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Human—lamb bonding: Oxytocin, cortisol and behavioural responses of lambs to human contacts and social separation

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Summary Friendly interactions between humans and animals such as gentling or petting have been shown to have positive behavioural and physiological consequences in many species. In primates, rodents and dogs, oxytocin has been associated with tactile contact and anti-stress effects that may influence bonding and responses to stress situations. However the activation of the oxytocinergic system in other human—animal interactions such as with herbivores, had not yet been studied. Sixteen female lambs were reared by artificial feeding reinforced with 3× 30 s daily stroking sessions. At 6 weeks of age, the test consisted in measuring first plasma oxytocin and cortisol responses in lambs during a first 6-min phase in the home pen where the familiar caregiver gently stroked the lamb, and then physiological and behavioural responses in a test pen during a 20-min — phase of social isolation followed by a 20-min — phase of reunion with its familiar caregiver. The lambs expressed behavioural agitation during the whole period of isolation. A strong affiliative response towards the human and a sustained reduction of the agitation behaviour were observed during reunion. Lambs' behaviours when isolated and when in contact with the human were correlated suggesting a response to social separation from the familiar caregiver more than to social isolation from congeners. No significant changes in cortisol levels were observed during the test. Oxytocin levels did not vary during human contact, but increased when the familiar caregiver left the lamb alone in the test pen. In conclusion, lambs displayed affiliative responses towards their caregiver, and the lack of cortisol response during isolation while oxytocin was released suggest an anti-stress effect of oxytocin.

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Introduction

Many studies have shown that oxytocin is involved in the regulation of social behaviours as well as in the mechanisms underlying the development and maintenance of attachment in mammals (Uvnäs-Moberg, 1997; Gordon et al., 2011). Oxytocin is a nanopeptide produced by the paraventricular and supraoptic nuclei of the hypothalamus and has been mainly described for its influence on parturition, lactation, social contact and the development of motherhood and sexual bonding between monogamous pairs (Kendrick, 2000; Carter, 2003). Research indicates that oxytocin is released into the blood circulation and the brain in response to very specific types of somatosensory stimulation such as vaginocervical stimulation during birth and sexual behaviour, nursing, feeding or tactile contacts (touch, warmth or vibration; Lee et al., 2009). Thus the important component of tactile contacts in social bonding (Dunbar, 2010) seems to be potentially facilitated by oxytocin (Carter, 1998). The release of plasma oxytocin during tactile contacts has been shown in intra-species interactions, mostly in primates (Dunbar, 2010) and also in inter-species interactions such as human–animal interactions in rodents and dogs. For example, in conscious rats, massage-like stroking of the abdomen is followed by increased levels of oxytocin (Agren et al., 1995) and positive interactions increase oxytocin concentrations in dogs and their owners (Odendaal and Meintjes, 2003; Mitsui et al., 2011).

Information describing an activation of the oxytocinergic system in other situations involving human–animal interactions is lacking. One particular case of note is that of farm animals, especially ruminants, as they interact commonly with human beings and several studies have shown that they can bond to humans (for review, Hemsworth & Boivin, 2011). Social bonds or attachment are commonly defined as differential behaviours or emotional interactions in the presence or the absence of the partner (Carter, 1998; Carter and Porges, 2010). Social attachments function to facilitate reproduction and social cohesion, provide a sense of security and reduce feelings of stress and anxiety. Attachment has principally been described in mother–infant (e.g. mother–offspring relationships in sheep, Keverne et al., 1997) and monogamous relationships (e.g. pair-bonding in prairie voles, Williams et al., 1992). However, interspecies bonding, especially between humans and animals, is much less well understood. Human–animal bonding seems to follow the same patterns as intra-species bonding. The formation of social bonds is considered as part of highly complex social behaviour and combines multiple cognitive processes including social motivation, approach and memory (Cairns, 1966; Gordon et al., 2011). A social bond cannot be directly measured, and so the concept of attachment has been defined by behavioural or physiological responses. Some criteria can characterize bonding: preference for the attachment figure, maintenance of proximity or voluntary contact with it, increased measures of stress when separated from it and decreased measures when reunited (appeasement) (Carter, 1998; Carter and Porges, 2010). In human–animal relationships, interactions with humans can generate positive emotional states that result in decreased fear responses towards the human, and the animal's perception of a positive relationship (Boivin et al., 2003). Stroking animals in a manner similar to intraspecific allogrooming can elicit a calming, anti-stress response including relaxed body postures, an increase in approach to humans (e.g. in cattle Schmied et al., 2008a) and a reduction in heart rate (e.g. in cattle Schmied et al., 2008b, in horses Feh and deMazieres, 1993). Such responses could be associated with oxytocin release and interpreted as attachment behaviours. Among farm ruminants, artificially fed lambs provide an ideal situation to investigate the affiliative relationship that forms during human tactile contact together with the physiological mechanisms involved. Artificial rearing of young lambs and calves is a longstanding conventional practice shown to facilitate the establishment of a strong bond with humans. This is due to the combined effect of being separated from the mother, immediately at birth or a few hours later, and the daily contacts with a human able to replace the maternal figure (Lyons et al., 1988; Boivin et al., 2003; Krohn et al., 2003; Tallet et al., 2009). Tallet et al. (2005, 2009) showed that artificially reared lambs receiving daily human tactile contact expressed a much higher affinity for the caregiver than those receiving no contact or simply being in the presence of a human. In addition, Tallet et al. (2009) observed in lambs reunited with a caregiver after a period of social isolation, a more pronounced calming effect in individuals that had been regularly handled. However, whether these behaviours can be linked to oxytocin and cortisol responses remained to be elucidated. In sheep, the role of oxytocin in the onset of maternal behaviour and selective maternal bonding has been well illustrated (Kendrick, 2000). By contrast, nothing was known about this role in the lamb: it was thus of interest to determine whether the oxytocin response was influenced by social interactions with humans resulting from selective social inter-specific bonding. In other species, the presence of a bonding partner has been shown to provide social support with positive consequences for the individual's physiological responses to stress (Sachser et al., 1998), a mechanism that may involve oxytocin (DeVries et al., 2003). Oxytocin increases tolerance to stressful stimuli and attenuates the stress response by mediating both physiological and behavioural responses induced by the hypothalamic–pituitary–adrenal (HPA) axis (Neumann et al., 2000; DeVries et al., 2003; Amico et al., 2004). For example, high doses of oxytocin induce a sedative-like effect characterized by a decrease in physiological stress indicators and decreased locomotion (Uvnäs-Moberg, 1998). In this context, oxytocin and cortisol may interplay. A release of oxytocin in response to various stressful stimuli and its effect on the activity of the HPA axis and cortisol release has been described in the literature (inhibited or stimulated, according to the study, Neumann et al., 2000). For example in humans, teenage girls receiving physical, vocal and non-verbal comfort contact with their mother following a stressful procedure showed the highest levels of oxytocin and the most rapid return of cortisol to baseline of cortisol (Seltzer et al., 2010) and in sheep, exogenous oxytocin suppresses cortisol concentrations (Cook, 1997). During social interactions (including orgasm and nonsexual physical contact, reviewed in Carter, 1998), oxytocin may facilitate social support and affiliation through a mechanism that may buffer the HPA axis.

The aim of this study was to describe plasma oxytocin and cortisol changes during human–animal interactions involving gentle tactile stimulation or absence thereof in lambs that had developed a high affinity for a familiar caregiver or not. For this purpose, the behaviour of the lamb was observed