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BRIEF REPORT

# Behavioral Effects of Introducing Pied Tamarin (*Saguinus bicolor*) to Black Howler Monkey (*Alouatta caraya*) and White-Faced Saki (*Pithecia pithecia*) in a Zoological Park

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Mixed-species primate exhibits are becoming more common in zoological parks as a means to display a diverse array of animals both more naturalistically and with more economy of space. Here, we describe behavioral changes during the introduction process of a pair of pied tamarins (*Saguinus bicolor*) to an established group of black howler monkeys (*Allouatta caraya*) and white-faced saki monkeys (*Pithecia pithecia*). Data were collected during six phases, representing introductions among the various species and to exhibit space and off-exhibit holding. The pied tamarins were consistently the most active of the three species. Although activity levels of the howler and saki monkeys remained constant throughout, that of the tamarins declined as the introduction progressed. Several episodes of aggression between the tamarins and the sakis were observed, but did not coincide with patterns predicted by previous intra-specific introductions. The three-species mix remained stable for several months; however, escalating aggression ultimately led to the removal of the sakis from the mixed-species exhibit. Despite our mixed results, we contend that only through continued trials, coupled with careful and systematic monitoring, can we ultimately identify stable mixes of species. Am. J. Primatol. 70:1–5, 2008. 

**Key words: pied tamarin; black howler monkey; white-faced saki monkey; mixed-species exhibits**

## INTRODUCTION

Mixed-species exhibits have become more prevalent in recent years as zoos look for new ways to create naturalistic environments that enrich their animals and educate the public as well as make efficient use of limited exhibit space [Wojciechowski, 2004]. Despite the growing number of mixed-species exhibits and brief reviews of their particular successes and failures [Ziegler, 2002], there have been relatively few formal studies on the inter-specific interactions, both direct and indirect, which must occur to form a stable, mixed-species primate exhibit. In summer 2005, Lincoln Park Zoo Primate House staff introduced 1.1 pied tamarins (*Saguinus bicolor*) to an exhibit that already held 1.3 black howler monkeys (*Alouatta caraya*) and 1.1 white-faced saki monkeys (*Pithecia pithecia*). We capitalized on this opportunity to systematically observe changes in the animals' behavior to provide information for use both for the ongoing husbandry of these animals and for future mixed-species introductions.

Black howler monkeys and white-faced sakis are both common in mixed-species exhibits [Ziegler, 2002]. Pied tamarins, however, are rarely mixed with other species, in part because they are very active and are known to be aggressive and difficult to keep in captivity [Baker & Pissinatti, 2003; Wormell, 2000]. Only Jersey Wildlife Trust and Cleveland Zoo have housed them with other primates (callitrichids and cebids, respectively) [A. Henderson and M. Brayshaw, personal communication]. However, as wild populations of pied tamarins dwindle [Junqueira Subirá, 1998], it is increasingly important to strengthen and expand the captive population.

Introductions normally proceed in multiple steps, giving the animals gradually increasing contact with one another. Past observations of intra-specific introductions have shown that at each stage, aggression among individuals will generally increase at first but then return to a pre-introduction baseline [Burks et al., 1998, 2001]. Thus, we expected to observe this pattern of aggression here, although

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**TABLE I. Stages of the Introduction**

| Phase | Dates/ length | Hours of observation[a] |
|---|---|---|
| 1. Pre-introduction<br>The howlers and sakis were observed on exhibit, and the tamarins were observed in an off-exhibit enclosure, where they had been kept since their arrival at the Helen Brach Primate House on February 28, 2005 | 6/20 to 6/29<br>10 days | P: 3.3 S: 3.6 H: 3.5 |
| 2. Saki–tamarin howdy<br>The sakis were kept off-exhibit, and the tamarins were moved into an adjacent holding, with 1-inch mesh in between. Animals had olfactory, visual and limited tactile contact. Howlers were on exhibit alone | 6/30 to 7/6<br>7 days | P: 1.6 S: 1.5 H: 1.2 |
| 3. Saki–tamarin introductions<br>The sakis and tamarins were given full access to one another's enclosures for a limited amount of time nearly every day. Burlap was added over the mesh to prevent aggression when the animals were separated. Thirteen introductions were performed, lasting between 20 and 105 min. Howlers were still on exhibit | 7/7 to 7/20<br>14 days | P: 3.5 S: 3.7 H: 1.8[b] |
| 4. Tamarins and sakis on exhibit<br>The howlers were shifted off-exhibit, whereas the tamarins and sakis were allowed on exhibit, often with access to the off-exhibit enclosure | 7/21 to 7/27<br>7 days | P: 2.9 S: 3.1 H: [c] |
| 5. Simultaneous howdy with howlers<br>While on exhibit, tamarins howdied with howlers, who were still in holding. One enclosure separated the howlers and exhibit. Tamarins and sakis both had access to this enclosure | 7/28 to 8/11<br>15 days | P: 2.3 S: 2.3 H: [c] |
| 6. Full introduction<br>On August 12, 1.3 howlers were shifted onto exhibit with the tamarins, whereas the sakis were kept in holding. All animals were on exhibit the following day until aggression was observed between the sakis, 0.2 howlers and later on, the tamarins. The howlers were removed and added back one at a time, beginning with the male | 8/12 to 8/25<br>15 days | P: 2.2 S: 2.5 H: 1.9 |

[a]P, pied tamarin; S, saki; H, howler.
[b]Phase three howler data were analyzed with phase two because these phases were equivalent for the howlers.
[c]Data were not taken on the howlers while in holding (phases three through five).

it had not been previously documented in an interspecific introduction. We hoped that through a careful introduction, we would achieve a mixed-species grouping that was both stable and enriching for the animals involved.

## METHODS

The howler monkey–saki monkey mixed-species group had been together for over a year at the outset of this investigation. The howler monkeys, ages 6–15 years, were non-breeding (the male was vasectomized), as were the saki monkeys (a mother–son pair, ages 13 and 6, respectively), of which the female received a contraceptive implant. All were parent-reared, except for two of the howler monkey females, whose rearing history was unknown but presumed parent reared. The non-breeding pair of pied tamarins (male, 6 years; female, 2 years and contracepted) had been hand reared. The pied tamarins arrived at Lincoln Park Zoo in January of 2005. The introduction of the pied tamarins to the black howler and white-faced saki monkey exhibit took place in six stages (see Table I), involving first the introduction of the pied tamarins to a new exhibit, then introducing them to the saki monkeys, and finally introducing the saki/tamarin group to the howler monkeys. The animals were housed in different enclosures at different stages, including off-exhibit holdings approximately $2 \times 4 \times 3$ m high, and an exhibit approximately $3 \times 10 \times 10$ m high. Behavioral data were collected during each stage of the introduction, beginning on June 20, 2005, and ending on August 25, 2005, for a total of 41 hr. Each species was observed between 14 and 42 min per day.

We developed an ethogram general enough to apply to all three species based on existing ethograms for pied tamarins [Buchanan-Smith & Jordan, 1992; Coates & Poole, 1983; Schaffner et al., 2005], white-faced sakis [Dugmore, 1986] and golden-faced sakis [Setz & Gaspar, 1997]. The first author and another trained observer collect all data, with $>90\%$ inter-observer reliability. Two sets of five scan samples were collected two to three times per day [Altmann, 1974; Martin & Bateson, 1993]. Scans were at 1 min intervals for each species. At the sample point, behavior was recorded for each individual of the focal species and all-occurrence sampling was used to

record interactions. Data were collected using a Series 5 Psion$^{TM}$ (London, UK) hand-held computer and were transferred daily onto a desktop computer.

During a portion of phase three, and at the start of phases four and six (when levels of activity and interaction were exceedingly high), the primary researcher took ad libitum observations on paper, consistently noting occurrence and location of physical aggression, and in the case of the daily off-exhibit introductions, which animal was first to cross to the others' holding. Zoo keepers videotaped these high-activity periods, and we later reviewed tapes and keeper logs to supplement direct observation and used these data in place of frequency counts for aggression.

We present descriptive statistics only for this case study. We evaluated activity budgets across species and frequency of aggression. All research complied with protocols approved by the Research Committee of Lincoln Park Zoo and adhered to all local, state and federal requirements.

## RESULTS

The male and female pied tamarins were both extremely active before the introduction, engaged in active behaviors on average 77 and 85% of the time, respectively. They were rarely observed in their nest box, and the majority of their activity was locomotion. The male saki was less active than the tamarins, (63% on average) but more active than the howlers and female saki, which each averaged only 35–40% activity. The sakis' primary active behavior was locomotion, whereas most of the howlers' activity consisted of foraging and allogrooming.

As shown in Figure 1A, the pied tamaris became decreasingly active in the later phases of the study, declining from 82 and 77% time active for the male and female, respectively, in phase one to 37 and 24%, respectively, in phase six. Meanwhile, the howlers and sakis maintained relatively constant levels of activity over the course of the introduction. Rates of specific behaviors did not change noticeably for either the howler monkeys or saki monkeys, and

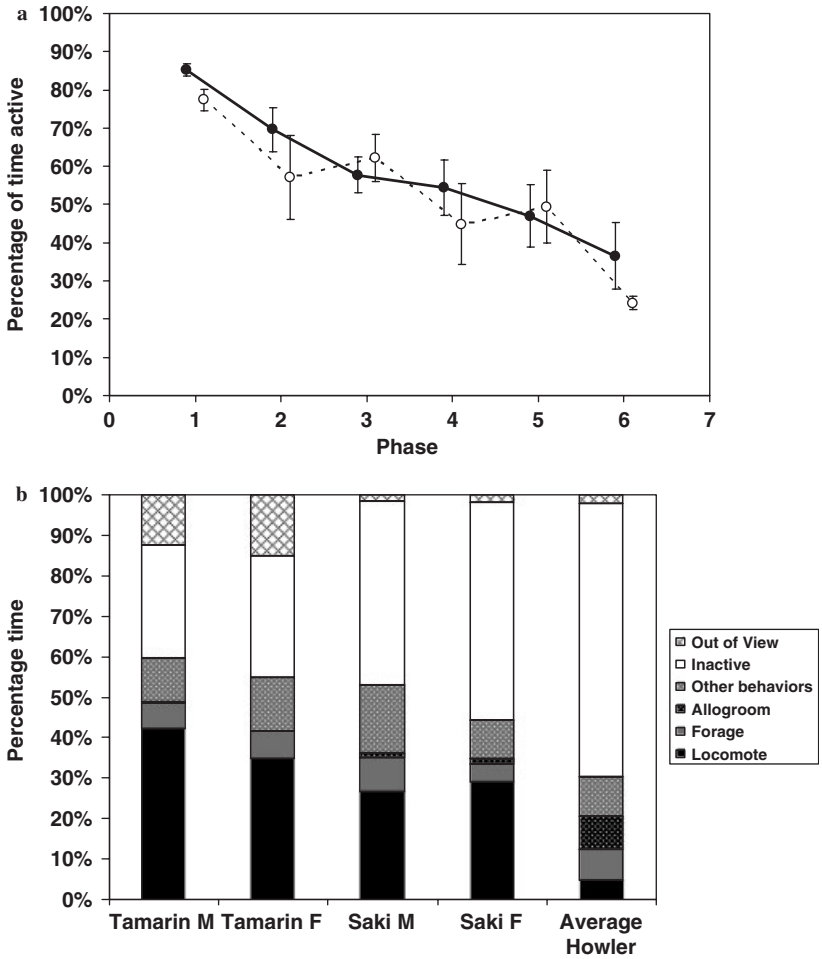


Fig. 1. (**a**) Activity levels for male (solid line) and female (dashed line) pied tamarins throughout each phase of the introduction. (**b**) Overall activity budgets for all species. For pied tamarins and white-faced sakis, activity budgets are presented for each individual (M = male, F = female). Howler monkey is represented by the average of all four howler monkeys.

for the tamarins, only locomotion varied, showing a marked decline as the introduction phases progressed. Figure 1B illustrates the activity budgets of the subjects averaged across all phases of the study.

The highest rate of physical aggression was observed between the sakis and tamarins during the first half of phase three, occurring in six out of the first seven introductions, ranging in severity from a tail pull to fights involving all four animals and resulting in minor injuries. All aggression was directed from the tamarins to the sakis, except for the tail pull and a fight in the seventh introduction, in which the male saki injured the female pied tamarin. No subsequent physical aggression was observed during this phase. In every off-exhibit introduction, the tamarins crossed to the adjacent holding before the sakis, who sometimes did not cross at all. In general, the female tamarin crossed before the male, except in the last three introductions when the male crossed first.

There was one fight warranting keeper intervention in each of the last three phases. The first two fights occurred a few days into their respective phases and involved the male saki and both tamarins. The last fight before cessation of data collection occurred at the beginning of phase six when all the animals were first exhibited together. The female howlers began chasing the sakis, and only later did the tamarins become involved when one jumped on the male saki's back. Which tamarin jumped on the saki could not be determined, but the following day, the female tamarin was observed favoring her right arm.

## DISCUSSION

Overall, there was remarkably little physical aggression during the introduction, especially once the tamarins and sakis were on exhibit (phases four through six). As predicted by their reputation, the pied tamarins—particularly the female—were the most aggressive species during the time frame of this study, judging by the direction of observed aggressive behaviors in phase three and their initiative in crossing to the sakis' holding. The virtual lack of aggression in phase three after the female tamarin's injury suggests that she was particularly instrumental in initiating the conflicts in this phase.

Except for the fight when the howlers were first returned to the exhibit, the proximate causes of the physical aggression in phases four through six were not obvious and contradicted the prediction that the most severe aggression would occur at the beginning of a phase. Perhaps the animals' interest or lack of familiarity with their new environment inhibited aggression in the beginning of phase four when they were first moved onto exhibit, and the presence of the howlers sufficiently distracted them at the beginning of phase five. That the tamarins were likely the aggressors supports this explanation, as they would have been more affected by the newness of the exhibit or the presence of the howlers than the sakis, who were familiar with both the exhibit and the howlers. Alternatively, the pattern of aggression over these phases could have also been related more to the female tamarin's injuries than to the timing of the phases.

Indeed, the only patterns of aggression consistent with the pre-introduction hypothesis are the drop in aggression observed part way into phase three and the fight on the first day all the animals were together—the former of which is probably better explained by the female tamarin's injury. These findings suggest that the predictions based on intra-specific introductions may not be applicable to inter-specific introductions, perhaps because members of different species are less inclined than conspecifics to interact with each other, aggressively or affiliatively.

At the conclusion of our study, in August 2005, the mixed-species group (1.3 howlers, 1.1 saki, 1.1 pied tamarin) was viewed as a successfully integrated group. The group remained together and no additional overt aggression was seen. In mid-October of 2005, the female pied tamarin sustained a bite wound that required veterinary treatment. During her recovery period, during which the female pied tamarin remained off-exhibit for approximately ten weeks and the male alternated between being on- and off-exhibit, we continued to see high levels of aggression between the female saki and one of the female howlers, something that had not occurred previously. The return of the pied tamarins to the mixed-species group was uneventful. However, continued aggression between the howler monkeys and saki monkeys during and after this period resulted in the permanent removal of the saki monkeys from the exhibit group, after almost 6 months of intermittent aggression.

Although indeed the female pied tamarin was initially the most aggressive animal in the three-species group, she was not obviously involved in any subsequent aggression we observed between the howler monkeys and saki monkeys. It is possible that the aggression between the saki and howler monkeys may have been unrelated and was perhaps owing to changes in age and dominance among the howler monkey females. Alternatively, the high level of activity and initial aggression involving the pied tamarins may have led to more general increases in aggression and decreases in social tolerance between the saki and howler monkeys. Despite our mixed results, it is only through such continued trials of mixed-species assemblages, combined with careful documentation and quantitative observation, that we can identify stable mixes of species. As the need and interest for maintaining mixed-species exhibits

increase, such information will be critical for long-term maintenance and stability.

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