Sullivan, 2012). Unusual emotional development can lead to stress-related problems leading tobehavioral regulation difficulties, interpersonal problems, and involvement in high-risk antisocial activities (Bick and Nelson, 2016; Miner-Williams 2017).

## 2. Attachments

### 2.1 Attachment Definition

Bowlby defines attachment in children as a strong trait to seek closeness and contact with certain people and in certain situations, especially when experiencing fear, fatigue or illness. Attachment refers to the emotional connection of infants or young children to adult caregivers as attachment figures, where they will selectively change to adults by increasing closeness when they need comfort, support, nurturing or protection (Zeanah, Charles; Berlin, Lisa; Boris, 2013) .

### 2.2 Attachment Stages

An infant's attachment behavior will be shown to their caregivers within a few minutes after birth, which occurs in the birth process and the transition from a warm and comfortable environment to an environment full of new sensory experiences. This process is frightening for infants as they begin to identify with the caregiver, form memories of experiences with the caregiver, and continue to seek closeness with the caregiver to survive. Caregivers are subjected to social and intimacy-seeking behavior, and provide the baby with the food, protection, and warmth that the infant needs to survive. The programmed behavior, as already mentioned, is carried out in the mother's womb along with prenatal learning from the smells and sounds of the caregiver, which greatly facilitates transition and attachment. This behavior is combined with postnatal learning in the infant, in which other images of a mother and other caregivers are quickly learned by the infant. A newborn baby is more oriented and prefers the sounds and smells of its mother, because the prenatal and postnatal experiences along with the sounds and smells of the mother can help reduce the baby's crying (Landers and Sullivan, 2012).

*Attachments* developed and appeared during the first few years of life along with major biobehavioral changes that can be predicted to occur at 2–3 months of age, 7-9 months of age, 18-20 months of age and at 12 months of age. These changes occurred for the first time when new behaviors and capacities emerged qualitatively, which made it possible to describe the emergence of attachment behavior in infants. Deviant environmental conditions seem to impair attachment development more than physical or neurological abnormalities in children. The difference in the balance between attachment behavior and exploratory behavior in each child may vary with different caregivers, because these behaviors are believed to be traits that arise from interactions between infants and certain adults (Zeanah, Charles; Berlin, Lisa; Boris, 2013).

### 2.3Attachment Theory

Attachment theory is based on the original idea of John Bowlby, which stated that humans are biopsychologically motivated by the need for attachment to others. This theory argues that our survival is mutually closely related and dependent on the capacity to build and maintain emotional bonds with others. Babies develop attachments to those who are "older and wiser", and try to maintain closeness to their caregivers under threatening conditions. The infant's crying, smiling, latching and following behaviors represent an orderly system, designed to maintain or restore closeness to caregivers. The attachment system is fully developed when the baby can crawl or walk, so the baby does not want to move away from the parent unless the situation is familiar. Attachments may have special meaning for babies, but are still considered important for humans throughout life (Leckman, James; Scott, Stephen; Snowling, Margaret; Taylor, 2015). The sensitive ability of a mother to be present and respond to her child in a way that depends on the baby's needs is the beginning of Ainsworth's definition. Nursing behavior including maternal sensitivity naturally shows a lot of variation and is relatively stable in a mother over time. Mother's sensitivity represents behavioral patterns that provide social experiences to infants and will show the important of managing and regulating consistent emotional systems, social systems, cognitive systems in infants. Maternal sensitivity can predict various forms of child outcomes including quality of attachment relationships, self-regulation, social functioning, socio-emotional development, and cognitive and language competence. Lack of skills required to respond sensitively to signals to children is

associated with risk of neglect (JE Swaina, P Kimd, J Spicere, SS Hoa, CJ Daytona, A Elmadihg, 2015).

Ainsworth draws on Bowlby's rationale about the biological basis of attachment, and the importance of actual experiences with caregivers, by highlighting the need to "stress" or activate the attachment system to be studied and measured. Children with normal or "safe" attachments will play happily in the presence of their mother, then show less play and excitement at separation, and bounce back when they see their mother again. In children with this condition, home observations will confirm a history of sensitive responses from the mother. But for children who feel less fun and are often ineffective in exploring the game, they will use it to defend themselves by covering up their inner stress when they meet their mother again. In such a child, home observations confirm a history of insensitive (disruptive) and/or unresponsive (rejecting) maternal behavior. Ineffective exploration, and stress that occurs during laboratory and home observations confirms an ineffective maternal behavior style (Green, 2003).

Physical contact between secure infants and their mothers is characterized by a gentle and affectionate style that makes contact pleasant for mother and baby. Towards the end of childhood, infants who have experienced open communication characterized by sensitive care are more effective in communicating with their mothers. The neurochemical, biological, and evolutionary sources of attachment behavior systems are well illustrated in "Strange Situation" which applies to infants aged 12-18 months. These situations work well because of their ability to provoke the attachment system and trigger the child's search for "the good enough mother" to feel safe. No newborn baby can survive and develop without providing a sense of security from the nurturing environment (Green, 2003). *Strange Situation Procedure* (SSP) was developed to examine differences in the balance of each child towards attachment and exploration when interacting with attachment figures and unfamiliar adults (Ainsworth, Blehar, Waters, and Wall, 1978), while the Strange Situation Procedure and Classifications of Attachment was designed to assess the balance between proximity seeking and exploration. The CNS is the "gold standard" for the systematic identification of infant-parent attachment patterns, whichinvolves a series of interactions between a 12- to 20-month-old baby, a caregiver, and a "strange" woman. Two brief separations between parenting and infant as minor stressors are designed to activate the child's need for caregiver support.Differences in the way infants regulate attachment and their exploratory behavior, particularly during reunion episodes, can be relied upon to be classified as secure, avoidant, or ambivalent/resistant and disorganized (Ainsworth et al., 1978;Zeanah, Charles; Berlin, Lisa; Boris, 2013)

Observational research has supported the four basic assumptions of attachment theory that already exist. These four assumptions will help to understand the fundamental and everlasting influence on parents in a generation, and which generations will havenext.The four assumptions that convey the essence of Bowlby's complementary theory are as follows:

1. The emotional relationship between individuals has a primary status and biological function

   Survival as an individual depends on the ability to establish and maintain emotional connections with others. Processes from birth and throughout the life span (especially in times of crisis), such as the "instinct" to cry, reach, and hold are functional expressions of very important biological processes along with the source of evolution (Green, 2003).
2. The way a child is treated has a strong influence on the child's development and then the functioning of his personality.

   A confident expectation of being understood, and an understanding of how improvement can be made when someone feels misunderstood, can be a process that goes through incompatibility to provide an important ingredient for the formation of a secure attachment (Green, 2003).
3. Attachment behavior is part of the system, has the benefit of "internal working models" in self and others, to guide expectations and behavior planning.

   *Internal working model*Attachment in children not only affects beliefs and expectations of others, but together can lead to the behavior and responses of others. Traumatic attachment experiences are associated only with unresolved grief in adults, and potentially frightening or

fearful behavior in parents, if adults are unable to come to terms with their unpleasant past (Green, 2003).

4. Attachment behavior is resistant to change, but there is the potential to change so that in a short time in a person's life he will be impervious to closeness or difficult to influence

   The longitudinal study of Klaus and Karin Grossmann in Germany has identified the long-term implications of early attachment to the mother. Children aged 3 years who get secure attachment can openly communicate their sadness (by looking at the other person's face) to the adult examiner. Children with a history of insecure attachment-avoidance express sadness but cannot directly show their sad faces and instead give a "social smile" (Green, 2003).

**3. Neurobiology Attachment**

Our brain development (neurodevelopment) determines who we are and how we behave, depending on the presence, pattern, frequency, quality and timing of experiences, both good and bad. The brain will remain plastic (flexible and able to adapt and learn from environmental stimuli) throughout life, learning becomes a lifelong activity. Neuroscience provides evidence that the brain physically changes, enhancing and strengthening neural connections through repeated experiences (Pam Winter, 2010).

Brain development begins immediately after conception, develops sequentially and cumulatively, which is integrated and continues throughout life. The nervous system is created, regulated and changed in response to experience through a life cycle, which begins immediately after conception. Brain development is shaped by the nature of the child's involvement in relationships with parental care and caregivers in the family and in the community, with response and sensitivity to child care as the main predictors. The way the closest adult behaves will primarily influence the child's emotional behavior, will have implications for the formation of individual brain development patterns, and prepare an increasingly common pathway of expectations to direct the way children respond to the environment. and will help explain why different children will master different skills at different ages. The child's ability to reach out and explore things when he feels safe comes from a nurturing, predictable and calm environment, where there is a caring adult, in accordance with the child's offer of attention and fulfillment of basic needs such as shelter, warmth, comfort and fulfilled love. Secure attachment plays an important role in regulating the stress response in times of stress, anxiety and illness in accordance with the child's offer to get attention and the fulfillment of basic needs such as shelter, warmth, comfort, and love are fulfilled. Secure attachment plays an important role in regulating the stress response in times of stress, anxiety and illness in accordance with the child's offer to get attention and the fulfillment of basic needs such as shelter, warmth, comfort, and love are fulfilled. Secure attachment plays an important role in regulating the stress response in times of stress, anxiety and illness (Pam Winter, 2010).

**3.1. Neurostructure**

Parenting is a social phenomenon that greatly affects children's brain development, requires flexibility and adaptation to various ecological conditions, and is reciprocally shaped by input from infants, partners, and society. The amygdala and reward circuits are both key components of the parental brain, supporting parental alertness or anxiety about infant safety as well as rewards in attachment relationships. Studies have shown an increase in brain plasticity in humans, which provides an opportunity for brain reorganization in the elderly(Feldman 2015). The human brain is an organ formed by mother-infant attachment and closeness to the mother's body to function in social ecologists. The young mammalian brain is immature at birth, and the need to be close to the nursing mother shapes the brain to constantly respond to the social world. Human maturation in the long term will sculpt the dialogical nature of the human brain and the need for constant social affiliation. The bonds that people experience throughout life are transformative and have the potential to repair negative relationships. The great plasticity of the human social brain and its behavior-based nature allow subsequent attachment to reorganize neural networks and repair, at least in part to negative initial experiences, and will

highlight the translational potential of attachment neurobiology research in humans.(Feldman and Stevens, 2016). The parent-infant bond exclusively involves brain plasticity which is necessary in seeking the compatibility of each child with the parent's brain through a process called "biobehavioral synchrony" which is the co-wiring of the brain and behavior of parent and infant to become a synchronous unit in support of brain growth and development. support baby's social competence(Feldman 2015). Biobehavioral synchrony is a key feature of attachment in humans, characterized by the coordinated coupling of nonverbal behavior with physiological responses between partners during social contact (Feldman and Stevens, 2016).

**3.2. Neurofunction**

Attachment regulation can also involve the development of discrepant specialized memory systems in the brain, such as procedural and semantic memory (processing of transient commands or cognitive information), described memory (processing more affective-based information), and episodic and walking memory systems (which integrates cognitive and affective information), each of which may be represented in a particular brain region. Two neuroendocrine systems that may be associated with this form of information processing are the dopaminergic and oxytosinergic systems, the development of which appears to be influenced by early life experiences, such as variations in maternal behavior. The dopaminergic system is involved in reinforcing stimulus-reward learning and making decisions based on predictable future rewards. The oxytosinergic system is important in the formation of social and spatial memories, behavioral affiliation, and the regulation of emotions. Recent data suggest an interactive effect between the mesocorticolimbic dopamine system, the oxytosinergic system, and the physiological stress system. Oxytocin receptor blockade results in an exaggerated response to the stress hormones ACTH and corticosterone in mice, and similar results are seen in oxytocin deficiency. The Mesocortical Dopamine System is also thought to have a stress-inhibiting effect via the medial prefrontal cortex. To Oxytocin receptor blockade results in an exaggerated response to the stress hormones ACTH and corticosterone in mice, and similar results are seen in oxytocin deficiency. The Mesocortical Dopamine System is also thought to have a stress-inhibiting effect via the medial prefrontal cortex. To Oxytocin receptor blockade results in an exaggerated response to the stress hormones ACTH and corticosterone in mice, and similar results are seen in oxytocin deficiency. The Mesocortical Dopamine System is also thought to have a stress-inhibiting effect via the medial prefrontal cortex. ToThese two differences are complementary mechanisms with one major role of the neuroendocrine system being to modulate the human stress response, thereby facilitating optimal social bonding and attachment (Stratearn, 2017).

Human delivery is considered a neurohormonal event and focuses specifically on the peripartal neuroendocrine mechanisms that participate in maternal and child attachment. There may be a disruptive effect of some obstetric interventions during the peripartal period on the neuroendocrine mechanisms of mother and child attachment, as well as their long-term consequences for the newborn. This impact can only be manifested later in life, during adolescence or even in adulthood. Motherhood arises because of brain neurochemical, morphological and functional changes designed to ensure the survival of the newborn. Pregnancy is one of the stages of life characterized by prominent hormonal changes. and is also a period of enhanced neuroplastic change those results in reduced human brain size and hippocampal volume in mice. Neuroendocrine and neuroplastic events during pregnancy that facilitate the initiation of maternal behavior, andinvolves various actions of steroid hormones, neurosteroids, prolactin, oxytocin, vasopressin, cathecolamines and endorphins (Olza-fernández et al., 2014).

**3.2.1 Neuroendocrine events in the fetus during labor**

Research on the mechanism of labor usingMRIat the time of delivery confirmed that the human fetus must pass through the curve to be born, and the fetal brain is subjected to intense physical stress during labour. Passage of the infant's head through the birth canal is accompanied by substantial activation of the sympathoadrenal axis and complete release of noradrenaline, cortisol and vasopressin. Strong sympathoadrenal

activation stimulates pulmonary fluid reabsorption and facilitates physiological adaptation of the newborn by promoting lung maturity, increasing blood flow, regulating circulating cytokine levels, mobilizing, and activating the central nervous system. Changes evoked by vaginal delivery are resolved after delivery by vagal stimulation evoked by skin-to-skin contact and early breastfeeding. Elevated levels of noradrenaline in newborns at birth may facilitate mother-child attachment, because noradrenaline levels in newborns are positively correlated with olfactory learning shortly after birth. Vaginal delivery is also associated with increased circulating vasopressin in the newborn, and may be involved in the analgesic effect induced by vaginal delivery.Disruption of neuroendocrine events even for serious medical reasons (cesarean section, administration of synthetic oxytocin, oxytocin or opioid receptor antagonists, preterm delivery, mother-infant separation after delivery or substitution of bottle feeding with breastfeeding), will not only have a short-term impact on attachment mother-child but also long-term effects on the newborn, an increased risk of behavioral changes or mental health problems that may not have been causally related to a peripartal origin, affect the development of several regions of the brain in the newborn (hippocampus) and may be risk factors for the development of autism, Attention Deficit Hyperactive Disorder (ADHD), anxiety, eating disorders, learning disabilities or other mental disorders.Peripartal neurohormonal disorders may also contribute to changes in maternal care and be a risk factor for the development of maternal affective disorders, such as postpartum depression (PPD) or post traumatic stress disorder (PTSD) (Olza-fernández et al., 2014).

Hormonal changes associated with pregnancy cause neural modifications in the hippocampus that facilitate various aspects of maternal care (learning, spatial memory, and emotional processing of facial signals). Stimulation in the baby after birth, including facial expressions, crying and touch/feeding stimulation, can also help to reshape the mother's brain during a period of persistent neural plasticity. Maternal experience increases Oxytocin Receptor (OTR) expression in the brain, and*oxytocin*, which is released during birth and breastfeeding, exerts long-term anxiolytic and bonding effects through changes in specific brain regions. O*xytocin*as an intermediary for the relationship between breastfeeding and reducing maternal neglect (Stratearn, 2011).

The neuropeptide hormone oxytocin, synthesized in the paraventricular and supraoptic nuclei in the hypothalamus, projects to the posterior pituitary gland, which is then released into the bloodstream, and it is well-documented for peripheral movements, including uterine contractions during childbirth and milk ejection during lactation. Oxytocin neurons project centrally to brain areas important in the manifestation of maternal social and behavioral behavior, including the medial preoptic area (MPOA), the basic nucleus of the stria terminalis, the ventral striatum (VS) (including the nucleus accumbens), and the ventral tegmental area (VTA). OxytocinIt is also important for the development of long-term spatial memory via the hippocampus, which supports maternal behaviors such as child rearing and foraging.berrole in stimulating the initiation and maintenance of maternal behavior, and maternal behavior which can also program the development of the oxytocin system in female offspring, as well as the quality of maternal behavior in adulthood.PGirls who reported experiencing emotional neglect in childhood showed significantly reduced CSF oxytocin levels, as was seen in other types of abuse (though not due to physical neglect). The best effect of peripheral oxytocin on women during childbirth is to increase uterine contractions with positive feedback, culminating in the expulsion reflex, a physiological process that makes the mechanism of labor successful and rapid.Vaginal delivery results in increased levels of oxytocin not only in the periphery but also in the brain.A significant increase in cerebrospinal fluid levels of oxytocin occurs during normal labor, but changes in central and peripheral oxytocin levels during labor in women do not show the same pattern. In conclusion, plasma oxytocin levels increase before delivery, cerebrospinal fluid oxytocin levels are higher after delivery than before delivery, indicating that plasma and brain oxytocin levels are regulated by different mechanisms and may have different functions (Olza-fernández et al., 2014).

Dopamine production in the nucleus accumbens of the ventral striatum (VS) appears to stimulate the maternal care response. Dopaminergic neurons facilitate stimulus-reward learning in the brain.(Stratearn 2017). These signals generally originate in the VTA and substantia nigra (SN) of the midbrain and project to various

regions throughout the brain, including the VS, dorsal striatum, prefrontal and anterior cingulate cortex.(Stratearn, 2011).Altered activity of the dopaminergic system is associated with a wide variety of human illnesses and psychopathologies, including drug addiction, attention deficit hyperactivity disorder, obesity, compulsive gambling, and several personality traits, all of which may also be associated with adverse early life events. PET studies have also shown that dopamine production in the human brain is associated with a lack of maternal care in childhood. It is hypothesized that abnormal development of the dopaminergic system may also be associated with differences in attachment patterns in adults (Stratearn 2017).

Another hormone that changes during birth in women and can affect the mother's interaction with her baby is cortisol, which in women increases during labor. This increase in cortisol levels may also contribute to the development of mother-child attachment, because circulating or salivary cortisol levels in human mothers have been positively correlated with several aspects of maternal behavior, including recognition of and attraction to infant body odors. Corticosterone also improves maternal behavior in postpartum rats (Olza-fernández et al., 2014)

### 3.2.2 Sensitive Period Immediately After Childbirth

Right after birth there is a so-called sensitive period, lasting about two hours, which includes the spontaneous initiation of breastfeeding. The first hour after birth is also a critical period for the development of attachment behavior. Skin-to-skin contact immediately after delivery helps the baby to conserve energy, adjusts the acid-base balance and breathing and has a calming effect, also increases attention mother to her baby and reduce cortisol levels in the mother. Oxytocin released during skin-to-skin contact also enhances the parent's response to infant cues. Early skin-to-skin contact also results in the baby's emotional regulation, stress reactivity, metabolic adaptation, social and cognitive development and the interaction between mother and baby in the future begins to grow, as well as the beginning of the continuous development of mother-child synchronization, which in part is facilitated by breastfeeding and oxytocin. The noradrenaline released in newborns during delivery facilitates learning and recognition of maternal odors. Smells from children induce maternal behavior in mothers, and humans also exhibit changes in smell and recognize their baby's smell as pleasurable. Cortisol plays an important role in the attraction to their babies' body odors in human mothers. Postpartum cortisol levels in women are positively correlated with the attractiveness of their babies' own smells and with their ability to recognize their babies' own smells. Vasopressin is also involved in maternal behavior, and this increased release of vasopressin is necessary for the maintenance of maternal care. Vasopressin release in the central amygdala is associated with increased maternal aggression, which may be partly mediated by maternal anxiety regulation (Olza-fernández et al., 2014).

### 3.2.3. Lactation

Nipple stimulation increases oxytocin levels in nursing mothers. Oxytocin release at the neurohypophysis, coupled with increased intracerebral oxytocin release during breastfeeding, mediates the relationship between breastfeeding and mother-child attachment, and occurs concurrently with increased oxytocin receptor release in certain brain regions. There is a positive correlation between salivary oxytocin levels and the behavior of pregnant women during the mother-child interaction. Interactions with infants lead to higher circulating oxytocin levels and increased activation of the mesocorticolimbic reward area in women with secure attachments. Higher circulating oxytocin in fathers is also correlated with affectionate and stimulating behavior when interacting with children (Olza-fernández et al., 2014).

## 4. Summary

Optimal mental health development is formed early in life, through the bond between infants and their

primary caregivers, especially mothers, which is described by attachment. The development of a good attachment is needed to form behavior that is in accordance with the environment, the formation of long-term emotions and cognitions, as well as interpersonal relationships that will continue to be carried throughout life. Research proves that maternal sensitivity will affect the shape of the resulting child, by emphasizing physical contact between mother and baby as a sensory system learning, followed by reciprocal processes as adults, and behavior that is passed down from mother to child. Oxytocin and dopaminergic. These two hormones are important in the formation of social and place memories, affiliative behavior and emotion regulation, reinforcement of reward learning stimuli, and in decision making.

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