

Maternal behavior in domestic dogs

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Abstract

For the past years, there is an increased interest for maternal behavior in human's best friend – the dog. Indeed, studies show that the quality of mothering is not only important for the survival of the puppies during the first weeks of life, for the bonding process but recently it shows that it might have a long-lasting impact on the puppies' future performance. However, how to define and measure maternal behavior? From the early studies to nowadays, the display of acts from the bitch right prior to parturition (preparation phase), and then continuously toward the puppies until weaning are the repertoire of actions that define maternal behavior. For the scientific community, maternal care is quantified as a principal component assessing attitudes that are easy to measure from the dam to the puppies such as: the time spent in contact, time and/or frequency of licking/grooming and time and position of nursing. Though, there is still a need to elucidate different aspects of maternal behavior in the dog, for example the effect of genetics, the impact of the emotional state of the bitch and the quality of maternal behavior, the role of hormones, the possibility to improve maternal behavior, there is some information to share. The idea is to give an overview of maternal behavior that permits veterinarians, breeders to identify and prevent problems to optimize the dog welfare.

Keywords: maternal behavior, canine, maternal care, puppy.

Introduction

Maternal refers to changes of individual females leading to be suitable as a caregiver - the mother. Behavior comprehends the discernible conducts of oneself. Therefore, maternal behavior is the set of attitudes that contributes directly to the care and the survival of the offspring normally after parturition. Overall, maternal behavior describes a combination of tactics and acts of the mother towards her offspring covering all the preparations prior to parturition and all the care to the newly born until weaning or until the independence of the offspring. Although, still poorly understood maternal behavior is a very important aspect of puppy production. Indeed, maternal care in domestic dogs, in particular within the critical first two weeks postnatal, was until recent years largely ignored by the scientific community even though it could be a predisposing factor for dog anxiety as described in other altricial species. (Czerwinski et al., 2016). Dogs are considered altricial species (immature youthful at the time of birth, that need the support of their parents to mature and survive) since puppies are born helpless, deaf and blind, and have limited movement (Kendrick et al., 1987) and they are very dependable on maternal care to survive. Characterization of maternal behavior in mammals gives an idea of the interactions between the mother and the offspring. However, particular aspects of maternal behavior could be relevant in a specific species. In the bitch, maternal interaction is highly associated to oral contact as licking the puppies (Rheingold, 1963; Scott and Fuller, 1965; Korda and Brewinska, 1977a; Grant, 1987; Malm and Jensen, 1996; Guardini et al., 2015; Czerwinski et al., 2016). In addition, the connection between the bitch and her newborn puppies shows some aspects of instinctive behaviors (Foyer et al., 2013). Maternal behavior is stimulated by genetics, environmental factors and internal signals in mice (Bridges, 2015) and similar factors should be important for dogs. Early life is a time that although physically immature the individual is most likely susceptible and responsive to different stimuli. In mammals, maternal behavior is highly associated to caretaking and it is linked to changes or activations of neural patterns that will be responsible for the transformation in the psychological changes in the female to become a mother (Korda and Brewinska, 1977a). However, how maternal care is established and it influences on the comportment of dogs as puppies or adults and its impact in maladjusted behaviors is still under debate (Wilsson and Sundgren, 1998a; Tiira and Lohi, 2015; Foyer et al., 2016 and Czerwinski et al., 2016). In dogs, the neonatal period is characterized by a rapid neurological development. Nevertheless, investigations to measure or acknowledge the role that maternal care plays during this critical window, or how the



experience of puppies during this time influences behavior later in life, including response to stressful events are scarce (Czerwinski et al., 2016) with some insight in recent years (Tiira and Lohi, 2015; Foyer et al., 2016; Guardini et al., 2016; Bray et al., 2017b and Guardini et al., 2017). Maternal care as a predisposing factor for dog anxiety is a relatively novel concept in dogs (Czerwinski et al., 2016). The ability to respond and perform, defining the dog's temperament has been associated with three important periods of development identified in canine. These development periods are (Battaglia, 2009):

- The first period also called the "primary" or "neonatal" begins around the third day and ends around day 16 of life.
- The second period also called the "socialization" going from the 3rd week of age and lasting until 12–14 weeks of age.
- The third period known as the "juvenile state" associated to the enrichment after socialization being established and it continues through 12 months of age.

Indeed, puppies in the first week after birth have no control of the body temperature (unable to shiver), reduced capacity to move (crawl movements), no capacity to excrete without external stimulation. However, newborns are able to smell, to suck, and to search warm places. The objective of this article is an overview of mother behavior in domestic dogs during the peripartum period and a brief summary of recent publications on this topic.

Bitch behavior close to parturition

Signs of impending parturition can be observed one or two days prior to the event (Wells, 2009 and Linde-Forsberg, 2010). Physiological and hormonal changes are important aspects to consider during eutocia (Arlt, 2020). Behaviors as restless, loss of appetite, nesting preparation and shivering have been indications to an imminent parturition (Bleicher, 1962; Hart, 1979 and Linde-Forsberg, 2010). The manifestation of these behaviors varies based on individual and environment. In addition, domestication and life experiences of a specific bitch can directly impact the extension of the expression of behaviors (Udell et al, 2010) directly influencing the repertoire of comportment around parturition. Therefore, bitches may seek isolation (Bleicher, 1962 and Wells, 2009) or search excessively for human attention (Hart, 1979 and Linde-Forsberg, 2010). Some bitches might try to dig a hole in an attempt to build a nest, or shred papers and/or blankets (Bleicher, 1962; Hart, 1979, Beaver, 1999 and Wells, 2009). In a questionnaire-based evaluation of the pre-partum behavior in the bitch, 71.43% of primiparous and 80.65% of non-primiparous bitches, showed some action to build a nest (Ferrari and Monteiro-Filho, 2004).

Bitch behavior at parturition

Normal parturition requires physiological and endocrinological changes. To better understand the process and address specific help if necessary, parturition has been described into three stages (Linde-Forsberg, 2005).

1. Stage one: starts with progressive and mild uterine contractions and ends with complete dilation of the cervix due to the elimination of the progesterone block. Clinical signs are panting, vaginal discharge (Wells, 2009). As the contractions increase with the action of estrogens and relaxin, the cervix will fully dilate (Pretzer, 2008).
2. Stage two: visible contractions, discharge of fetal fluid and passage of the fetus. In dogs, phase two ends with the expulsion of the last fetus. The total duration of the second stage is usually between three and 12 hours; in rare cases, it has lasted 24 hours and can be influenced by parity, age of the mother, interaction of parity and age, litter size (Linde-Forsberg, 2005).
3. Stage three: expulsion of the fetal membranes. Fetal membranes can be delivered after each puppy but also after several puppies are born (von Heimendahl and Cariou, 2009)

Although, the impact of stress affecting the duration of parturition in dogs is a controversial subject. Studies done in the sixties showed that imposed stress situation could lead to arrest of all phases of parturition (Bleicher, 1962) and has been described as a reason of nervous voluntary inhibition of labor (Freak, 1962).

Parturition occurs, normally, during quiet time. In a survey of French breeders, over 80% of responders said that whelping happened at nighttime (Santos, unpublished data).

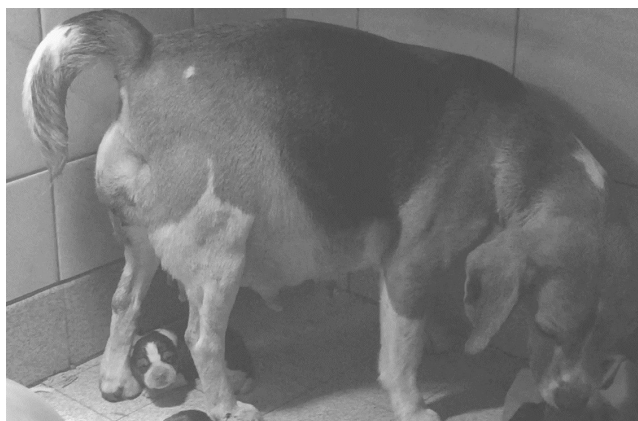


Figure 1: Stage two of parturition.

Bitch behavior soon after parturition

At parturition as soon as the puppy is delivered, the bitch will gently tear the amniotic sac, lick the puppy intensively, eat the fetal membrane remains, and sever the umbilical cord (Bleicher, 1962; Linde-Forsberg, 2005). All exchanges maternal-offspring ensued during this time are “critical” to establish maternal behavior and improve the chances of puppy survival. Oral interaction is an important aspect of maternal recognition as well as direct contact with the puppy and nurturing.

1. Oral interaction: Licking and cleanliness of the newborn: Licking is essential for puppy survival. Sometimes, puppies are born surrounded by the fetal membranes, and by licking the puppy, the bitch will free the puppy from the membranes and at the same time stimulate the respiration (Bleicher, 1962; Linde-Forsberg, 2005 and Santos et al., 2019). Licking also serves to stimulate urination and defecation in puppies and it is a common behavior of the bitch during the first 21 days of the puppies' life (Grant, 1987 and Linde-Forsberg, 2005). The frequency of licking declines slowly over time (Korda and Brewinska, 1977a; Grant, 1987; Guardini et al., 2015; Santos et al., 2020). The frequency of licking has been used to score quality of maternal behavior (Foyer et al., 2016; Guardini et al., 2016 and Bray et al., 2017b)



Figure 2: Oral interaction – behavior of licking the puppies.

2. Contact with the puppies: On the first day of life of the puppies, the new mother does not abandon the nest/whelping box (Freak, 1962; Rheingold, 1963; Hart, 1979 and Foyer et al., 2016). Some bitches can become extremely protective, especially against strangers (Bleicher, 1962 and Pal, 2005) and other dogs in the household. The first two/three days after birth, the bitch is in constant close contact with the puppies (Grant, 1987; Pal, 2005 and Santos et al, 2019b). Then, the time spent with the puppies will gradually decrease (Rheingold, 1963; Korda and Brewinska, 1977b; Grant, 1987; Guardini et al.,



2015; Foyer et al., 2016 and Santos et al., 2019b). This close contact is essential for the survival of the puppies since the capacity to regulate the body temperature will be acquired over time. As the puppies become less dependent on the bitch for the maintenance of body temperature, the bitch spends more time away from the puppies (Grant, 1987) and they are less in contact with the body of the mother (Korda and Brewinska, 1977b).

3. Nursing behavior: In mammals, the behavior of nursing or feeding is critical for the survival of the offspring. Nursing is one manifestation of maternal care controlled both by relevant changes in the hormonal state and by the central nervous system (CNS) which acquires a suitable level of selective reactivity during lactation (Korda, and Brewinska, 1977b). Nursing is a coordinated action, since the dam needs to allow the puppies to nurse and nursing activity can be initiated before parturition is finished (Hart, 1980), but feeding the puppies is not a priority of the bitch until all the puppies are delivered (Bleicher, 1962). The puppies need to be capable to suck. From the first day to day 21 of the puppies' life, nursing is stimulated by the bitch and the frequency of nursing is higher during nighttime (Grant, 1987). Overtime, duration and frequency of nursing decrease and primary factor changes. The stimulation for the puppies to suck done by the bitch is taken over by the puppies' willing once they become completely movable. No teat preference has been established in dogs, the most caudal gland seems to be more frequently engaged (Orfanou et al., 2016) and the first pair of mammary glands is rarely used with puppies being attached most often to the second and third pairs (Mila, 2015). The incidence of individual puppies trying to feed when the bitch is resting increased around the 5th - 6th week of postpartum, and may also make the bitch to leave the puppies and start the weaning process (Grant, 1987).

Factors that influence the maternal behavior

Variation in hormone levels; experience as a mother; environmental stress; genetics and hereditary tendencies may have an impact on the interaction mother-puppy and therefore maternal behavior.

1. Parity: Parity might play an important role in the quality of maternal behavior. In a survey-based study, French dog breeders described that primiparous bitches are more likely to show inappropriate maternal behavior (Santos et al., 2020) with the same tendency in an international dog breeder's profile survey (Santos et al., 2021). However, in studies of maternal behavior, the difference between primiparous and multiparous bitches are not so obvious. No major differences were observed in the behavior based on the parity (Bleicher, 1962; Hart, 1979; Ferrari and Monteiro-Filho, 2004 and Foyer et al., 2016). An experienced dam seems to be more prompt to the needs of the newborn and less disturbed by the physiological changes around parturition (Hart, 1979) and were ranked higher in a maternal behavior in a population of guide dogs (Bray et al., 2017b). Nevertheless, for German shepherd military working bitches experienced mothers showed less maternal behavior (Foyer et al., 2016). Indeed, the effect of parity in quality of maternal behavior needs further validation.

2. Litter size: Mothers with small litter having more contact with individual puppies displayed higher scores for the qualification of maternal care (Foyer et al., 2016 and Bray et al., 2017).

3. Genetics: the heritability of maternal behavior is poorly understood in dogs. However, genetics may play an important role in maternal behavior, therefore, selection of this trait should be considered. Removal of a bitch with poor maternal behavior is a positive strategy to select for good maternal behavior (Haupt, 2012). The selection should be done, most likely, after the second parturition since a primiparous bitch might not express fully her maternal style. Considering the innate aspect of maternal behavior and natural selection, human interference probably has a negative impact (Hart, 1979).

4. Hormonal and other factors: The direct role of hormonal profile and maternal behavior is poorly understood in the bitch. Progesterone imprint, prolactin (PRL) concentration and tissue sensibility to PRL seem to be important in the expression of maternal behavior since these factors are linked to the behavioral change during pseudopregnancy in this species (Gobello et al., 2011). Oxytocin is a key hormone to stimulate and maintain adequate maternal care and has been associated to the increase of maternal behavior in primiparous bitches over time (Guardini et al., 2015). Indeed, oxytocin levels in the plasma are higher and more variable during the expulsive stage of parturition than during late pregnancy in dogs. Interrelationships between the secretion pattern of oxytocin, the level of uterine contractility, and the progress of fetal expulsion in dogs need further exploration (Klarenbeek et al., 2007). In addition, the oxytocin might also be implicated with the onset of maternal behavior in the bitch as observed in rodents



(Nagasawa et al., 2012). The use of intranasal oxytocin appears to improve maternal behavior of bitches after C-section (Mason, 2016). In a simple description, the cervical stimulation, the presence of a wet puppy with amniotic fluid, changes in the hormonal profile (estrogen, progesterone, oxytocin and probably prolactin) are factors involved in maternal behavior (Haupt, 2012). The importance of amniotic fluid in maternal response has been well described in beagle bitches (Dunbar et al., 1981). The consumption of amniotic fluids appears to play a role in the development of maternal behavior and the establishment of the maternal/puppy bonding (Abitbol and Inglis, 1997 and Bleicher, 1962). The bitch will refuse puppies separated at birth and washed. After been refused, if the puppies were plunged in amniotic fluid, the bitch will re-accept them (Abitbol and Inglis, 1997). Situations of overstress in dogs may also interfere with maternal behavior as demonstrated in rodents (Nishi, 2020). The use of appeasing pheromone (Adaptil®) had a positive effect in the manifestation of maternal behavior in primiparous and multiparous bitches (Santos et al., 2019a).

Recent literature in maternal behavior

Indeed, until recent years, the scientific community (Czerwinski et al., 2016) neglected the study of maternal behavior in dogs and its impact on the cognitive development of dog. However, the interest for the area of study has increased and lately important aspects of maternal behavior of dog have been brought to light (Guardini et al., 2015; Foyer et al., 2016; Czerwinski et al., 2017; Guardini et al., 2016; Orfanou et al., 2016; Guardini et al., 2017; Bray et al., 2017 ab and Santos et al., 2019b).

The main limitation is the methodology adopted in each study, which is quite variable, making the comparison of the results not always possible. Although, there are differences in the duration and time of observation, the behaviors evaluated are, in general, similar.

- Guardini et al., 2015: ten bitches and 58 puppies (5 primiparous and 5 multiparous). Instantaneous and scan sampling observation, 15 minutes per day after returning from morning walk from d1 to d21.
- Foyer et al., 2016: twenty-two bitches (German Shepherd) and 94 puppies, Focal-animal observation, every second hour, for one hour during 24h totalizing 12 h of recording once a week, from d1 to d21.
- Czerwinski et al., 2017: six bitches and 25 puppies. Instantaneous and scan sampling observation. 24 hours for each chosen day (d3, d6, d9 and day 12 postpartum). 24 hours period was compared with 12 hours day, 12 hours night and with two sets of one hour (sum of randomized 15 minutes sequences making a total of one hour).
- Guardini et al., 2016: eight bitches (beagles) and 54 puppies. Instantaneous and scan sampling observation, 15 minutes every day after the morning walk (10 minutes of walking in the corridor of the maternity), from d1 to d21.
- Guardini et al., 2017: twelve bitches and 72 puppies. Instantaneous and scan sampling observation, 15 minutes every day in the morning after the bitch returned to the whelping box after the first walk, from d1 to d21.
- Bray et al., 2017a: twenty-one bitches and no information about the number of puppies. Instantaneous and scan sampling observation. Three days per week, 10-min sessions in the morning (between 9:00 and 12:00) and two 10-min sessions in the afternoon (between 15:00 and 18:00), from d1 to d21.
- Santos et al., 2019b: forty-one bitches and 220 puppies observed by video recordings done during daytime (between 09.00 and 17.00) at the first day, one, two and three weeks postpartum.

Globally, the data collected in all studies can be assembled in four types of interaction as:

- the presence of the mother with the puppies (time spent in the whelping box)
- nursing duration (allowing suckling - frequency, time and position)
- contact duration (direct contact with puppies)
- licking (specific or not for the anogenital area - frequency and/or duration)

Depending on the study, other interactions were also assessed. The time of the day and duration of observation were variable amongst all the studies. The duration of the observation should be taken into consideration to compare the data, since the sampling periods can lead to differences in the behavior and misrepresentation in the interpretation of the behavior (Czerwinski et al., 2017).

Impact of maternal behavior

The effect of maternal behavior on puppy development and the lag effect to adulthood need



further evaluation in the domestic dog. There are some evidences that could be positive, negative or neutral. Puppies from dams with high maternal score perform better in different evaluations. In German shepherds, the positive effect was observed in social engagement and aggression at the age of 18 months (Foyer et al., 2016). In Beagles, the effect was observed at the age of 2 months in exploratory behavior and signs of stress (locomotion patterns and vocalization during isolation). In a survey made in Finland, poor quality of maternal care was suggested to increase the fearful behavior in adult dogs (Tiira & Lohi, 2015). Contrastingly, in the study done in a population of guide dogs, the effect of maternal care was rather negative. Puppies from dams classified with high maternal scores showed less capacity to deal with stressful situations, poor performance and perseverance during a problem-solving task and lower chances to be selected as guide dogs (Bray et al., 2017b). More studies are needed to better understand the direct and indirect effect of quality of maternal behavior and outcome of dog as puppies and adults. Since, phobias and behavioral problems are the number one motive of abandonment and are also highly associated to failure in the process of adoption leading to euthanasia of pet dogs (Lambert *et al.*, 2015) it is important to comprehend the origin of the problem to try to prevent it. Therefore, impact of maternal behavior needs further studies.

Final considerations

There are many aspects of maternal behavior in dogs that need further considerations. Aspects associated with the mother as heritability of maternal characteristics, effect of bitch as an individual (temperament, personality, training, education and genetics in displaying maternal behavior), age of the mother (at first parturition – more mature animals have more maternal characteristics), and breed effect. In addition, aspects linked to the puppies such as litter size, gender composition of the litter, weight of puppies at birth. The influence of hormones as oxytocin and prolactin, the importance of amniotic fluid, the influence of pheromones in maternal care need to be addressed, as well. Information about the impact of maternal behavior in the adult life of dogs and the influence of the bitch's status (more or less stressed) during the period when maternal behavior is established, could provide new tools and strategies to prevent maladjusted behaviors in dogs.

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