

VISUAL CUE AND MATERNAL BEHAVIOR OF SHEEP: A REVIEW

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SUMMARY

Vision plays an important role in ewe-lamb bond during the early stages of a lamb's life. It was proved that odour is not the only cue included in the association between ewe and lamb. It seems necessary to pay attention to vision, whether of ewe or lamb, in grafting practices in sheep farming. Changes in the colour of the lamb can result in ewe lamb rejection as if own lamb was alien. Dams may be attracted to foreign lambs brushed with the same colour of their lambs at a distance of 10m. However, when dams approached coloured foreign lambs, their interest was reduced and lost. The aim of the present review is to shed light on the importance of visual cue in mutual recognition between ewe and her lamb.

Keywords: sheep, maternal, behaviour, vision, recognition, bond, ewe, lamb

INTRODUCTION

Maternal behaviour in sheep, like in many ungulates, is characterized by the rapid development of exclusive bonding to the neonate. Sensory regulation plays a major role in the onset and maintenance of ewe-lamb bond. Mothers can identify their young through the use of different sensory modalities, but the sensory basis for proximal regulation of lambs differs from that mediating distal recognition. Olfactory discrimination by the mother appears limited to a very short range (less than 0.25 m) (Keller *et al.*, 2003), and at a longer distance, recognition appears to depend on either visual or acoustic cues. Additionally, Hart (1985) indicated that some of the major senses are used relatively infrequently, but vision is involved to some extent in the perception of most stimuli and has been shown to be the dominant sense in many situations.

The visual appearance of a ewe, if altered enough, can confuse a lamb in the recognition of its mother. Farmers know that sometimes if a ewe is sheared, her lamb may have difficulty recognizing her. On the other side, blindfolding of ewe significantly affects her behaviour towards her lamb (Vince *et al.*, 1987 and Abdel-Moneim, 2009). Moreover, changing the visual appearance of lambs interferes with the mothers' ability to identify their own lambs and they reject them. Alexander and Shillito (1978b) found that ewes showed marked abnormalities of maternal behaviour such as vigorous avoidance of the approaching lamb which had been coloured by brushing pigments into the coat. The purpose of the present review is to cast light on the importance of visual cue in ewe-lamb bond.

Importance of bond between ewe-lamb:

The survival of the offspring is one of the critical elements for the reproductive fitness of the parents. In species in which parental investment is necessary for the survival and development of the progeny, recognition of the litter is beneficial since it allows

parental care to be directed preferentially towards the own progeny (Poindron *et al.*, 2003). The bonding process allows the mother to discriminate her own young, fosters stable ewe-lamb pairs within a herd, and ensures lamb survival (Pfister *et al.*, 2006). Furthermore, Dwyer (2014) reported that lamb survival is dependent on the coordinated expression of behaviours of both ewe and lamb. The author showed that the ewe-lamb bond leads to improving the welfare of the lamb and the profitability of the farm. This bond is established within hours of parturition (Sharafeldin and Kandeel, 1971 a,b; Nowak and Lindsay, 1990; Nowak, 1991; Romeyer, *et al.*, 1993; Asante, *et al.*, 1999; Terrazas *et al.*, 1999; Ferreira, *et al.*, 2000; Hernandez, *et al.*, 2001; Keller, *et al.*, 2003; Okabe, *et al.*, 2012; Hinch and Brien, 2013 and Ungerfeld, *et al.*, 2021; Freitas-de-Melo, *et al.*, 2022). The authors showed that, in ungulates, the main feature of mother-young relationship is the development of an exclusive bond (exclusive acceptance of their own young at the udder) with the newborn. Thus, at parturition, mothers are attracted to any newborn lamb (i.e. maternal responsiveness), but within the first few hours after parturition a female learns to recognize some features of her offspring and they generally show exclusive acceptance of their own young at the udder, with the advantage of restricting the access of maternal milk to their own litter (Hernandez *et al.*, 2001) and providing necessary resources and actively rejecting any alien young that attempt to suck (i.e. maternal selectivity) (Keller *et al.*, 2003).

The neonatal role in the recognition process was investigated by Shillito and Alexander (1975), Nowak (1991), and Asante *et al.* (1999). Nowak (1991) reported that the process of recognition of the mother by her offspring has received much less attention than the process of recognition of the young by its dam because the dynamics of individual discrimination are more rapid in the adult female than in the neonate. Shillito and Alexander (1975) reported that the mothers take the most active part in

the establishment and maintenance of a bond and plays the major role in this mutual identification during the first days of the lambs' life. Moreover, Asante *et al.* (1999) showed that though the neonate was previously thought to play a marginal role in the bonding process; current evidence indicates that it plays a more active role.

Gonyou (1984) and Abdel-Moneim *et al.* (2004) mentioned that behaviour of both the ewe and lamb around parturition time is critical, as failure to form a mother-offspring bond can result in poor growth or death. In addition, Dwyer (2003), Pfister *et al.* (2006) and Mora-Medina (2016) indicated that disruption of ewe-lamb bonding around parturition is detrimental to lamb survival.

Critical time for establishing ewe-lamb bond:

Nowak and Lindsay (1990) stated that ewe will feed her own lamb excluding other individuals after 30 to 120 min of contact, whereas a period of contact of only 5 min between the mother and her young is apparently sufficient to establish a maternal bond. Furthermore, Poindron *et al.* (2003) reported that, in sheep, the maternal bond is established within the first two hours. Meanwhile, Pfister *et al.* (2006) demonstrated that maternal-infant bonding must occur within 12h of birth. Moreover, Mora-Medina *et al.* (2016) reported that mother-young bonding in sheep is established during the sensitive period of the first 4 hours after birth. On the other hand, Alexander (1977), Vince *et al.* (1987), Asante *et al.* (1999), and Pfister *et al.* (2006) found that the initiation and maintenance of maternal responsiveness following parturition and the survival of a lamb during the critical few days after parturition are partially dependent upon neonate activity, sensory information from the young and its ability to rapidly distinguish between its mother and other ewes.

Several researchers indicated that the young is capable of rapidly developing a preferential relationship with its dam. Nowak *et al.* (1987) showed that some lambs could show a preference for their mothers as early as 12 h after birth. Shillito and Alexander (1975), Nowak and Lindsay (1990), and Nowak (1991) reported that the young of sheep and goats can discriminate their own from alien dams within 2 days of birth. Whereas Asante *et al.* (1999) found that Merino lambs can discriminate between their dams and an alien ewe at about 24 h of age. Moreover, Shillito and Alexander (1975) reported that a large proportion of lambs can recognize a ewe as an alien on the first day of life. Furthermore, Nowak (1991) showed that the way newborn lambs discriminate their dams changes rapidly during the first 3 days of life, with recognition ability improving with age.

Many investigators studied the time of establishment of maternal recognition through the visual cue. Keller *et al.* (2003) found that in multiparous ewes, recognition of their lamb from a distance is established very rapidly during the first

six hours after birth. Similarly, Poindron *et al.* (2003) concluded that sheep are fully able to discriminate their neonate without the help of olfactory cues very early after parturition through vision. Furthermore, Hernandez *et al.* (2001) and Poindron *et al.* (2003) stated that ewes were already able to discriminate their own lamb from an alien one without the help of olfactory cue in a situation not involving acceptance at the udder as early as 8 h after birth. Moreover, Ferreira *et al.* (2000) observed that ewes could discriminate between their own and an alien lamb only on the basis of visual cue as early as 12 h postpartum. Meanwhile, Terrazas *et al.* (1999) mentioned that mothers might be able to recognise their young by visual cue as early as 24 h postpartum.

On the other hand, Terrazas *et al.* (1999) found that visual recognition could develop at later stages after olfactory cue, at 5 days after birth depending on the management condition. Nevertheless, Booth and Katz (2000) and Booth (2006) reported that establishment of maternal recognition through the sense of vision is approximately 1 week after parturition. Meanwhile, Kendrick *et al.* (1996) concluded that maternal ewes were slow to learn to recognize the faces of their lambs, 2-3 weeks after birth. Furthermore, Hernandez *et al.* (2001) reported that visual recognition takes several days or weeks to develop. Hence, at 1 month of lactation, anosmic ewes showed signs of discrimination at the udder, showing more rejection behavior towards alien lamb, which suggests that the development of some compensatory process in the control of selective nursing is possible.

In sheep, Nowak (1991) reported that the young could discriminate their own from alien dams at a distance when the lambs were 2-3 days old. The visual cue was involved in discrimination, at close contact on the first day after birth and at a distance when the lambs were older. Meanwhile, Nowak (1991) mentioned that for the wild ungulates, field observations suggest that discrimination of the mother at a distance of several meters is established in the first few days following birth on the basis of visual features.

Importance of different senses for establishing ewe-lamb bond:

Newly born lambs are known to be sensitive to stimulation in all sensory modalities to react and to discriminate between different sounds, odors, tactile, temperatures, textures and visual stimuli (Vince *et al.*, 1987). Moreover, Alexander (1977) and Nowak (1991) found that neonates can recognize or at least discriminate their own from alien mothers on the basis of individual characteristics (such as behavior, appearance, voice, odour and even tactile cues). The young can recognize specific signals from their mothers at an early stage of their development. Furthermore, Vince *et al.* (1985) reported that the isolated lamb movement towards a non-smelling, silent and cold model, strongly suggested that the lamb is programmed to make for a visual

configuration of some kind. Additionally, Vince *et al.* (1987) showed that vision plays an important part in the initial teat-seeking activity of newly born lambs; those deprived of visual cue failed to approach the ewe, and when the blindfold was removed, lambs stood at once and then made a rapid first approach to the udder.

Ferreira *et al.* (2000) and Keller *et al.* (2003) reported that ewes identify their young through the use of different sensory modalities. However, Alexander (1977), Alexander and Shillito (1977a) and Alexander and Stevens (1982) showed that ewes suckling lambs readily distinguish between their own offspring and those of other ewes, the recognition depends on a combination of auditory, visual and olfactory cues, and even tactile cues. Several researchers indicated that there are two types of maternal discrimination against offspring after a selective bond is formed between a mother and her young. Firstly: recognition at a distance which permits the location of the young. Secondly: recognition at close quarters which is necessary before the young are allowed to suckle. The sensory basis for proximal recognition of lambs differs from that mediating distal recognition (Morgan *et al.*, 1975; Poindron and Schmidt, 1985; Ferreira *et al.*, 2000 and Keller *et al.*, 2003).

Additional support concerning the importance of visual cue comes from the studies of some authors. Gonyou (1984) pointed out that ewes recognized older lambs primarily by sight, then hearing and finally by smell. However, the author showed that audition with vision was important in identifying a lamb over a short distance. Poindron and Schmidt (1985) reported that both visual and auditory cues are involved in recognition at a relatively long distance. Moreover, Terrazas *et al.* (1999) reported that audition with vision play a major role in distal recognition. Mothers might be able to recognize their young by acoustic cue and vision as early as 24h postpartum. Moreover, Alexander and Shillito (1977a) concluded that odour, alone, appeared to be an ineffective cue. Thus, ewes that were free to smell, but could neither see nor hear their lambs, achieved fewest correct scores of recognition and failed most frequently to make a choice. In this context, Mora-Medina *et al.* (2016) showed that vision in combination with the auditory, olfactory and gustatory system in ungulates is vital for environmental perception and individual recognition.

On the other hand, some authors revealed the importance of visual and auditory cues in mutual ewe-lamb recognition. Alexander (1977) showed that vision and auditory cues are important in mutual recognition of ewes and lambs, but auditory cue is of secondary importance if strong visual cue indicates an alien partner. Alexander and Shillito (1977a) confirmed the previous result as they observed that removal of auditory cue was of less effect than the effect of removal of visual cue.

However, Lenhardt (1977) reported that many mothers will respond to the bleating of any young not in visual contact. The author observed lack of ability of mother to recognize their young's cries. Mother can utilize hearing to identify their young only when the call is different enough to be individually recognizable. Poindron *et al.* (2003) reported that vocal and visual recognition are important for the mother to locate her young before establishing physical contact, even on the first day postpartum.

Role of visual cue in ewe-lamb bond:

Kendrick (1991) reported that there are good evidence that sheep use their visual sense to aid in the recognition of objects and individuals, first, it has been shown that sheep can perform complex visual discrimination learning tasks in the laboratory using geometrical symbols as stimuli. Second, sheep use their visual sense to discriminate between feeds. Third, visual perception of the presence and size of horns gives information concerning dominance and gender in horned ungulates. Fourth, mountain sheep can accurately visually identify humans or coyotes at distance greater than 1km.

Although visual recognition of individuals is a well-accepted fact in primates, less importance has been given to this form of recognition in nonprimate species, the emphasis has instead been placed on audition and olfaction in these species. Although auditory and olfactory recognition are important in many of these species, it would be unfair to ignore the role of visual cues in this respect. Kendrick (1991) reported that sheep and many other nonprimate species have excellent visual acuity and probably even good color vision and are therefore perfectly equipped to distinguish individuals by using this sense.

In sheep, Kendrick (1991) and Kendrick *et al.* (1996) showed that electrophysiological studies have shown that the primary visual cortex of sheep has the same cell types, including binocularly drive cells, as that of the monkey and a neuroanatomical organization and have neural circuits in the temporal cortex of the brain, which respond preferentially to faces as opposed to other visual stimuli, similar to that of the monkey. Further, it has been shown that the primary visual cortex of the sheep is fully developed and functional at birth, unlike that of the monkey, so it can be employed at the onset of postnatal life in the complex business of recognizing and making appropriate behaviour reaction to individuals and objects in the surrounding environment.

Kendrick (1991) and Kendrick *et al.* (1996) suggested that frontal views of faces (i.e. direct eye contact) are more effective stimuli than profiles or views of the back of the head. Thus, sheep could distinguish between pairs of faces presented in frontal view but found difficulty if the faces were presented upside down in profile or with the eyes covered. Furthermore, Sheep have panoramic vision

of 330°–360° and binocular vision of 25°–50°. Physiological optics is likely to produce a well-focused retinal image of objects in the middle and long distance (Blackshaw, 1986).

In this context, sheep are thought to have colour vision and are able to distinguish between a variety of colours: black, red, brown, green, yellow, and white. Alexander and Shillito (1978 b) stated that ewes were able to distinguish between a variety of colors of artificially colored lamb.

On the other side, Kendrick *et al.* (1996) and mora-medina *et al.* (2016) stated that sheep could distinguish between faces of different species or breeds and even between male and female members of the same breed. Two different breeds of sheep (Clun Forest and Dalesbred) could discriminate between sheep faces and those of other species, such as humans, dogs and goats on the basis of facial features, using back-projected images presented in a Y-maze. Kendrick *et al.* (1996) concluded that sheep can learn to distinguish between individual adult sheep faces but that breed and social familiarity influence the level of performance. Furthermore, sheep learn significantly faster to recognize sheep faces of a familiar breed compared to geometrical symbols and can distinguish between faces of animals of another unfamiliar breed better than for symbols but was worse than that seen using faces of a familiar breed. The authors concluded that sheep could use facial discrimination as an important means of social recognition of individual flock members.

Furthermore, many authors indicated that vision cue plays an important role in ewe-lamb recognition. Alexander (1977) concluded that visual cue is important in mutual recognition of ewes and lambs; it's the first important cue if strong visual cues indicate an alien intruder. Moreover, Alexander and Shillito (1977a), Alexander and Shillito (1978 a, b), Abdel-Moneim (2009), Ligout and Porter (2004), Abd-alla *et al.* (2011) and Abd-alla *et al.* (2012) reported that visual cues are of major importance in maternal discrimination. Thus, appearances play a role in attracting the ewe towards the lamb, aiding ewes to recognize their own lambs and to discriminate against aliens and screen it out. Furthermore, Terrazas *et al.* (1999) stated that mothers develop recognition of their lamb through vision. In the meantime, Smith (1965) and Stephens and Linzell (1974) who confirmed that vision helps to direct the newborn lamb's activity to the udder area. Similarly, Bareham (1975) showed that lambs blindfolded at 2 days of age failed to suckle from their mothers. In the meantime, Poindron *et al.* (2003) showed that visual recognition is important for the mother to locate her kid before establishing physical contact even on the first day postpartum. Moreover, Gonyou (1984) reported that ewes recognized older lambs primarily by sight. Furthermore, Alexander and Shillito (1977 a) showed that the effect of removal of visual cues appears to be greater than the effect of removal of auditory cue.

Moreover, Vince *et al.* (1987) tested the reaction of blindfolded lambs with their mothers for 1h after birth and showed that these lambs failed to approach the ewe and some did not stand, although all approached the udder and sucked very quickly after the blindfold was removed.

On the contrary, Ferreira *et al.* (2000) and Keller *et al.* (2003) found that ewes preferentially approach the image of their own lamb. Moreover, Alexander and Shillito (1978 b) and Gonyou (1984) found that ewes showed a significant preference for lambs of the same colour as the ewe's own lamb when ewes were presented with a trio of anaesthetized alien lambs of various colours.

Effect of distance on recognition between ewe and lamb:

Many studies indicated that ewes rely on visual cue to discriminate between lambs at a distance. Terrazas *et al.* (1999), Booth and Katz (2000) and Booth (2006) stated that vision cue play a major role in distal recognition. Whereas, Gonyou (1984) reported that vision was important in identifying a lamb over a short distance. Alexander and Shillito (1977a, b) reported that visual cue can override auditory or olfactory cues originating from a distance of several meters away to screen out aliens. Moreover, Alexander and Shillito (1977b) reported that appearance of lamb provides important cues that aid ewes to distinguish between their own and alien lambs when several meters away. The authors stated that bizarre changes in appearance of the lamb can result in changes of ewe behaviour as if the own lamb was an alien. Furthermore, Ferreira *et al.* (2000) reported that dams may use visual cue from a distance to recognize their lambs. Meanwhile, Poindron and Schmidt (1985), Ferreira *et al.* (2000) and Keller *et al.* (2003) revealed that ewes can discriminate between lambs on the basis of visual cue at a distance longer than 0.25 m.

In this context, Alexander and Shillito (1977a) stated that the olfaction cue has a role when the ewe is less than 0.25 m from the lamb. This led Alexander and Shillito (1977 a) and Alexander (1978) to suggest that lamb's odour appears to be recognized by the ewe when both are kept in very close quarters only (i.e. less than 0.25 m), and the odour of the lamb is only perceived at very short distances. Similar findings were reported by Lindsay and Fletcher (1968), Morgan *et al.* (1975) and Alexander and Shillito (1977a) who revealed that olfactory examination (proximal recognition of lambs at very close quarters less than 0.25 m) is necessary before the youngs are allowed to suckle and be accepted at the udder. Moreover, Alexander and Shillito (1977a) concluded that olfaction appears ineffective over a distance more than 0.25 m. Hence, when the lambs are more than 0.25 m beyond the ewe's reach, very few ewes will choose their own lamb correctly. In support of the previous results, Ferrier *et al.* (2000) demonstrated that the lamb own odour cannot be

discriminated at a distance greater than 0.25 m. Moreover, Booth (2006) reported that olfaction is the primary cue used by ewes to recognize their lambs during close contact status, such as nursing. Furthermore, similar findings were recorded on goats by Poindron *et al.* (2003) who found that goats were not able to recognize their kid on the basis of olfactory cues alone when they were one meter away. The authors confirmed that the odour of the neonate can be detected only from a very short distance (physical contact). In this context, Lindsay and Fletcher (1968) found that no effect of smell in recognition of the lamb at a distance of 2.5 m in T-maze. Nevertheless, Morgan *et al.* (1975) reported that ewes can use olfactory cue to assist in finding their lambs when the intervening distance is up to 12 m.

Effect of change in appearance of lamb on ewe behaviour:

On the other hand, changes in features of lamb can result in abnormal behaviour of his dam. Alexander and Shillito (1977 b) stated that bizarre changes in appearance or changes in the colour of the lamb can result in ewe behaviour as if their own lamb was an alien, they hesitated in their approach to the lamb or moved so as to avoid it. Moreover, Alexander (1977) found that blackening of lambs' body slowed the approach of the ewes towards them and led to hesitation and caused confusion or even dodging in the ewe's approach, and agonistic responses in some ewes. Additionally, Alexander (1977) indicated that ewes' scores of interest in lambs were reduced by blackening. Similarly, Alexander and Shillito (1978 b) found that ewes showed marked abnormalities of maternal behavior such as vigorous avoidance of approaching the lamb which had been coloured by brushing pigments into the coat. Partial habituation occurred rapidly, though some abnormalities were still evident after 3 days.

Ewes attend to some parts of the lamb's body to recognize it. Alexander and Shillito (1977b) concluded that the visual cue that aids the ewe to distinguish her own from an alien lamb comes largely from the head. They stated, further that the responses to lambs with blackened heads were similar to the responses to completely blackened lambs. There was little effect of blackening the front legs, the ears, or rump together with the tail. There were intermediate responses when the eye region, the crown or the whole trunk together with the legs were blackened.

CONCLUSION

Vision cue plays an important role in ewe-lamb recognition. Vision helps to direct the newborn lamb activity to the udder area. In this context, lambs blindfolded at 2 days of age failed to suckle from their mothers. Ewes can discriminate between lambs on the basis of visual cue at a distance longer than 0.25m. Moreover, the effect of removal of visual cue

appears to be greater than the effect of removal of auditory cue. Meanwhile, changes in the features of lamb can result in abnormal behaviour of his dam. Ewe can distinguish her own from alien lambs largely from the head.

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حاسة الإبصار وسلوك الأمومة في الأغنام: بحث مرجعي

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تلعب حاسة الإبصار دوراً مهماً في الارتباط بين النعجة والحمل خلال المراحل الأولى من حياة الحمل. وقد ثبت أن الرائحة ليست الحاسة الوحيدة المسئولة عن الارتباط بين النعجة وحملاتها. ومن الضروري الانتباه إلى حاسة الإبصار (النظر)، سواء كانت للنعجة أو الحمل، في ممارسات التبنّي في مزارع الأغنام. قد أدى تغيير لون الحمل إلى رفض النعجة لهذا الحمل كما لو كان الحمل غريباً. وقد إنجذبت الأمهات إلى الحملان الغريبة عنها والتي تم تلويحها بنفس لون حملاتها الأصلية وعلى مسافة ١٠ أمتار. يهدف هذا البحث المرجعي إلى إلقاء الضوء على أهمية حاسة الإبصار في التعرف المشترك بين النعجة وحملها.