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The effect of environmental enrichment and visitors on the behaviour and welfare of two captive hamadryas baboons (Papio hamadryas)

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Abstract

*The welfare of zoo animals depends on a combination of physical, social, dietary and other ecological characteristics of the captive setting. We analysed the influence of the transfer of an adult couple of hamadryas baboons (*Papio hamadryas*) from a small and non-enriched cage that was closed to the public to a larger and enriched exhibit at the visitation area of the Sapucaia do Sul Zoological Park, RS, Brazil. A total of 350 h divided into four stages were spent observing the baboons: (i) in the non-enriched enclosure before the transfer; (ii) soon after the transfer to the enriched enclosure; (iii) six months; and (iv) 12 months after the transfer. The occurrence of stereotypic, social aggressive and social affiliative behaviours was recorded by 'all occurrences' sampling. The female showed a decrease in frequency of a stereotypic behaviour (spinning) and an increase in grooming in the enriched enclosure. The male showed a decrease in the frequency of certain stress-related or stereotypic behaviours after transfer, but other stress-related behaviours either increased or remained constant. The male behaviour of throwing faeces was affected by the presence of visitors. We suggest that the well-being of the female was more positively influenced by the new enclosure than that of the male, although gender differences may reflect the normal behavioural repertoire of this sexually dimorphic species.*

Keywords: *animal welfare, hamadryas baboon, public influence, stereotypic behaviour, stress-related behaviour, zoo animals*

Introduction

The welfare of captive animals in zoos, laboratories and breeding centres has concerned scientists and animal-right activists (Shyne 2006) and a long debate has focused on determining the best strategies for improving it and for measuring the effectiveness of these improvements (Broom 1991; Fraser 2009). A common method applied for evaluating life quality of captive animals involves the identification and frequency of occurrence of stereotypic behaviours that are indicative of sub-optimal environments and that are absent in wild populations (Mason *et al* 2007). A stereotypic behaviour is "repetitive, invariant and has no obvious goal or function" (Mason 1991) and it is "induced by frustration, repeated attempts to cope and/or CNS (brain) dysfunction" (Mason *et al* 2007).

The goals of environmental enrichment of captive settings are improving welfare, reducing stereotypic behaviours and increasing the behavioural repertoire of captive animals (Swaisgood & Shepherdson 2005). Environmental enrichment is defined as "an animal husbandry principle that seeks to enhance the quality of captive animal care by identifying and providing the environmental stimuli necessary for optimal psychological and physiological well-being" (Shepherdson 1998). Techniques of environmental enrichment can be food-associated, physical, sensorial and social among others (Honess & Marin 2006). According to Swaisgood and Shepherdson (2005) and Shyne (2006), most experiences of environmental enrichment have been successful in improving welfare. Successful examples with captive non-human primates involve feeding (Reinhardt & Roberts 1997), social (Eaton *et al* 1994; Schapiro *et al* 1996) and physical (more complex enclosures: Mallapur *et al* 2005) enrichments.

In addition to physical, social, dietary and other ecological limitations, captive animals, especially at zoos, are exposed to the presence of human observers (visitors or staff members) that can affect their welfare. This "effect of the public" is observed in primates and other animals (Davey 2007), and although there is no consensus on whether zoo visitors have a neutral, negative or positive effect, most studies suggest that the interaction with humans stresses captive animals (Hosey 2000, 2005). The response to visitors also shows a considerable intra- and inter-specific variation, justifying further studies on this issue (Chamove *et al* 1988).

In this study, we analyse the effect of physical enrichments on the behaviour of an adult couple of hamadryas baboons

(*Papio hamadryas*) at the Sapucaia do Sul Zoological Park, State of Rio Grande do Sul, Brazil. We evaluate the occurrence of stereotypic, aggressive and affiliative behaviours before and after the transfer of the couple from a small-sized, simple cage closed to the public to a larger, more complex exhibit open to the public. We also evaluate the effect of the public on the behaviour of the monkeys. As it is common to find social animals kept singly or in couples in captivity (Morgan & Tromborg 2007), the results of this study may shed light on the negative consequences of this and appropriate management to improve welfare.

Previous studies with captive hamadryas baboons showed welfare improvements resulting from social enrichment, such as pair/trio housing and positive reinforcement training (Bourgeois & Brent 2005), group housing after isolation (Kessel & Brent 2001) and food-related enrichment (Jones & Pillay 2004). However, data on the effect of enclosure size and structural complexity and the influence of the exposure to visitors on their welfare are missing. Wild baboons live in groups containing up to 200 members that have a complex and rigid social structure (Kummer 1995). Therefore, the captive life, maintenance within an abnormal social structure and exposure to visitors are potential stressors that compromise their welfare (Morgan & Tromborg 2007).

Materials and methods

A couple of adult hamadryas baboons was studied at the Sapucaia do Sul Zoological Park, State of Rio Grande do Sul, Brazil. According to the zoo staff, the male was transferred from another park in 2004 with his precise age unknown, whereas the female arrived at the zoo in 2005 at the age of 19. At the beginning, the male was kept with six females on an island, where he sired a number of offspring, showed aggressive behaviours towards females and used to display stereotypic behaviours. All the infants and females, with the exception of his current cage mate, either died or were transferred to other zoos.

The remaining couple were then moved to another enclosure in the visitation area, where the male continued exhibiting stereotypic behaviours and a high level of aggressiveness, frequently attacking the female and throwing faeces, sand, rocks and other objects at staff members and visitors. Due to these behaviours, the couple were transferred to an enclosure outside the visitation area, where they remained for one year. This enclosure was 4.0 × 5.0 × 2.0 m (length × width × height). The floor and water vessel were made of cement (Figure 1[upper]). The only enrichment was a leather ball. Meals were composed mainly of tropical fruits and polenta, including milk and eggs. Meat was offered once a week.

On 12 January 2007 the couple were transferred back to the visitation area to a recently enriched enclosure, located approximately 3.0 m from the visitors' pathway. This enclosure was 7.0 × 8.7 × 2.9 m and had a substrate covered by sand. It also contained a dead tree 2.0 m in height, logs, a water container and a 2.0-m long wooden footbridge with a net roof of reused fire hose (Figure 1[lower]). The rail of both enclosures was made of the same materials. The leather ball remained with the study subjects until the second observation period in this new enclosure (AT2, see below). It was removed before the beginning of the final observation period because it was damaged. The diet remained the same.

Study subjects were observed by the author *ad libitum* for three days before the beginning of the data collection to evaluate the applicability of an ethogram of chacma baboons (*Papio ursinus*) (Hartley 2002) and to improve it with the inclusion of stereotypic behaviours. The author spent a total of 350 h divided into four stages observing the baboons: (i) in the non-enriched enclosure before the transfer (BT); (ii) soon after the transfer to the enriched enclosure (AT1); (iii) six months after the transfer (AT2); and (iv) 12 months after the transfer (AT3). BT observations were made from 12 to 28 December 2006 for an average of 3 h per day, totalling 50 h. AT1 (12 to 31 January 2007), AT2 (3 May to 3 July 2007) and AT3 (4 January to 21 June 2008, but mostly [68%] in January and February) for an average of 4 h per day, totalling 100 h each. Observations were performed each day and all concentrated from 0800 to 1200h in the morning, thereby reducing the effect of the time of day on the behaviour of the study subjects.

The 'behaviour' (or 'all occurrences') sampling (Martin & Bateson 1993) was applied during 50 min each hour to estimate the rate of occurrence of stereotypic, social aggressive and social affiliative behaviours (Table 1). The frequency and duration (in [s]) of all behaviours were recorded using a handheld stopwatch. The remaining 10 min of each hour were spent recording all the behaviours of the study subjects by the focal-animal sampling (5 min for each individual; data not presented here). Stress-related male behaviours included faecal throwing, aggressive impulse, self biting, jaw chomping, masturbation, staring and repeatedly pulling and biting the same place of the enclosure rail. According to Kummer (1995), faecal throwing, staring and jaw chomping are confrontational behaviours observed in free-ranging hamadryas baboons, whereas self biting is a stereotypic behaviour widespread among primates (Dellinge-Ness & Handler 2006). The only stress-related female behaviour was turning around her own body (Mallapur & Choudhury 2003). Oral stereotypic behaviours, such as licking the enclosure wall, have been described for ungulates (Bashaw *et al* 2001; Bergeron *et al* 2006) and other animals (Swaisgood & Shepherdson 2005). In this paper, however, wall licking was not treated as a stereotypic hamadryas baboon behaviour because there was no support for such a theory in the literature.

The frequency and duration of each behavioural category performed by each individual were compared among the four stages using an ANOVA with bootstrap re-sampling (Yu 2003) with 1,000 repetitions ran in the software PASW Statistics 18. A *post hoc* Tukey-Kramer test was run when the behaviour varied among stages. Since frequency and duration data presented the same statistical results, only the first are shown here. The influence of the public was analysed by comparing the behaviour of the study subjects

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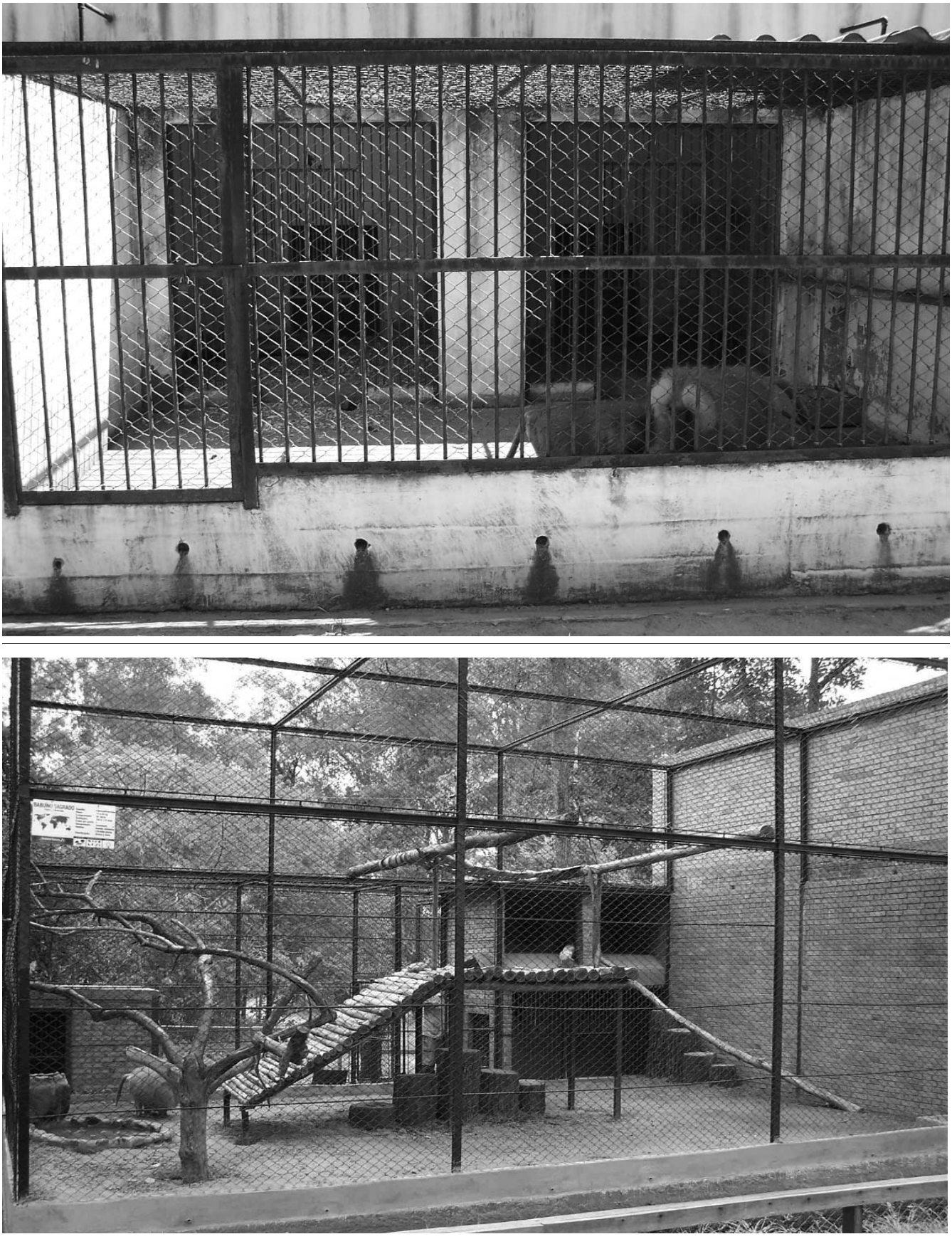
Figure 1



Small enclosure (upper) located in an area without access to the public, and larger and physically enriched enclosure (lower) located in the visitation area of the zoo.

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Table 1 Ethogram with the list of stereotypic, social aggressive and social affiliative behaviours of hamadryas baboons at the Sapucaia do Sul Zoological Park, Brazil.

Behaviour	Stress-related	Stereotypic
Aggressive impulse: male apparently bites one leg while quickly turning around its own body before running to the enclosure rail, grasping and shaking it	Yes	Yes
Self biting: male bites own leg repeatedly	Yes	Yes
Rail pulling: male pulls the enclosure rail repeatedly with both hands	Yes	Yes
Fence biting: male inclines head 90° and bites the enclosure rail	Yes	Yes
Ball biting: individual bites the leather ball quickly, shaking its head	Yes	Yes
Spinning: individual spins its body 360° at the corner of the enclosure once or several times	Yes	Yes
Throwing: male throws faeces, sand, rocks or other objects towards visitors or staff members	Yes	Maybe
Jaw chomping: individual, typically the male, chomps his jaws quickly; sometimes the teeth impact is audible; an aggressive behaviour	Yes	Maybe
Staring: individual raises its eyebrows staring at its mate or at a person	Yes	No
Masturbation	Yes	No
Wall licking: individual licks the enclosure wall	Maybe	Maybe
Supplantation: individual supplants the other without any apparent interaction	Probably not	No
Unsuccessful supplantation: male walks towards the female, apparently trying to supplant her, but she resists, not allowing him to take her place, sometimes vocalising	Probably not	No
Grooming: individual grooms the fur of its mate	No	No
Digging: individual digs the substrate with a single or both hands	No	No
Bark removal: individual manually removes the bark of a tree trunk	No	No
Belly exposure: female exposes her belly while lying on her back with arms and legs extended	No	No

between Sundays and Mondays in the AT1 (n = 15 days of data collection in each) and AT3 (n = 12 for Sundays and n = 8 for Mondays) stages by the independent *t*-test with bootstrap re-sampling with 1,000 repetitions. These days were compared because the zoo is closed to the public on Mondays, whereas the largest numbers of visitors are observed on Sundays (RP Leal, personal communication 2008); it was not possible to get data on the actual number of people visiting the zoo in each sampling day. This analysis was not run for the AT2 stage because there were too few observations on both Mondays and Sundays.

Results

Among the stereotypic or stress-related behaviours displayed by the female only, spinning showed a decrease in frequency after the transfer of the study subjects to the enriched enclosure ($F_{3,345} = 96.57$, $P < 0.001$), whereas ball biting increased in AT2 ($F_{2,246} = 3.46$, $P = 0.03$). Other behaviours showed an increase in at least one post-transfer stage (grooming: $F_{3,295} = 12.62$, $P < 0.001$; wall licking: $F_{3,295} = 2.9$, $P < 0.03$; belly exposure: $F_{3,345} = 21.37$, $P < 0.001$) (Figure 2).

Jaw chomping was the most common male behaviour, and its rate of occurrence decreased from BT (10.1 events h^{-1}) and AT1 (12.2 h^{-1}) to AT2 (5.0 h^{-1}) and AT3 (5.9 h^{-1}; $F_{3,345} = 51.97$, $P < 0.001$; data not shown in Figure 3). Two other stereotypic or stress-related male behaviours decreased in at least one post-transfer stage (aggressive impulse: $F_{3,345} = 4.96$, $P < 0.01$; fence biting: $F_{3,345} = 13.30$, $P < 0.01$), whereas rail pulling ($F_{3,345} = 13.30$, $P < 0.001$) and throwing ($F_{3,345} = 4.09$, $P < 0.01$) increased. Self biting remained similar from BT to AT2, increasing significantly in AT3 ($F_{3,345} = 13.36$, $P < 0.001$). Whereas wall licking was the only other behaviour to show an increase after transfer ($F_{3,345} = 13.56$, $P < 0.001$), grooming ($F_{3,345} = 17.26$, $P < 0.001$), supplantation ($F_{3,345} = 32.86$, $P < 0.001$) and unsuccessful supplantation ($F_{3,345} = 17.17$, $P < 0.001$) decreased (Figure 3).

The transfer to the new enclosure also elicited the appearance of new behaviours. This was the case of digging by both individuals and bark exploration and removal by the female (Figures 2 and 3).

Throwing faeces was the only stress-related male behaviour that differed between days with more visitors compared to days with no visitors; being more frequent on Sundays than Mondays in both stages (means, AT1: 1.86 vs 0.06 events h^{-1}, $t_{28} = 3.73$, $P < 0.01$; AT3: 2.75 vs 0.25, $t_{18} = 2.96$, $P = 0.04$).

Discussion

The transfer of the adult couple of hamadryas baboons from a smaller and simpler cage with no access to visitors to a larger and structurally enriched enclosure at the visitation area of the Sapucaia do Sul Zoo showed distinct effects on the behaviour of the study subjects. Female spinning decreased and grooming increased, suggesting an improvement in welfare (see Mason *et al* 2007; Fernandez *et al*

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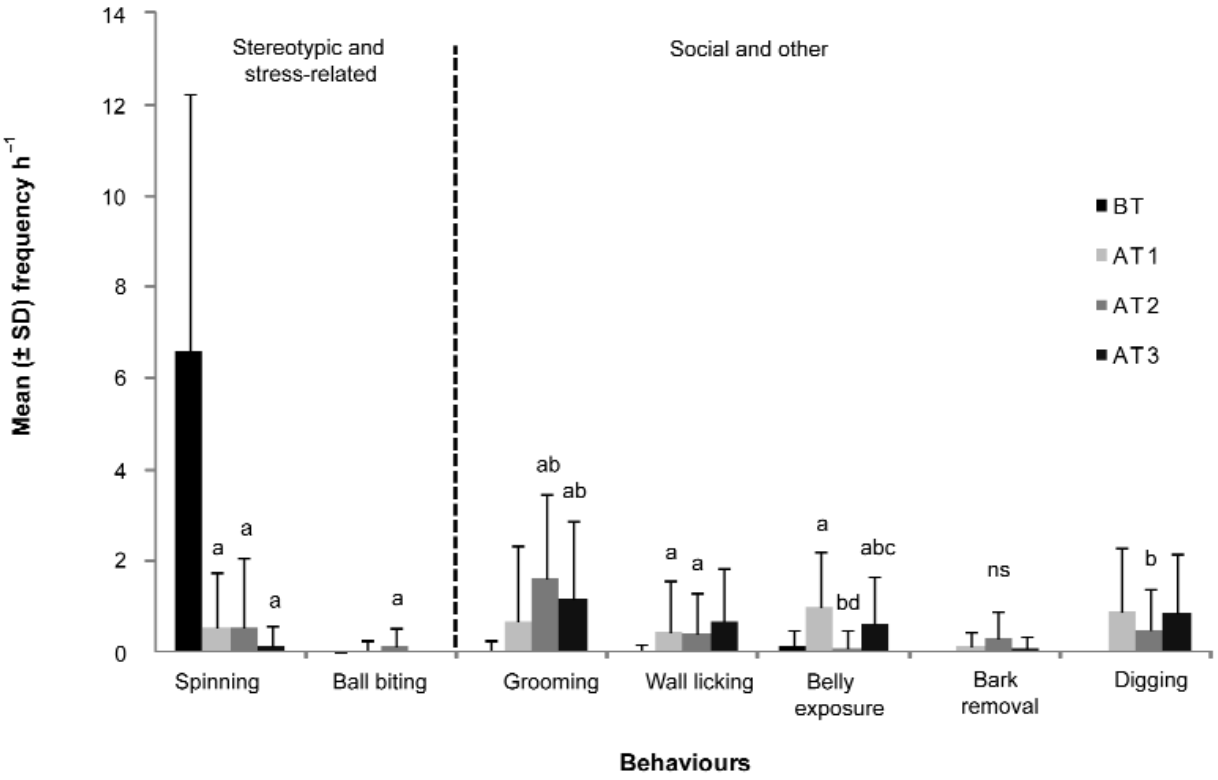
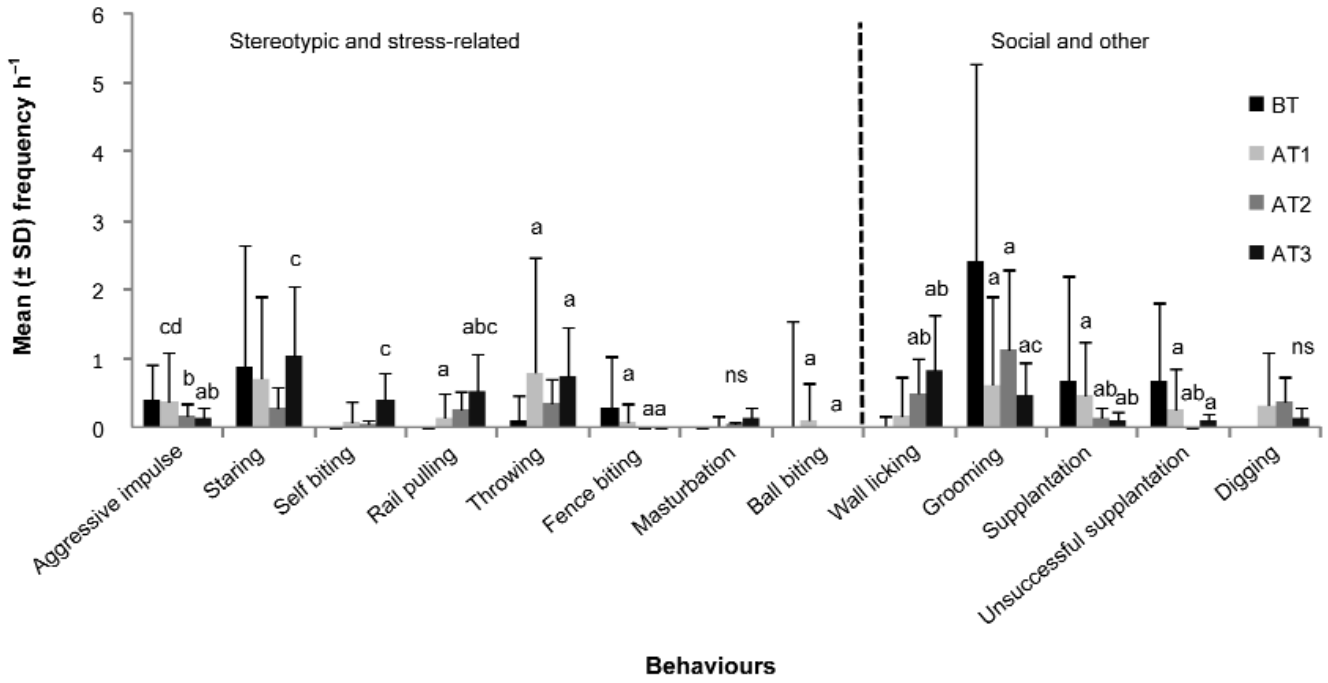
Figure 2



Rate of occurrence (average frequency of events h^{-1}) of each behaviour displayed by the female during the four stages of the research (behaviour abbreviations as per Table 1). Within each histogram (behaviour), letters indicate group classes; a = different from BT; b = different from AT1; c = different from AT2; d = different from AT3; $P < 0.01$ according to the *post hoc* Tukey-Kramer test with bootstrap re-sampling with 1,000 repetitions.

Figure 3



Rate of occurrence (average frequency of events h^{-1}) of each behaviour displayed by the male during the four stages of the research (behaviour abbreviations as per Table 1). Within each histogram (behaviour), letters indicate group classes; a = different from BT; b = different from AT1; c = different from AT2; d = different from AT3; $P < 0.01$ according to the *post hoc* Tukey-Kramer test with bootstrap re-sampling with 1,000 repetitions.

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2009). In the case of the male, the decrease in jaw chomping, aggressive impulse, fence biting and supplantation is compatible with an improvement in welfare, but the increase in self biting, rail pulling and faecal throwing, the decrease in grooming and the unchanged investment in masturbation point to a decrease in or maintenance of male well-being. Although the increase in allogrooming by the female could be related to an increase in female-directed male aggression (see Barrett *et al* 1999), the decrease in supplantation by the male lends no support to this hypothesis. The concomitant decrease in grooming, supplantation and unsuccessful supplantation by the male, on the other hand, suggests he spent less time interacting with his mate in the new enclosure. Therefore, this individual did not show a consistent change in the pattern of stereotypic and stress-related behaviours he used to display in the small enclosure with the female and also seemed to have maintained a high level of aggression as that reported by the zoo staff for when he was kept in another enclosure within a larger social group. However, both individuals showed directional changes in most behaviours throughout the study, suggesting that the environmental enrichment may have a long-term effect on their behaviour.

The increase in the exposure of the belly and the extension of arms and legs during the summer stages in the new enclosure (AT1 and AT3) probably have no relation to welfare. These behaviours are compatible with the hypothesis that this body posture has a thermoregulatory purpose aimed at increasing heat loss to the environment by increasing the surface-to-volume ratio as described by Stelzner and Hausfater (1986) for yellow baboons (*Papio cynocephalus*).

The sandy substrate and the availability of a dead tree in the enriched enclosure also allowed an increment of the behavioural repertoire of the study subjects by eliciting digging, a characteristic behaviour of wild baboons (Hamilton 1985), by both individuals throughout stages after transfer and bark exploration and removal by the female. There were no new behaviours related to the exposure of study subjects to a human audience as suggested by Hosey and Druck (1987).

The comparison between Sundays and Mondays suggests that only the male was negatively affected by the presence of the public, although only faeces-throwing towards the public was more frequent on Sundays. However, this stronger male reaction may be expected in a species whose reproductively active dominant males are capable of controlling the access of a cluster of up to 10 adult females in the wild (Jolly 2007).

Our results highlight the complex nature of managing wild animals in captivity (Mason 2010). Overall, whereas the new enclosure appeared to have had a positive effect on the welfare of the female, both the transfer and the exposure to the public were predominantly negative or neutral to the male.

Animal welfare implications

The physical enrichment of the larger exhibit elicited the appearance of behaviours that were not observed in the smaller cage, but it apparently displayed differing levels of efficiency in terms of improving the welfare of each study subject. Considering that dominant male hamadryas baboons are expected to behave aggressively towards potential competitors, it is possible that in the absence of same-sex conspecifics, the increase in frequency of faeces-throwing by the male after the transfer was triggered by another source of stress — exposure to visitors.

Other strategies for improving the welfare of hamadryas baboons at the Sapucaia do Sul Zoo could involve the distribution of foraging boxes at the enclosure (as performed by Jones & Pillay 2004), housing of the monkeys on islands to increase their distance from the public (as done previously at the zoo), reduction of the visual contact between the monkeys and the public by the establishment of barriers, such as rocks and shrubs, and 'blind' glasses instead of rails as fences, and education of the public and monitoring of visitors' behaviour.

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