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Review Article

Maternal care: efficient and inefficient mothers

Cuidado maternal: madres eficientes e ineficientes

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Abstract
The bond between mother and offspring is a fundamental aspect of individual development. The mother is the one who provides care and seeks infant survival. The quality of such care will depend largely on the state of physical health and an environment with greater opportunity to meet basic needs and a low stress. This topic has been studied from many perspectives, such as psychological, medical and social. Recently described some neurobiological processes motherhood as they are; the impact of mother-offspring relationship both in the nervous system of the infant and mother. In raising this relationship affect all its development from its fetal stage to adulthood. In this paper we explore what today is known in the literature about the mother-infant in the development of a healthy individual and the link between a poor relationship and alterations in the development of progeny or even no offspring survival.

Key words: Maternal behavior, Maternal attachment, Mammals, Offspring.

Resumen
El vínculo entre la madre y su descendencia es un aspecto fundamental del desarrollo del individuo. La madre es la que brinda cuidados y procura la supervivencia del infante. La calidad de dicha atención dependerá en gran medida del estado de salud física y de un ambiente propicio con mayor oportunidad de cubrir las necesidades básicas, así como un bajo nivel de estrés. Este tema ha sido estudiado desde muchas perspectivas, como la psicológica, médica y social. Recientemente se han descrito algunos procesos neurobiológicos de la maternidad, como son; el impacto de la relación madre-cría tanto en el sistema nervioso del infante como de la madre. En la cría esta relación afectará todo su desarrollo, desde su etapa fetal, hasta la adultez. En este trabajo exploramos lo que hasta hoy se conoce en la literatura acerca de del vínculo madre-cría en el desarrollo de un individuo sano y la correspondencia de un vínculo deficiente con alteraciones en el desarrollo de la progenie o incluso la no supervivencia.

Palabras clave: Conducta Materna, Apego materno, Mamíferos, Crías.

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1. Introduction: Maternal “love”

The unconditional maternal love is not just hugging or affection offered by mothers to their children, a mother's love goes beyond a demonstration of affection which can be seen all the care provided by mothers to their children, increasing their possibilities to survive, adulthood and ensure their progeny, whatever the species to which they belong.[1] In a brain evolved like most vertebrate females, there are specialized structures that scientists have managed to associate the care of infants.[2] This partnership has been observed through experiments ranging from behavioral models to sophisticated models to anatomical, cellular and molecular level, focused on understanding the strong bond between mothers and their offspring.[3]

In all species including humans, interactions between mothers and their young require integration of external stimuli and internal states, where the signals emitted by the children are detected by the mothers, so that these and perceived reacted to infants by providing the required welfare, as the signal olfactory, auditory, visual, gustatory or somatosensory.[4] Such is the case of rats where stimulation is reciprocal between mother and offspring for the deployment of maternal behavior, where the interaction between the stimuli received by the signals emitted by the pups provide important benefits to be breastfed as pups, groomed, get hot, be carried to the nest or get well anogenital licking stimulation to defecate and urinate, while this behavior is also where the mother makes a profit as it recovers water and electrolytes in the urine their young.[5,6] Thus stimuli emitted by pups provide them rewarding responses from the mother.

Many of the structures involved in the performance of maternal behavior, corresponding to the limbic system, which is a set of brain areas responsible for emotions. Moreover it also requires the integration of the nervous, endocrine, sensory and motor system and the overall functioning of these systems are those that determine and guide the deployment of maternal behavior.[7] For example in mammals maternal care consists of a set of motor movements and sensory events that prepare mothers from the end of pregnancy, childbirth and lactation to provide maternal care to offspring, which implies heat, food, cleanliness and protection that infants receive from birth until they are independent, so that maternal care is very important for the development and survival of infants, because all these cares favor the formation of a very strong bond between mothers and newborns, to which has been called "maternal attachment" that is very important for the development of emotional state and future behavior in adulthood.

2. Maternal Behavior and brain

For many years, both humans and animals have been observed where the positive and negative effects to those infants receiving adequate or inadequate maternal care. But, how to know if a mother has proper care of their young?

During the decade of the 70's significant progress was made in the description of the various behavioral processes involved in the mother-infant bond. In these studies it was established

that these behaviors involve different multisensory processes.[8,9] In the case of rodents such as olfactory, auditory signals and motor responses such as grooming behavior, protection and breastfeeding among others, are extremely important for their development.

All of these behaviors also require cognitive processes that, together with sensory and motor processes, help the attention, memory, social recognition, motivation and learning, acquire relevance in presence of bonding between mother and breeding and consequently attachment is established.[7]

Affective disorders appeared at an early age affecting the development of certain neural structures, for example, infants who face stressful situations by separation from the mother for long periods, suffer irreversible changes in neurobiological processes that are reflected in adulthood.[10] This is seen mainly in tasks where learning, memory, or to resolve high-risk situations or stress are involved. In these studies both in humans and in animal models,[11-14] it has also been reported that in early stress reaches cause depression, schizophrenia, or addiction in adulthood.[15] There are also clear examples of the effects of such short-term separation. Infants born in hospitals that are separated from their mothers for various reasons, whether those born premature and should stay in bassinets or incubators or treated by the physician, their heart rate changes, and when they return to their mothers and have direct physical contact, the basal rate resets. Moreover it has also been shown that "maternal neglect" can seriously interfere with the emotional development of children making them vulnerable to future psychiatric disorders. This vulnerability is linked to the early development phase, where several brain regions related to social behavior as the prefrontal cortex (mainly anterior cingulate and orbital) are still developing which maturation lasts until the end of adolescence. So that, early experiences are modulating the functional development of this cortical area, where the neuronal organization will affect the adaptive capacity of children.[16]

3. Motherhood and hormones

Hormones elicit a maternal behavior, studies such of Rosenblatt and collaborators, in 1988[17] proposed that the drop of progesterone level that take place at birth may facilitate mother behavior, but maintenance of certain displays show that hormones alone are no sufficient to promote those behaviors e.g. virgin females without circulating ovarian hormones, display maternal behavior after extensive exposure to pups.[18] Although, studies about hormone levels during gestation and parturition explain how levels goes through many ups and downs, and each hormonal change has an impact in observable behavior, such affiliate, aggression, and more marked on reduce sexual behavior[19] (it may lead the mother to focus on offspring), this suggest that endocrine system is important for maternal displays.

Nonetheless there are very marked hormones related to maternal care, such oxytocin (OXT) which is released during childbirth, breastfeeding and copulation and is associated with feelings of pleasure, calm, formation of attachment bonds, increased sensitivity of touch, smells, gestures and words (released at central level). Moreover, in rodents and

primates that inhibits the release of stress hormones (glucocorticoids), regulates the release of dopamine (DA) and noradrenaline (Na) (attention, motivation, alertness, prolactin -maternal responses-) and opioid (welfare, pleasure).[20] To that oxytocin perform their functions must be synthesized in the nervous system and other body tissues. In the mammalian brain the hypothalamus has nerve cells that synthesize and then release from the pituitary gland into the bloodstream, in this way prepare the uterus at the time of delivery and breast to release milk. Accordingly on this, studies in rodents, OXT regulation provides both; physical and mental benefits on infants and mothers, it helps to structure a positive social interaction in further experiences of the young, in other words, the bond among mother and offspring will be a pattern to offspring to socialize with others at their adulthood. Equally important is peptide vasopressin (AVP) that is involved in self-defense and aggression, the role in mother behavior seems to modulate along with OXT[21] although it is difficult to know specifically the role of each peptide, hormone or neurotransmitter, these enclose an interaction to maintain some features in mother behavior. Additionally stress is one important factor that has an effect on biochemical mechanisms as hormone levels,[22] neuronal pathways, behavioral outcomes and molecular mechanisms.[23]

4. Mother-child relationship: How to benefit or affect maternal care to their children?

Various positive and negative effects related to maternal care, have shown in newborns during the first hours after delivery. Studies about the response to the mother's voice demonstrated that in newborns the left hemisphere is activated, a cerebral area related to language and learning.[24] In this sense, Kennel and Klaus (1998) after making a comparison between a group of human mothers who were separated from their infants and a group of mothers who were allowed to have contact with the newborn immediately after birth, showed that the latter are the ones who developed a greater sensitivity to the needs of the infant, being more patient and loving,[25] so it has been suggested that during this first meeting, the newborn stimulates the sense of the mother to detect the maternally relevant signals.

Figure 1. Rat mother with her pups. Display licking and grooming behavior

In most cases infant crying is the first form of communication in its earliest stage of life, this stimulus is also the medium through which the infant expresses his need for attention. Crying baby is able to modulate the behavior of the mother, preparing to act (sense of urgency to help) and causing her emotional response that does respond empathically.[26,27]

In most mammals, olfactory signals profoundly influence social reactions. These signals are emitted by urine, feces, saliva and secretions of various cutaneous glands and are often deposited by deployments often stereotyped behavior. Olfactory signals deposited by an individual are perceived by others of the same specie by the main olfactory system and vomeronasal organ.[28] Olfactory stimulation influences maternal behavior, because the smell comes from any infant becomes a nice encouragement for new mothers, generating statements of attraction and alert,[29] especially during the early postpartum (1-4 days postpartum) compared to other odors from adult bodies.[30] On the other hand the neonate provides vital information to the mother during the sensitive period to allow maintenance of maternal responsiveness. So deprivation of licking and suckling do not disturb maternal acceptance, the rate of rejection increased as the olfactory contact between mother and offspring decreased, for example, in one group of ewes that could not smell their lambs, the rate of acceptance was as low as in the group of mothers totally deprived of their young for 12 hr.

In rats, isolated females at birth, when reach adulthood show difficulties and shortages to display maternal behavior. So attention deficit and hyperactive be more impulsive, more emotionally reactive, compared with females reared by the mother. A similar experiment with mice, animals turned in to hyperactive and anxious behaviors, compared with another group of mice that were not separated from their mothers.[31] Moreover it has been shown that the greater amount of attention, more ability to develop adequate response to stress. This was observed in rats where epigenetic studies showed that certain genes are modified depending on the amount of maternal care when they were pups and that these changes are maintained long term and can be passed from generation.[32] However, research confirms that genetic imprinting in human infants is not as deterministic as in rats, but can be altered by life experiences after birth and neglect in early parenting.[33]

These studies helps to understand how early experiences can affect the development of offspring in infancy and in adulthood. In this sense we have a clue since maternal care and attention have an impact on the chemistry of the limbic system; consequently, maternal behavior can influence how offspring will face their entire lives.

For humans the mother-child bond affects the brain development of children. Investigations revealed that the absence or weakness of the mother-child bond in the first months of life of the young is related to anxiety, depression, aggression and hostility of the newborn, at other times in their lives. This is because the mother-child bond affects the hypothalamic -pituitary-adrenal axis (HPA axis), a system that controls reactions to stress, including segregation of a stress hormone cortisol,[34] e.g. studies in humans and animal models have confirmed that addiction is a state of security, anxiety or fear that occurs in both children and the young, which can be determined by the accessibility and responsiveness given by the mother or who is establishing the link. So the attachment is an emotional bond that develops emotional security where the young notice maternal protection.

5. Discussion: Is there a bad mother behavior?

Recently has been proposed that the age of motherhood in humans could be one factor to consider about child care, this may be due lack of parenting skills in young mothers[4] and social level and genetic factors,[35] these studies show that is possibly to argue that there is a "good or bad" mother behavior, although in animals there are examples of abnormal mother response in conditions such as cocaine exposure during lactancy period[36-38] we must consider the biological functions of those outcomes, and determine if there is a successful strategy in benefit to the litter, e.g. when a rat pup born with congenital malformations or abnormalities, the mother kill those pups[38] infanticide has been associated with mother experience; mothers with no previous experience are more prone to kill their offspring than experienced females, although capybara females do not kill their pups due to experience, equally primiparous and multiparous show similar rate of frequency of this behavior.[39] Another condition that leads to infanticide or

cannibalism is food intake e.g. female hamsters fed with light diet, cannibalized more and maintain smaller litter size than females with fat diet, so it is possible that this behavior is modulated by availability of metabolic fuels.[40]

6. Conclusion

Maternal care, increases the chances of survival for children and the benefits to adulthood, so ensures that the offspring. However the interaction between mother and young requires the integration of external stimuli and internal states of both parties to provide a required response. Hormones induce maternal behavior, but are not absolute for eliciting care behaviors. In mother-young bond, central neuronal Oxytocin projections play a role to establish a positive contact, and helps to establish social interactions in adulthood. In this sense, maternal neglect can seriously interfere with the emotional development of the offspring, if the mother-infant bond is absent or weak, the development is affected. Some of the failures in development of young like isolation derive in future abnormal maternal behavior when infants reach adulthood, and become more hyperactive and anxious; also in humans causes attention deficit, hyperactivity and impulsivity. Failures of mother care at early age are involved in the development of depression, schizophrenia and addiction. The state of insecurity, anxiety and fear can be determined by the accessibility and responsiveness given by the mother, or whoever is setting the emotional bond.

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