Title	Reconciliation with pair-bond partner in budgerigar, Melopsittacus undulatus
Sub Title	
Author	一方井, 祐子(Ikkatai, Yuko) 渡辺, 茂(Watanabe, Shigeru)
Publisher	Centre for Advanced Research on Logic and Sensibility The Global Centers of Excellence Program, Keio University
Publication year	2012
Jtitle	CARLS series of advanced study of logic and sensibility Vol.5, (2011.) ,p.87- 92
JaLC DOI	
Abstract	
Notes	I. Study of Logic and Sensibility Part 1: Brain and Evolution
Genre	Research Paper
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=KO12002001-20120224-0087

8 Reconciliation with Pair-bond Partner in Budgerigar, *Melopsittacus undulatus*

Yuko Ikkatai[1,2,3] *and Shigeru Watanabe*[2,4]

[1] Graduate School of Human Relations, Keio University
[2] Centre for Advanced Research on Logic and Sensibility (CARLS), Keio University
[3] Japan Society for the Promotion of Science
[4] Department of Literature, Keio University

I. Introduction

Agonistic conflicts occur when individuals gather in a group. Various costs of conflicts, such as energy and time, are known to affect combatants. Social animals are thought to have evolved behavioral strategies to decrease the cost of conflicts.

Many primates initiate affiliative interactions with former opponents after a conflict (e.g., long-tailed macaques, Cords 1992; chimpanzees, Witting & Boesch 2005, Geladas, Leone & Palagi 2010). Such "reconciliation" is thought to enable combatants repair their relationships, alleviate distresses, and prevent renewed aggressions (Aureli & van Schaik 1991; Aureli et al. 2002). Recently, it has been suggested that corvid birds engage in reconciliation. Subadult ravens engage in reconciliation with valuable group members (Fraser & Bugnyar 2011), suggesting that reconciliation is one of the conflict-management strategies observed not only in social mammals but also in social birds. Reconciliation might enhance logical ability of social animals. However, whether social birds show reconciliation when they become sexually mature has rarely been examined. For monogamous adult birds, valuable group members are pair-bond partners.

In this study, we examined whether an agonistic conflict can be managed in pair-bond adult budgerigars. Similar to corvids, budgerigars are a highly social species that form fission-fusion societies and long-term monogamous relationships (Wyndham 1980; Wyndham 1981). Here we investigated 1) whether an agonistic conflict affects subsequent affiliative interactions and 2) whether reconciliation occurs in budgerigars.

II. Method

1. Subjects

The subjects were two flocks of ten adult budgerigars (*Melopsittacus undulatus*), aged 2–4 years. Each flock comprised of five males and five females. All birds were obtained commercially from a local supplier. Their sex was determined by blood DNA analysis (Fridolfsson & Ellegren 1999). Subjects were identified based on their feather color variations.

Birds were flock-housed in indoor aviaries (W 0.9 m × L 0.9 m × H 1.3 m). They were fed daily with a standard seed mixture. Fresh water was available *at libitum*. The experimental room was set to 23 ± 2 ºC on a 12:12h light-dark cycle with light onset at 08:00 hrs.

2. Apparatus

The experiment was carried out in a home aviary. Four wooden perches were placed at the two corners of the back-side wall. Four video cameras were fixed outside the aviary, all of which were connected to a quadro-split video monitor, which simultaneously covered the four perches of the aviary.

3. Observation procedure

One-hour video recording was conducted between 13:00 and 16:00 hrs in September–October 2008 for group I and in October–December 2009 for group II. Total recording duration was 11 hours (6 hrs for group I and 5 hrs for group II).

Observations were performed using video-recorded data. For each recording session, observer (YI) collected all agonistic (pecking motion and pecking attack) and affiliative (bill touching, head bobbing, bill hitting, active feeding, and allopreening) interactions along with participant identities.

4. Data analysis

If an agonistic interaction affects subsequent affiliative interaction with a pair-bond partner, the affiliative interaction with the pair-bond partner should occur within a particular temporal window. To examine this prediction, we first measured the interval between the onset of an agonistic interaction and subsequent affiliative interaction during a 5-min post-conflict period (observed data). Next we compared the distribution of the observed data with simulation data as the control. Simulation was executed using the bootstrap procedure. First, (a) the interval between the onset of an agonistic interaction and a subsequent agonistic interaction, and (b) the interval between the onset of an affiliative and a subsequent affiliative interaction were pooled. Next, the agonistic intervals and affiliative intervals were randomly re-ordered separately to attain sequences. Third, the two sequences were compared. The first interval between the onset of an agonistic interaction and a subsequent affiliative interaction was measured (simulated data). This re-ordering was repeated 150 times for each subject. The observed data and the simulated control data were compared with the Kolomogorov–Smirnov test.

III. Results

The temporal distribution of the interval between the onset of agonistic interaction with the pair-bond partner and the first affiliative interaction with the pair-bond partner following the aggression was significantly different between the observed (n = 114) and simulated (n = 971) data ($\chi^2 = 5.559$, $df = 1314$, $P < 0.001$, Fig. 1a), demonstrating that an agonistic conflict affects subsequent affiliative interactions. We investigated the effects of data type (observed vs. simulated) and group (group I vs. group II) on the occurrence of reconciliation using a two-way analysis of variance with log-transformed data. A significant main effect was found for data type (data type × group: $F_{1, 1074} = 0.004$, $P = 0.947$, data type: $F_{1, 1074} = 126.525$, $P < 0.001$, group: $F_{1, 1074} = 1.220$, $P = 0.270$, Fig.1b), demonstrating that affiliative interactions with pair-bond partners occurred faster after agonistic interactions than without agonistic interactions during the post-conflict period.

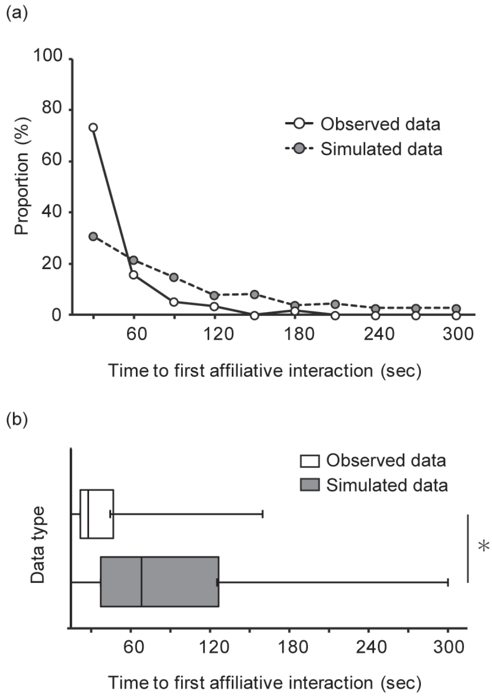

Figure 1: Reconciliation with pair-bond partners. (a) The temporal distribution of the first affiliative interactions post-conflict was significantly different between the observed and simulated data. (b) The time to first affiliative interaction in the observed data was significantly faster than that in the simulated data. Boxes represent the interquartile range between the 25th and 75th percentiles. Mid horizontal lines represent medians. Vertical lines represent the entire range of values.

IV. Discussion

In this study, we showed that budgerigars engage in post-conflict reconciliation with their pair-bond partners, suggesting that agonistic conflicts can be managed with pair-bonding in budgerigars.

Reconciliation has rarely been reported in other birds. Contrary to budgerigars, adult rooks never show reconciliation with their pair-bond partners (Seed & Clayton 2003), because rooks do not engage in agonistic interactions with their pair-bond partners. A valuable relationship hypothesis states that post-conflict reconciliation is likely to occur between opponents who share valuable relationship (de Waal & Yoshihara 1983; Aureli et al. 2002). The benefits they would acquire from reconciliation should overweigh the cost of re-approaching the opponent after an agonistic conflict. For monogamous adult budgerigars, the most important valuable relationship would be nearly equal to a pair-bond relationship. Post-conflict affiliation might be necessary for them to maintain their lifelong relationships.

This is the first study that shows the occurrence of post-conflict affiliation in budgerigars. The temporal distribution of post-conflict reconciliation was quite similar to primates (e.g., Leone & Palagi 2010), suggesting that both primates and birds might share the cognitive ability needed for reconciliation.

Acknowledgements

This research was partially supported by the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for JSPS Fellows, 2009–2011, 09J55562. The experiment complies with the Animal Care and Use Committee of Keio University (Animal care and use approval no. 08006).

References

Aureli, F., Cords, M., & van Schaik, C. P. (2002). Conflict resolution following aggression in gregarious animals: a predictive framework. *Animal Behaviour,* 64, 325–343.

Aureli, F., & van Schaik, C. P. (1991). Post-conflict behaviour in long-tailed macaques (*Macaca fascicularis*) II. Coping with the Uncertainty. *Ethology*, 89, 101–114.

Cords, M. (1992). Post-conflict reunions and reconciliation in long-tailed macaques. *Animal Behaviour*, 44, 57–61.

de Waal, F. B. M., & Yoshihara, D. (1983). Reconciliation and redirected affection in rhesus monkeys. *Behaviour*, 85, 224–241.

Fridolfsson, A. K., & Ellegren, H. (1999). A simple and universal method for molecular sexing of non-ratite birds. *Journal of Avian Biology*, 30, 116–121.

Leone, A., & Palagi, E. (2010). Reconciling conflicts in a one-male society: the case of geladas (*Theropithecus gelada*). *Primates*, 51, 203–212.

Fraser, O. N., & Bugnyar, T. (2011). Ravens reconcile after aggressive conflicts with valuable partners. PLoS ONE, 6, e18118.

Seed, A. M., Clayton, N. S., & Emery, N. J. (2007). Postconflict third-party affiliation in rooks, *Corvus frugilegus*. *Current Biology*, 17, 152–158.

Witting, R. M., & Boesch, C. (2005). How to repair relationships–reconciliation in wild chimpanzees (*Pan troglodytes*). *Ethology,* 111, 736–763.

Wyndham, E. (1980). Diural cycle, behaviour and social organization of the budgerigar *Melopsittacus undulatus*. *Emu*, 80, 25–33.

Wyndham, E. (1981). Breeding and mortality of budgerigars (*Melopsittacus undulatus*). *Emu*, 81, 240–243.