Behavioural Changes in Response to an Injured Group Member in a Group of Wild Moustached Tamarins (*Saguinus mystax*)

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Introduction

Injury and disease can be major sources of death in wild primates (Dunbar, 1988). However, healed injuries indicate the potential for recovery (Schultz, 1939; Zihlman *et al.*, 1990; Lovell, 1991), but whether or not an individual recovers and survives may depend not only on the severity of the injury or disease, but also on whether it can remain in contact with its group. This may be important in terms of reduced predation risk, access to food resources, thermoregulation, and compensatory care (Chapman and Chapman, 1987; Dittus and Ratnayeke, 1989; Gould, 1997). If locomotion is impaired, an individual's capability to keep up with a travelling group will depend on the behaviour of the rest of the group. Kin structure and/or the level of within-group co-operation probably influence how far single animals or a whole group will modify their behaviour in favour of a disabled individual. In this paper, we examine behavioural modifications in a group of a co-operatively breeding primate, *Saguinus mystax*, after one individual was hurt during a raptor attack and remained temporarily handicapped. Specifically, we look at changes in patterns of resource use and retirement to sleeping sites as measures of potential behavioural and ecological costs. The event reported here was unforeseen, and no *a priori* predictions could be made; thus our analyses are *post hoc* examinations of factors that we perceived as having been modified.

Methods

The observation was made during a field study of moustached tamarins, *S. mystax*, and sympatric saddle-back tamarins, *Saguinus fuscicollis*, at the Estación Biológica Quebrada Blanco (EBQB) in north-eastern Peruvian Amazonia (04°21'S, 73°09'W; for details of the study site see Heymann, 1995). A well-habituated group of eight *S. mystax* living in association with five *S. fuscicollis* has been followed by the first author (ERTH) for 4-7 days per month since March 1997. Periods of observation ("observation blocks") of each species are alternated. At the time of the event described here, the *S. mystax* group consisted of an adult male, two subadult males, one adult female, two subadult females, a juvenile male and a juvenile female (hereafter called F-j). Routine data collection included instantaneous scan-sampling at 10-minute intervals, recording the activity and height of each visible group member of the focal species, the time of leaving and retiring to sleeping sites, and the time of entering and leaving feeding trees.

Since our impression was that the group modified its pattern of feeding site use after F-j was injured, we calculated the number of feeding trees visited per day and the percentage of feeding tree visits represented by repeated visits to the same feeding tree per day. We compared the means of these parameters between the period before the attack, during the three days immediately after, and in the period following. We also calculated the time lag between the first and the last animal entering a sleeping site, and compared this between the different periods. Percentages were Arcsine-transformed before analyses. Comparisons were made with a one-way ANOVA, followed by the Tukey HSD test for unequal sample size using Statistica® 5.0.

Results

Raptor attack

When observations of the *S. mystax* group began on 1 July, 1997, all group members were apparently healthy and none showed any problems with locomotion. On 5 July the *S. fuscicollis* group became the focal species. The *S. mystax* were associated with the *S. fuscicollis* from the early morning on, and stayed with them for the whole day. In the afternoon of 5 July, the *S. mystax* were spread out and resting on open branches exposed to sunlight about 15 m above the ground, in a tree approximately 18 m in height.

At 1514 h, two alarm calls were given almost simultaneously, and all the tamarins dropped from their resting places. At this moment, a medium-sized raptor flew rapidly through the canopy, coming from above and diving into the sub-canopy. A loud scream was heard from a *S. mystax*, and the raptor was seen turning around and flying towards the place where the tamarins had dropped to the forest floor. Another scream was heard and several tamarins were seen running on the floor. The raptor turned around again and perched on a branch, looking towards the tamarins. The raptor was dark-brown on the upper parts and light-brown with white spots on the belly, and had a total length of about 40 cm – perhaps a *Micrastur semitorquatus* or related species. When the observer approached to take a closer look the raptor flew away. His three flights had taken a total of 25 seconds; the entire event, from the first alarm call to the raptor flying away, lasted approximately one minute 20 seconds.

None of the tamarins were missing after the attack, but F-j was injured, with her left leg hanging down as she sat. She tried without success to lift it onto the branch with her left hand and screamed when starting to walk. No external wound was apparent, but she limped heavily when walking. When the group moved off from the place where they were attacked, F-j had problems keeping up, particularly since the others were moving low down in the vegetation, where she was unable to leap between vertical supports. From the site of the attack the group moved towards a sleeping tree about 250 m away. F-j followed behind, but eventually lost contact with the group. At 1627 h the group entered a new sleeping tree. F-j gave contact calls several times but did not receive a reply. She passed by the sleeping tree, still giving contact calls. At this time, her calls were answered, and F-j returned and entered the sleeping tree at 1645 h.

Behavioural changes after the attack

Modification of the group's activity was most notable on the first day after the attack. During progression, F-j lagged behind and frequently gave contact calls. Whenever the distance between F-j and the group exceeded about 25 m, the group stopped and waited for F-j to catch up. F-j stayed for over four hours in a feeding tree, to which the rest of the group returned a total of seven times that day. During the next two days, F-j also remained in feeding trees for prolonged periods, while the group foraged and made repeated visits to other feeding trees in the surroundings. On one occasion when the distance between F-j and the group exceeded 70 m, contact between F-j and the group was maintained through long calling.

On the days after the attack, the group visited fewer feeding trees per day compared to previous and later observation blocks, but the differences were not significant (Fig. 1a). However, the percentage of visits to feeding trees represented by repeated visits to the same tree(s) varied significantly between periods and was higher in the days following the attack (Fig. 1b).

On the three days following the attack, F-j was always the last animal to leave and to enter sleeping sites. The mean time lag between the first and last animal to enter a sleeping site was significantly higher on the day of and the three days following the attack in comparison to periods before and after this event ($F_{2,39} = 21.704$, $p < 0.0001$; Table 1). F-j recovered and survived into adulthood, but slight limping always remained notable.

Discussion

Given the highly co-operative nature of tamarin societies (Caine, 1993; Goldizen, 1987; Shahuano Tello *et al.*, 2002), one would predict some response to the injury by other group members or the group as a whole. In the present case, patterns of resource use were modified on the days following the attack (compared to previous and later observation periods). This allowed F-j to remain in contact with the group despite being strongly impaired. It is unlikely that the modification resulted from seasonal variation in resource availability, as the period covered by the analyses includes the middle-late rainy season (March-May), a transitional month (June), and the early-middle "dry" season (July-August). Given a decline of fruit availability from the rainy towards the "dry" season at our study site (Tirado Herrera and Heymann, unpubl.
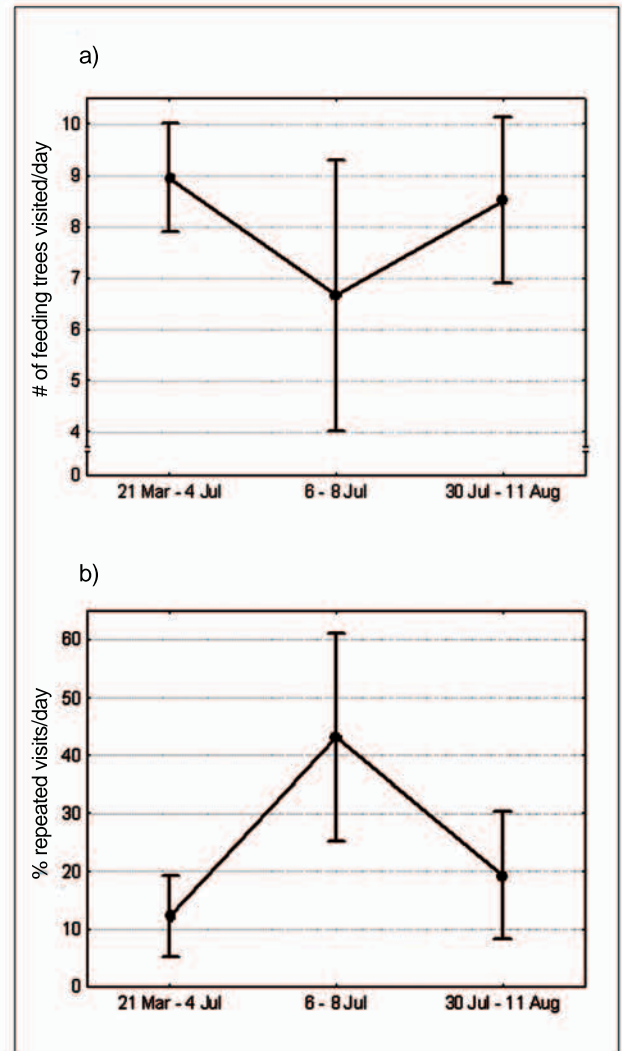

Figure 1. Comparison of parameter values between the period before, immediately after, and following the attack. (a) Number of feeding trees visited per day ($F_{2,27} = 1.3727$, $p = 0.27$). (b) Percentage of visits to the feeding trees per day accounted for by repeated visits to the same tree ($F_{2,27} = 5.994$, $p < 0.01$). Dots represent means, and vertical bars 95% confidence intervals.

Table 1. Time lag (min) between first and last animal entering sleeping tree and comparison with other groups.

Study group	Group size	Mean	SD	Maximum	n days
This study	8				
a) 21 Mar – 4 Jul 1997		1:24	0:41	3:00	29
b) 5 Jul 1997 (day of attack)*		18:00	-	-	1
c) 6 – 8 Jul 1997*		5:40	4:36	11:00	3
d) 30 Jul – 11 Aug 1997#		1:47	0:40	3:00	9
EBQB 1985/86[†]	3	0:24	0:17	1:00	5
EBQB 1990[†]	4-5	1:01	0:45	2:45	15
EBQB 1995[§]	7	<2:00	<1:24	5:57	13

* last animal always F-j
\# F-j last animal on 2 days
Tukey HSD test: a vs. d: n.s.; a vs (b+c): p < 0.0005; d vs. (b+c): p < 0.0005

[†] Heymann (1995)
[§] Heymann, unpublished data

data), a seasonal effect should have resulted in a constant increase or decrease, respectively, of the parameters examined here, rather than in the observed fluctuation.

Modification of resource use (increased number of repeated visits to the same feeding site) may incur costs in terms of increased risk of cueing-in a predator and reduced dietary variability. Since the genetic relationships of the group members are not known (although F-j most likely is the daughter of the adult pair and the sister of the subadult and juvenile group members), it is not clear whether benefits obtained through kin selection or other benefits balanced these costs. An additional cost factor may have been represented by F-j lagging behind the group when entering a sleeping site. Rapid retirement to a sleeping site within 1-2 min is highly consistent between different groups (Table 1), and probably represents an anti-predator strategy (Caine, 1987; Heymann, 1995). Lagging behind could potentially increase the risk of being detected by, or cueing-in, a predator.

Whether or not F-j would have survived without the modification in the group's behaviour cannot be answered. Our observations provide evidence that wild tamarins modify their behaviour in response to an injured member.

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Diurnal Birth of a Wild Red Titi Monkey, *Callicebus cupreus*, at the Estación Biológica Quebrada Blanco

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In most diurnal primates, births take place during the night (Jolly, 1972, 1973), which may relate to ecological, behavioural or physiological factors (Timmermans *et al.*, 1998). The circumstances surrounding a birth are therefore usually not observed. Such observations might be particularly interesting in species where offspring are carried mostly by individuals other then the mother – such as in titi monkeys, night monkeys, the marmosets and tamarins – to see how soon the newborn may be transferred to a helper. Here we report unusual circumstances surrounding the birth of a red titi monkey, *Callicebus cupreus*, observed at the Estación Biológica Quebrada Blanco (EBQB) in north-eastern Peruvian Amazonia (04°21'S, 73°09'W; for details of EBQB see Heymann, 1995).

The titi monkey group was composed of the adult pair, a subadult male and an as-yet unsexed juvenile. This well-habituated group had been under regular monthly observation between October 2002 and September 2003 as part of a thesis project (Perez Yamacita, in prep.). The group was monitored by two of us (CFA and EWH) on 10-13 October 2003, and quantitative data were collected by the first two authors with the help of CFA on 16-18 October 2003 as part of a field course. Instantaneous scan sampling at 10-minute intervals was employed for data collection (Martin and Bateson, 1993). While monitoring the group, we noted the swollen abdomen of the female titi monkey, suggesting that she might be pregnant. She copulated with her mate on 11 October 2002.