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Post-conflict friendly reunion in a permanent group of horses (*Equus caballus*)

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ABSTRACT

Gregarious animals living in permanent social groups experience intra-group competition. Conflicts over resources can escalate into costly aggression and, in some conditions, non-dispersive forms of conflict resolution may be favoured. Post-conflict friendly reunions, hence reconciliation, have been described in a variety of species. The aim of this study was to explore, for the first time, the occurrence of reconciliation in a group of domestic horses (*Equus caballus*) and learn more about strategies used to maintain group cohesion. The behaviour of seven horses living as permanent group in an enclosure for at least 2 years was observed by video for 108 h from June to August 2007. We used a Post-Conflict/Matched Control method to assess the existence of reconciliation and third-party affiliation. Behaviours recorded Post-Conflict, or during Matched Control periods, were classified as affiliative based on previous descriptions of visual communication patterns in horses. The proportion of attracted pairs over total post-conflict situations was significantly greater than the proportion of dispersed pairs, both during dyadic interactions ($p < 0.001$) and during triadic interactions ($p = 0.002$). The results of the present study show that both dyadic reconciliation and third-party post-conflict affiliative interactions form important social mechanisms for managing post-conflict situations in horses.

1. Introduction

Post-conflict friendly reunion, termed reconciliation, between two former antagonists immediately after a conflict, was first described by de Waal and van Roosmalen (1979) in chimpanzees. These authors demonstrated that some behavioural patterns (sequences of kisses, hugs and vocalisations) occurred more often during post-conflict situations between the two opponents than during normal affiliative activities of the group. Post-conflict friendly reunions are likely to be favoured in groups of animals which form individualized relationships, and where post-conflict hostility between opponents and consequent loss of benefits from the relationship would be costly (Aureli et al., 2002). In such situations reconciliation can function to communicate the end of hostility between former opponents decreasing the negative consequences associated with the risk of renewed attacks for both opponents (Aureli et al., 2002).

Various methods for evaluating reconciliation in animals have been proposed, but the main concept is always to compare interactions in the group during a specific period when no overt aggression is seen (baseline ethogram) and the same interactions immediately after a conflict, using the Post Conflict-Matched Control method (de Waal and Yoshihara, 1983; Aureli et al., 1989; Judge, 1991; Veenema et al., 1994). A Contact Conciliatory Tendency measure (Veenema et al., 1994) is used to compare the Post-Conflict period with a Matched Control period, normally selected to be on the day following the conflict, at the same time as the Post Conflict period and under non-conflict circumstances. The Contact Conciliatory Tendency is a good measure for comparing the frequency of reconciliation between different dyads, groups or species as it accounts for varying possibilities of contact between different animals within a group (Aureli and de Waal, 2000). The involvement of a third animal can also be quantified, and the interaction of a third animal with one or both of the former opponents has been described as triadic affiliation. de Waal and van Roosmalen (1979) describe "consolation" in primates as a friendly contact between the victim of aggression and a third subject of the social group, while "appeasement" is the term used when a third animal interacts with the aggressor (Kutsukake and Castles, 2004). In these situations, a Triadic Conciliatory Tendency quantifies post-conflict interaction between a participant in the conflict and a third subject of the group (Call et al., 2002). Since the work on chimpanzees, reconciliation has been studied in many gregarious species with specific social systems. Reconciliation mechanisms have been studied in about 30 species of primates (Aureli and de Waal, 2000; Aureli et al., 2002), in other mammalian species such as the dolphin (*Tursiops truncates*, Weaver, 2003), domestic goat (*Capra hircus*, Schino, 1998), hyena

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(*Crocuta crocuta*, Wahaj et al., 2001), dog (*Canis familiaris*, Cools et al., 2008; Cozzi et al., 2008), and wolf (*Canis lupus*, Cordoni and Palagi, 2008) and in birds, including the rook (*Corvus frugileus*, Seed et al., 2007).

The aim of this study was to use the Post Conflict/Matched Control method (modified after Cools et al., 2008) to explore the occurrence of post-conflict reconciliation in a permanent group of horses (*Equus caballus*) and the role of any third-party involved in a post-conflict situation.

Horses are non-territorial, gregarious equids that naturally tend to form groups and stable relationships and to share space and other resources in captivity, as in the wild (Heitor et al., 2006b). For example, alliances and cooperation between stallions of the same group have been observed (Feh, 1999), permitting them to have a range of benefits, such as reducing predation risks and improving access to resources (Linklater and Cameron, 2000). Broadly speaking life in social animals is determined by complex long-term social relationships. Therefore, group cohesion in horses is very important (Waring, 1983) and is facilitated by a range of cognitive processes such as individual recognition and memory of inter-individual interactions. Thus, horses are not only capable of distinguishing between familiar and unfamiliar horses (Proops et al., 2009) but also recognizing social status of familiar horses relative to their own (Krueger, 2008; Krueger and Flauger, 2008; Krueger and Heinze, 2008). Post-conflict resolution may be especially promoted in small groups where the investment in each inter-individual relationship is likely to be high. A number of previous studies of post-conflict resolution have therefore been conducted with a small group of subjects (Schino, 1998; Weaver, 2003; Seed et al., 2007; Cordoni and Palagi, 2008), and we predicted that post-conflict friendly reunion may also be shown in a small, but permanent group of horses.

2. Materials and methods

2.1. Animals and rearing conditions

The animals and the experimental site were provided by the Italian Horse Protection Association (Firenze, Italy). The group consisted of 7 horses that had lived together in the same 4 ha enclosure for at least 2 years (Table 1), thus allowing the horses to display a natural behavioural repertoire. All group members were free to interact with one another or avoid each other when necessary. Hay and water were provided *ad libitum*, and grass was also available for grazing. Horses used a wooded area as shelter. During the experiment, the horses did not take part in any other tests and they had no contact with other horses and humans, other than the caretaker who provided the hay on a daily basis. This group of horses can be considered permanent according to the model proposed by Cools et al. (2008) which defined conditions of captivity between unrelated individuals that spend all or part of their lives in shared areas.

2.2. Observed behaviours

The observed behaviours during the experiment were based on the horses' ethogram of social behaviours previously described by several authors. In the present experiment we used behaviours defined and collected in two categories: aggressive and affiliative. The "aggressive" behaviours category was used to define the start of the Post Conflict period (Table 2), but details of these behaviours were not recorded. For the aim of the experiment, behaviours of the "affiliative" category were analysed (Table 3).

Table 2
Behaviours included in the category "aggressive" used as start point for the 10 min Post Conflict observations.

Aggressive behaviours	
Threat to bite	Ears laid back and at least one of the following: (1) extension of head and neck towards another horse, (2) fast movement towards another horse for no more than three body-lengths (Heitor et al., 2006a).
Threat to kick	Ears laid back and at least one of the following: (1) backward movement, (2) hindquarters turn, (3) hind limb raising, (4) hind limb projection backwards while moving away (Heitor et al., 2006a).
Mild threat	Ears laid back and looking at or walking towards another horse (Heitor et al., 2006b).
Threat to strike	The aggressor's ears were laid back and its head and shoulders were oriented toward another individual. One or both forelimbs moved outward and forward toward the other animal but no contact was made (Weeks et al., 2000).
Bite	Ears laid back, head raised, open mouth and extension of head and neck towards another horse, attempting to close teeth on its body (Heitor et al., 2006a).
Kick	Ears laid back and projection of one or both hind limbs towards another horse, attempting to strike it (Heitor et al., 2006a).
Strike	The aggressor's ears were laid back, and one or both forelimbs moved outward and struck the body of another animal (Weeks et al., 2000).
Push	Pressing of the head, neck, shoulder, chest or body against another horse, causing it to move one or more legs to regain balance (Christensen et al., 2002).
Chase	Ears laid back, head raised, closed mouth and pursuing another animal for more than a three body-lengths distance (Heitor et al., 2006a,b).
Nipp	Similar to bite, but mouth less widely open and teeth closing on small piece of flesh (Lloyd et al., 2007; McDonnel and Haviland, 1995).
Attack	Ears laid back, head raised, open mouth and pursuing another animal for more than a three body-lengths distance, attempting to close teeth on its body (Heitor et al., 2006a).

2.3. Experimental procedure

Observations were made from an elevated wooded area near the fence of the enclosure, thus allowing the operators to observe the space in which the horses lived but to remain hidden to avoid interference. When a conflict occurred (aggressive behaviour) the behaviour of both former opponents of the conflict, and any third subject that interacted with the opponents, was recorded indi-

Table 1
Details of age, sex, breed and the arrival date in the group for each horse involved in the experiment.

Name	Age	Sex	Breed	Arrival in group
Oliver	23	Gelding	Criollo	21/06/2004
Bisquit	21	Female	Italian Saddle Horse	30/06/2004
Giulia	20	Female	Budyonny	21/06/2004
Calippo	16	Gelding	Quarter Horse	27/07/2004
Betsye	15	Female	Appaloosa	06/08/2004
Shugar	11	Female	Quarter Horse	25/10/2004
Cecil	10	Female	Quarter Horse	01/03/2005