# The importance of considering the behavioural form of reconciliation in studies of conflict resolution

Richard McFarland[a,b,*] & Bonaventura Majolo[a]

[a]School of Psychology, University of Lincoln, Lincoln, U.K.

[b]School of Physiology, University of the Witwatersrand, Johannesburg, South Africa

*Correspondence: R McFarland, Brain Function Research Group, School of Physiology, Faculty of Health Sciences, University of the Witwatersrand, Medical School, 7 York Road, Parktown, Johannesburg 2193, South Africa. E-mail: richard.mcfarland@wits.ac.za, Tel: +27(0) 715 999709.

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**Abstract** (250 words)

Reconciliation is the most extensively studied conflict resolution mechanism in animal societies. However, despite the extensive literature on this topic, behaviours considered to represent post-conflict affiliation have not been consistent across studies of reconciliation. Critically, reconciliation is usually defined as post-conflict contact affiliation (e.g. grooming) and the importance of including inter-opponent distance regulation is often neglected. Moreover, to date, no study has simultaneously investigated different behavioural forms of reconciliation. We tested, in two groups of wild Barbary macaque (*Macaca sylvanus*), the relative importance of post-conflict close-proximity and grooming in the mediation of two important costs of aggression: damage to the opponent's social relationship and elevated post-conflict anxiety. We provide evidence that close-proximity approaches function to resolve conflicts: close-proximity approaches reduced the victim's post-conflict anxiety and were predicted by the quality of the social relationship with the opponent. Moreover, post-conflict grooming alone, although predicted by the quality of the opponent's social relationship, did not influence the victim's elevated post-conflict anxiety. Our results suggest that inter-opponent distance regulation plays an important role in reconciling the costs of aggression in Barbary macaques. We advocate that further efforts should be made to test which behaviours play a role in conflict resolution in different species. This is important as even closely related species may differ in the function of behaviours that superficially appear to be rather similar. Moreover, the choice of behaviours used to study conflict resolution determines the frequency with which reconciliation is observed and can thus bias comparisons across species.

Key words: Aggression; Barbary macaques; Conciliatory tendency; Conflict management; Proximity regulation; Social relationships

## Introduction

Competition between conspecifics for food, social and mating partners is widespread in the animal kingdom (van Schaik 1989). Such competition can often lead to aggression, which in addition to posing a risk of physical injury, is commonly associated with a range of post-conflict costs. These costs include, for example, renewed aggression, damage to the opponent's social relationship and increased post-conflict anxiety (Aureli et al. 2002; McFarland & Majolo 2011a,b). There is comprehensive evidence that these costs of aggression can be mediated through acts of reconciliation (Aureli & de Waal 2000; Aureli et al. 2002). Reconciliation is defined as the exchange of friendly behaviour between former opponents in the minutes immediately following a conflict (Aureli & de Waal 2000). The 'integrated hypothesis' (Aureli 1997) predicts that reconciliation serves to reduce the risk of renewed aggression, repair damaged social relationships (i.e. is predicted by the quality of the opponent's social relationship), and that high quality social partners will be more effective at alleviating post-conflict anxiety through reconciliation compared to low quality social partners. Reconciliation is the most studied behavioural mechanism in conflict resolution, and has been observed in a range of group-living primate and non-primate species (Schino 2000; Aureli et al. 2002; Cordoni & Palagi 2008; Cools et al. 2008; Fraser & Bugnyar 2011; McFarland & Majolo 2011a).

Despite the extensive literature on this topic, behaviours considered to represent conciliatory post-conflict affiliation have not been consistent across studies of reconciliation. This may partly be due to the fact that some forms of conciliatory behaviour are specific to a particular species or higher taxonomic level (Aureli et al. 2002). For example, the use of soft grunts is considered crucial in allowing former opponents to reconcile in chacma baboons (*Papio ursinus*: Cheney et al. 1995, Silk et al. 1996) and chimpanzees (*Pan troglodytes*) have been

observed to use ‘kisses’ to reconcile after a conflict (de Waal & van Roosmalen 1979). Moreover, the necessity to reconcile a conflict may also show marked variation across species. For example, it has been suggested that the highly cooperative and cohesive group structure observed in red-bellied tamarins (*Saguinus labiatus*) obviates the need for reconciliation, as a conflict has no negative effects on their social relationships (Schaffner & Caine 2000).

Behaviours used in reconciliation have also been described as being either ‘explicit’ or ‘implicit’ (de Waal and Ren 1988). These authors describe explicit forms of reconciliation as behaviours rarely observed outside of a conciliatory context (e.g. ventro-ventral and hind-quarter embraces in macaques: de Waal & Ren 1988; Arnold & Barton 2001). These behaviours are thought to be observed more often in tolerant species (e.g. de Waal & Ren 1988; Arnold & Barton 2001; Fraser & Aureli 2008) as context-specific behaviours are needed by the actor to make their conciliatory intentions explicit. Conversely, implicit forms of reconciliation are behaviours more widely used during affiliation (e.g. distance regulation: Call 2000, brushing contact: de Waal 1989). These behaviours are thought to be sufficient in signalling reconciliation in more despotic species (e.g. de Waal & Ren 1988; Aureli et al. 1993).

Within the same genus there are clear differences in the rate at which reconciliation occurs. Among macaques, more tolerant species (Thierry 2000) have been observed to reconcile more frequently than despotic species. However, even across studies of the same species behaviours used to measure reconciliation have not always been consistent (e.g. macaques: Table 1). Such disparity across the literature is problematic for a number of reasons. The inconsistency in the behavioural representation of reconciliation used across the literature makes comparative studies, both between and within species, extremely difficult. Moreover, without independently testing the role of specific behaviours for their conflict resolution function, one may

inadvertently over- or under-represent the frequency at which a species reconciles (i.e. its corrected conciliatory tendency, CCT: de Waal & Yoshihara 1983; Veenema et al. 1994).

"Approximate location for Table 1"

Traditionally, studies on conflict resolution have investigated grooming, body-contact, embraces and vocal/facial displays such as grunts, lip-smacking or teeth-chattering (de Waal & van Roosmalen 1979; Cheney et al. 1995; Aureli 1997; Aureli et al. 2002) as forms of reconciliation. Several authors have also suggested that inter-opponent distance regulation is equivalent to using contact behaviours in restoring tolerance and reconciling a conflict (York & Rowell 1988; Cords 1993; Call 1999; 2000; Patzelt et al. 2009; McFarland & Majolo 2011a,b). However, while the theoretical issue of operationally defining reconciliation has previously been addressed (in terms of the importance of mere proximity as a form of reconciliation: Cords 1993), evidence in support of this issue is limited to experimental testing of whether post-conflict proximity regulation reduced a dyad's latency to co-drinking (Cords 1993); whereby co-drinking was considered to indicate that tolerance levels were restored to baseline levels following aggression. To date, no study has simultaneously investigated different forms of behavioural reconciliation.

Using data from wild Barbary macaques (*Macaca sylvanus*), we aimed to test and exemplify this theoretical problem by analysing and comparing the effect that reconciliation, as measured by either close-proximity approaches or grooming, has on the mediation of two important post-conflict costs of aggression: damage to the opponent's social relationship and the

victim's post-conflict anxiety (Aureli et al. 2002; McFarland & Majolo 2011a). We have previously demonstrated (McFarland & Majolo 2011a) the occurrence of reconciliation in our study animals and shown that victims of aggression, but not aggressors, experience elevated post-conflict anxiety.

Following the 'integrated hypothesis' (Aureli 1997) and the suggestion that both close-proximity and grooming serve a conciliatory function (York & Rowell 1988; Aureli et al. 2002), we predicted that (1) post-conflict close-proximity approaches and grooming would independently reduce the victim's post-conflict anxiety, and, (2) post-conflict close-proximity approaches and grooming would be more likely to be observed between opponents sharing a high quality relationship. Finally, if it is true that distance regulation is an important measure of reconciliation (York & Rowell 1988; Cords 1993; Call 1999; 2000), we predicted that (3) the CCT of our study animals would be higher when considering close-proximity approaches as a measure of reconciliation, compared to grooming alone.

## Methods

### Study animals and field site

We studied 48 adult and sub-adult animals living in two groups (Group F and Group L) of wild Barbary macaque in the Middle Atlas Mountains of Morocco (33° 24'N – 005° 12'W). At the beginning of the study, group F consisted of 11 males and 8 females and group L consisted of 19 males and 10 females. We collected data daily between 06.00 and 19.00 hours from June 2008 to September 2009. Study animals were fully habituated to the presence of human observers and relied on a completely natural diet. The Commissariat aux Eaux et Forêts et à la Lutte Contre la

126 Désertification of Morocco provided research permission and the University of Lincoln Ethics
127 committee granted ethical approval. This study was entirely observational and did not affect the
128 welfare of our study animals.

129 Conflict and post-conflict data

130 We used the 'post-conflict–matched-control method' (de Waal & Yoshihara 1983; McFarland &
131 Majolo 2011a) to collect data. We recorded the identity and respective role of each of the
132 opponents anytime aggression (i.e. threat, lunge, charge, chase, slap, grab or bite) was observed.
133 The aggressor was defined as the initiator of the first aggressive display and the victim was
134 defined as the recipient of this aggression. A conflict was considered to be over when aggression
135 had not been exchanged for a period of ≥30s. (Aureli 1997; Kutsukake & Castles 2001;
136 McFarland & Majolo 2011a,b). Of the 414 conflicts observed, we collected post-conflict data for
137 a duration of five minutes from either the victim (N=191) or the aggressor (N=223). We
138 considered a five minute window to collect post-conflict data as reconciliation usually occurs in
139 the first few minutes after a conflict (McFarland & Majolo 2011a).

140 During each post-conflict session we collected data on the occurrence of allo-grooming
141 (hereafter grooming) and close-proximity approaches (i.e. approaches where two individuals
142 remained within ≤1.5m proximity without either animal being displaced or aggressed for at least
143 30s). Teeth-chattering, sandwich interactions (i.e. macaques facing each other in close ventro-
144 ventral contact), infant handling, close-proximity approaches and grooming exchanged by former
145 opponents have all been considered potential forms of reconciliation in Barbary macaques
146 (Hesler & Fischer 2008; Patzelt et al. 2009; McFarland & Majolo 2011a,b). However, only
147 close-proximity approaches (followed 16% of all conflicts) and grooming (6%) occurred at a

high enough frequency in our study for them to be analysed independently for their conciliatory role (Table 2). Moreover, teeth-chattering, sandwich interactions and infant handling always occurred immediately before, after or simultaneously with either grooming or close-proximity approaches. All occurrences of grooming were preceded by a close-proximity approach. We recorded all occurrences of self-scratching during post-conflict sessions to provide a measure of anxiety for the victim or aggressor of the conflict (Maestripieri et al. 1992; Schino et al. 1996). A bout of self-scratching was considered to be over when an animal had stopped scratching for ≥10s. We collected data during matched-control sessions following the same methodology described for post-conflict sessions. We collected matched-controls within ≤2 weeks (mean=4.63 days, range=1–14 days) of their matched post-conflict session to control for seasonal variation in the expression of contact affiliation. Matched-controls were not started until the focal subject had not been involved in an aggressive interaction with another monkey for at least five minutes prior to, or during the matched-control, and no other group member was within a ≤1.5m proximity to the matched-control focal subject.

"Approximate location for Table 2"

Social relationship quality

We used scan and focal sampling techniques to collect data on the social relationships between all group member dyads across the entire study period. We collected scan samples every hour on the activity of the study animals (i.e. resting, feeding, travelling, grooming and body contact), the identity of social partners, and their ≤1.5m proximity to other group members. An animal was

only sampled once in each scan. We used continuous 20 minute focal sessions to collect data on the proportion of approaches exchanged between the study animals that resulted in close-proximity (see above for definition). Each animal was sampled only once each day. We randomized the order of each day's focal sessions and focal data were evenly distributed across the study period and time of day.

Analyses were based on 414 conflicts, 792 scans and 1102 hours of focal data. We measured the quality of each dyad's social relationship using a composite sociality index (CSI: Silk et al. 2003):

$$\mathrm{CSI} = \frac{\sum_{i=1}^{3} \frac{x_i}{m_i}}{3}$$

$x_i$ = the dyad's mean value for each of the three behavioural variables

$m_i$ = the group's mean value for each of the three behavioural variables

Based on evidence that affiliation, tolerance and proximity are three important measures of social relationship quality in non-human primates including Barbary macaques (Fraser et al. 2008; Majolo et al. 2010; McFarland & Majolo 2011c), we entered the following variables into the CSI: (1) Affiliation: the proportion of scans in which the dyad was grooming or in body contact, (2) Proximity: the proportion of scans in which the dyad was within a ≤1.5m proximity, and, (3) the proportion of approaches between the two members of a dyad that resulted in close-proximity (i.e. an approach not followed by aggression). Higher CSI values represent higher quality social relationships. CSI values ranged from 0 to 8.15 (mean=1.32 CSI/dyad).

## Conciliatory tendency

Our study animals' CCT was calculated when the form of reconciliation was considered both inclusive and exclusive of close-proximity approaches. We used the 'post-conflict-matched-control method' (de Waal & Yoshihara 1983) to analyse the occurrence of reconciliation by comparing the latencies to affiliation in the post-conflict session to their corresponding matched control. Conflicts were only considered in this calculation when both the corresponding post-conflict and matched-control data were available. When affiliation occurred earlier in the post-conflict session than the matched-control, the pair was considered 'attracted'. When affiliation occurred earlier in the matched-control than the post-conflict session, it was considered 'dispersed'. Finally, if affiliation occurred at the same time, or did not occur in either the post-conflict session or the matched-control, the pair was considered 'neutral'. Following the equation proposed by Veenema et al. (1994): (attracted pairs – dispersed pairs) / all pairs, we calculated our study animals CCT when the form of reconciliation was considered inclusive or exclusive of close-proximity.

## Statistical analysis

We used four generalised linear mixed models (GLMMs) to test our predictions. We ran our analyses using each conflict as a single data point. We entered victim and aggressor ID as random factors in all GLMMs to control for the non-independence of the data points, thus avoiding the risk of pseudo-replication (Pinheiro & Bates 2000).

We found our dependent variable self-scratching rate to not be normally distributed (i.e. $P<0.05$) using Shapiro–Francia normality tests. Therefore, we ran two GLMMs with Poisson distribution and log link (hereafter Poisson GLMM) to test our first prediction that close-

proximity approaches and grooming would both help mediate the victim's post-conflict anxiety. We entered self-scratching as count data (i.e. number of occurrences in the post-conflict session). We entered either close-proximity approaches or grooming (both binomial: yes, no) as our independent variable. We also entered group ID (group F or L), the dyad's age (adult-adult, subadult-subadult or adult-subadult) and sex combination (male-male, female-female or male-female) and rank distance, as well as the occurrence of bystander affiliation (i.e. whether or not the focal animal exchanged a friendly interaction with a bystander in the post-conflict session) as control fixed factors because these variables may also affect post-conflict anxiety (Majolo et al. 2009; McFarland & Majolo 2012). We did not need to enter an 'exposure' variable into the Poisson GLMMs as the time window for all observations were the same (i.e. 5min). We re-ran the aforementioned Poisson GLMM analyses using negative binomial regression; an alternative but equally appropriate method to analyse skewed data (i.e. self-scratching data included multiple zero values). The results of the negative binomial regressions were virtually identical to the Poisson GLMMs (i.e. the P values and coefficients were very similar and the significance level remained unchanged). Therefore, the use of Poisson GLMMs in our study was robust against skewed data. For the sake of brevity, we present here only the results of the Poisson GLMMs.

We ran two GLMMs with binomial distribution and logit link (hereafter logistic GLMM) to test our second prediction that the quality of the opponent's social relationship predicted the occurrences of post-conflict close-proximity approaches and grooming. We entered either close-proximity approaches or grooming as our dependent variable and dyad relationship quality (i.e. CSI value) as our independent variable. We also entered group ID and they dyad's age and sex combination and rank difference as control factors as they can affect the occurrence of

reconciliation (Majolo et al. 2009). GLMM analyses were performed using STATA v10.1 Software (StataCorp 2007). All figures (i.e. drop-line charts) were produced in IBM SPSS Statistics Version 20. Drop-line charts display scores for each individual with lines extending through each group of data points.

The proportions of 'attracted' and 'dispersed' pairs were compared using a Wilcoxon signed-ranks test, run at the level of the individual. A one sample t-test was used to compare the CCT% of our study animals when reconciliation was defined as either close-proximity approaches or grooming.

## Results

### Post-conflict anxiety

In support of our first prediction, the victim's mean rate of post-conflict self-scratching was significantly lower for conflicts followed by close-proximity approaches (excluding cases resulting in grooming), compared to those not followed by close-proximity approaches or grooming (Poisson GLMM: Table 3(a), Fig. 1). However, in contrast to our first prediction, there was no significant difference in the victim's post-conflict self-scratching rate for conflicts followed by grooming compared to those not (Poisson GLMM: Table 3(b), Fig. 2).

"Approximate location for Fig.1 and Fig. 2"

Relationship damage

In support of our second prediction, post-conflict close-proximity approaches (excluding cases resulting in grooming) were more likely to occur following conflicts between opponents that shared a high quality relationship (i.e. dyads with a high CSI value) compared to those with a low quality relationship (Logistic GLMM: Table 3(c), Fig. 3). Similarly, post-conflict grooming was significantly more likely to occur following conflicts between opponents that shared a high quality relationship compared to those with a low quality relationship (Logistic GLMM: Table 3(d), Fig. 4).

"Approximate location for Fig.3 and Fig. 4"

Conciliatory tendency

Of the 61 post-conflict-matched-control pairs where close-proximity approaches were observed, significantly more pairs were attracted (N=60) compared to those dispersed (N=1), giving a CCT of 0.16, i.e. (60–1)/381 (Wilcoxon: Z=-4.242, P<0.001, N = 24 individuals). Of the 26 post-conflict-matched-control pairs where grooming between former opponents was observed, significantly more pairs were attracted (N=26) compared to those dispersed (N=0), giving a CCT of 0.07, i.e. 26/381 (Z=-3.720, P<0.001, N = 17 individuals). CCT was significantly higher when reconciliation was defined as grooming and close-proximity approaches (16%) approaches, compared to grooming alone (7%: $T_{380} = 3.729$, P<0.001).

**Discussion**

We provide evidence that close-proximity approaches are sufficient in reconciling the negative consequences of aggression in wild Barbary macaques: close-proximity approaches reduced the victim's post-conflict anxiety and were predicted by the quality of the opponent's social relationship. Moreover, grooming alone (i.e. excluding post-conflict sessions with close-proximity approaches only, but not grooming), although predicted by the quality of the opponent's social relationship, did not have an impact on the victim's elevated post-conflict anxiety despite the fact that they were preceded by close-proximity approaches.

Our findings do not dismiss the notion that grooming plays an important role in mediating the consequences of aggression; there is comprehensive evidence that post-conflict grooming is associated with reduced post-conflict anxiety in numerous animal species (Schino 2000; Aureli et al. 2002). However, our results do suggest that close-proximity approaches also play a role in reconciling the costs of aggression in wild Barbary macaques. Our finding that close-proximity approaches are enough to reconcile the negative consequences of aggression suggests that implicit forms of reconciliation (de Waal & Ren 1988; Call 2000) are often used by this species. This finding, in addition to the low CCT observed in our study (see below), appear to contrast with the classification of the Barbary macaque as a relatively tolerant social species (Thierry 2000). In fact, Grades 2 and 3 (sensu Thierry 2000) of the dominance style scale appear to have mixed features shared with both dominant (Grade 1) and tolerant (Grade 4) species (Balasubramaniam et al 2012).

Most importantly, our results exemplify the necessity to consider inter-opponent distance regulation as a potential form of reconciliation. In the current study, for example, if close-proximity was not investigated as a form of reconciliation, we would have failed to observe an anxiety reducing function of reconciliation in our study species. These findings have important

implications for comparative studies and the modelling of conflict management styles across primates. In studies of Old World monkeys, in particular macaques, the behavioural expression of reconciliation has often been limited to contact affiliation (e.g. Table 1). Proximity regulation as a social tool has more commonly been associated with primate species which may lack the sophisticated dexterity required for social grooming or show fewer overt signs of affiliation, such as patas monkeys (*Erythrocebus patas*: Rowell & Olson 1983; York & Rowell 1988). We predict that previous studies that have failed to explore, or inconsistently used proximity regulation as a measure of reconciliation, may have over- or under-estimated the occurrence of reconciliation in their study species. This was apparent in our study as when we considered reconciliation inclusive of close-proximity approaches our study animals had a CCT twice as high (16%) as when we only considered grooming (7%). Such difference can affect the findings of studies comparing social behaviour between species based on their tendency to reconcile (e.g. Thierry 2000).

Our findings add to the growing evidence that it is important to consider the conciliatory role of inter-opponent distance regulation in studies of reconciliation in non-human primates (Cords 1993; Call 2000). Our findings demonstrate the need to analyse species specific behaviours independently for their role in mediating the costs of aggression, before they are used as a representative form of reconciliation. Such continuity in the methodological approach to the study of reconciliation will facilitate comparative research on post-conflict behaviour in different species.

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## Figure legends

**Fig. 1 –** Drop-line chart showing the difference in victim post-conflict self-scratching in relation to whether post-conflict close-proximity approaches occurred or not (circles represent individual subjects)

**Fig. 2 –** Drop-line chart showing the difference in victim post-conflict self-scratching in relation to whether post-conflict grooming occurred or not (circles represent individual subjects)

**Fig. 3** – Drop-line chart showing the difference in opponent social relationship quality in relation to whether post-conflict close-proximity approaches occurred or not (circles represent individual subjects)

**Fig. 4** – Drop-line chart showing the difference in opponent social relationship quality in relation to whether post-conflict grooming occurred or not (circles represent individual subjects)

## Tables and Table legends

**Table 1** – Behaviours used to define reconciliation in previous studies of macaques

| | *M.sylvanus*[1] | *M.sylvanus*[2] | *M.sylvanus*[3] | *M.mulatta*[4] | *M.fascicularis*[5] | *M.fascicularis*[6] | *M.fuscata*[7] | *M.fuscata*[8] | *M.fuscata*[9] | *M.fuscata*[10] | *M.nemestrina*[11] | *M.arctoides*[4] | *M.radiata*[12] | *M.nigra*[10] | *M.silenus*[13] | *M.assamensis*[14] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Allogrooming | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | | ✓ |
| Body contact | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | ✓ |
| Huddling/embraces | | | ✓ | | ✓ | | | ✓ | | | ✓ | ✓ | ✓ | | | ✓ |
| Mounting | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | ✓ |
| Muzzle contact | | | ✓ | | ✓ | | ✓ | ✓ | ✓ | | ✓ | | ✓ | | | ✓ |
| Mutual lip-smacking/teeth-chattering | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | |
| Playing | | | ✓ | | ✓ | | ✓ | ✓ | | | | | | | | |
| Genital inspect/present | | | ✓ | ✓ | ✓ | | | | | | | ✓ | ✓ | | | |
| Passive contact | | | | | | ✓ | | ✓ | | | | | ✓ | | | |
| Inter-opponent distance | ✓ | | | ✓ | | ✓ | | | | | | ✓ | | | | |
| Feeding in close-proximity | | ✓ | | | | | | | | | | | | | | |
| In-descriptive physical contact | | | | | | | | | | ✓ | | | | ✓ | ✓ | |

[1]McFarland & Majolo 2011, [2]Patzelt et al. 2009, [3]Aureli et al. 1994, [4]Call 1999, [5]Aureli et al. 1989, [6]Cords 1992, [7]Aureli et al. 1993, [8]Kutsukake & Castles 2001, [9]Majolo & Koyama 2006, [10]Petit et al. 1997, [11]Castles et al. 1996, [12]Cooper et al. 2007, [13]Abegg et al 1996, [14]Cooper et al. 2005

453 **Table 2** – The number and proportion of conflicts followed by different forms of friendly

454 affiliation observed in two groups of wild Barbary macaque over a 15 month period

| | **N conflicts** | **% conflicts** |
|---|---|---|
| Grooming | 26 | 6.3 |
| Sandwich interactions | 1 | 0.2 |
| Mutual teeth-chattering/lip-smacking | 1 | 0.2 |
| Infant handing | 1 | 0.2 |
| ≤1.5m close-proximity approaches | 67 | 16.2 |
| *Total conflicts observed* | *414* | |

455

456 **Table 3** – Poisson and logistic GLMM regression results

| Dependent variable | Independent and control variables | β ± SE | 95% CIs | N | *Z* | *P* |
|---|---|---|---|---|---|---|
| (a) Victim post-conflict self-scratching | Post-conflict close-proximity approach | -0.70 ± 0.33 | -1.34 to -0.05 | 191 | -2.12 | 0.03 |
| | Group ID | -0.28 ± 0.24 | -0.76 to 0.20 | 191 | -1.13 | 0.26 |
| | Age combination | 0.12 ± 0.16 | -0.20 to 0.43 | 191 | 0.73 | 0.47 |
| | Sex combination | 0.01 ± 0.22 | -0.42 to 0.45 | 191 | 0.07 | 0.95 |
| | Rank difference | 0.03 ± 0.02 | -0.01 to 0.07 | 191 | 1.42 | 0.16 |
| | Bystander affiliation | -0.39 ± 0.26 | -0.91 to 0.12 | 191 | -1.50 | 0.13 |
| (b) Victim post-conflict self-scratching | Post-conflict grooming | -0.56 ± 0.53 | -1.59 to 0.47 | 191 | -1.06 | 0.29 |
| | Group ID | -0.21 ± 0.24 | -0.69 to 0.27 | 191 | -0.87 | 0.39 |
| | Age combination | 0.09 ± 0.16 | -0.22 to 0.40 | 191 | 0.58 | 0.57 |
| | Sex combination | 0.04 ± 0.22 | -0.39 to 0.47 | 191 | 0.18 | 0.85 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Rank difference | 0.02 ± 0.02 | -0.01 to 0.06 | 191 | 1.19 | 0.23 |
| | Bystander affiliation | -0.34 ± 0.26 | -0.85 to 0.18 | 191 | -1.29 | 0.20 |
| (c) Post-conflict close-proximity approach | Relationship quality (CSI) | 0.30 ± 0.10 | 0.11 to 0.49 | 414 | 3.07 | 0.002 |
| | Group ID | -0.96 ± 0.35 | -1.65 to -0.27 | 414 | -2.74 | 0.01 |
| | Age combination | -0.17 ± 0.23 | -0.62 to 0.29 | 414 | -0.72 | 0.47 |
| | Sex combination | 0.10 ± 0.33 | -0.54 to 0.75 | 414 | 0.31 | 0.76 |
| | Rank difference | 0.07 ± 0.03 | 0.01 to 0.12 | 414 | 2.23 | 0.03 |
| (d) Post-conflict grooming | Relationship quality (CSI) | 0.29 ± 0.14 | 0.02 to 0.56 | 414 | 2.09 | 0.04 |
| | Group ID | -0.81 ± 0.56 | -1.91 to 0.29 | 414 | -1.44 | 0.15 |
| | Age combination | -0.48 ± 0.41 | -1.28 to 0.33 | 414 | -1.16 | 0.25 |
| | Sex combination | 0.14 ± 0.54 | -0.92 to 1.19 | 414 | 0.25 | 0.80 |
| | Rank difference | 0.07 ± 0.04 | -0.02 to 0.15 | 414 | 1.50 | 0.13 |

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