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REGULAR ARTICLES

Effect of continuous female exposure on behavioral repertoire and stereotypical behaviors in restrained male dromedary camels during the onset of the breeding season

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Abstract This study aimed to test the effects of the three management systems on the behavioral repertoire and particularly on the incidence of stereotypical behavior in restrained camels. Five male camels were tested under the following management systems: (i) unexposed, housing in a single box (Unexpo); (ii) continuous exposure, exposed continuously to females (ConExpoF); and (iii) re-unexposed, housing again in a single box (Re-Unexpo). Every day, bulls were filmed for 30 min and videos were analyzed using a focal animal sampling ethogram. Under the ConExpoF system, camels spent the majority of time in standing with opened legs (490.0 ± 94.3 s), looking (925.0 ± 93.7 s), and walking toward the females (206.0 ± 73.4 s) and they ate and ruminated less compared to Unexpo and Re-Unexpo systems. Rumination and standing durations were significantly longer in Re-Unexpo than in Unexpo and ConExpoF management systems. When camels were continuously exposed to females, they showed few stereotypical behaviors compared to Unexpo (490.0 ± 146.1 s) and Re-Unexpo (624.0 ± 146.1 s) systems. The frequency of both total and oral stereotypes was significantly higher in Unexpo and Re-Unexpo systems compared to ConExpoF; however, no significant difference was observed among the three management systems in the frequency of locomotor stereotypes. Overall, it appears that the continuous female exposure system might be a suitable management practice for male camels used for intensive reproduction, as it decreases the manifestation of stereotypical behavior in comparison with housing for 24 h in a single box.

Keywords Behavioral repertoire · Dromedary camel · Management system · Stereotypical behavior

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Introduction

Camels are a multipurpose livestock species, with a high economic and agroecological importance in arid and subarid dry lands. In Africa, dromedary camels (*Camelus dromedarius*) are considered an important natural resource due to their ability to use harsh conditions providing efficient services in agriculture and valuable products (milk, meat, hair) (El Harrak et al. 2011; Faye 2014). The intensification of the breeding of this species for milk production (Hammadi et al. 2010; Nagy and Juhasz 2015) and sperm collection (El-Hassanein 2003; Monaco et al. 2013) has become more common in many countries. However, intensive management in camels could affect its behavioral repertoire (Fatnassi et al. 2014) and might lead to the development of abnormal behaviors (Padalino et al. 2014), and to impaired reproduction and reduced productivity, as also demonstrated in other domestic species like dairy cows (Flower and Weary 2003) and horses (McDonnell

2000; Stout 2005). Different indicators such as production (performance, yield), physiological (endocrine changes, cardiovascular responses), and pathological indicators and ethological criteria such as abnormal behavioral patterns were used as welfare indicators (Keeling and Jensen 2009; Sarrafchi and Blokhuis 2013). Nevertheless, among these indicators, a stereotypical behavior appears to be advantageous since behavioral changes are often the earliest signs that can be found to indicate suboptimal living conditions (Dawkins 1998; Keeling and Jensen 2009).

For dromedary camels, the first identification and description of stereotypical behaviors were conducted by Padalino et al. (2014), who identified two general forms of stereotypes: locomotor and oral. The latter authors found that housing male camels in single boxes led to the development of stereotypical behavior, but the incidence of this behavior was reduced by allowing 30 min of social contact with females and 1 h of freedom in a paddock. However, there is still a gap of knowledge regarding the effects of other management systems on camel welfare and manifestation of stereotypy. Consequently, hypothesizing that the continuous exposure to females of male camels, used for artificial insemination, could reduce the incidence of stereotypical behaviors and consequently improve their well-being and performance, the aim of this study was to evaluate the effects of three different management systems (unexposed, re-unexposed, and continuous exposure to females) on behavioral repertoire and particularly on the incidence of stereotypical behaviors in dromedary camels at the beginning of the breeding season.

Material and methods

Animals

Five clinically healthy male dromedary camels, ranging in age from 6 to 17 years, with a mean body weight of 535 ± 43 kg and good body condition score (3.5 ± 0.35 arbitrary units; from 0 to 5 in accordance with Faye et al. 2001), were used for this trial. Camels had been reared under an intensive system at the Arid Lands Institute's experimental station in Medenine, Tunisia. Camels were fed with 6 kg oat hay at 9:00 a.m. and 3 kg concentrate supplement at 3:00 p.m. The feeding quantity and quality remained constant during the experiment. Water was available once every 2 days.

The experiments were conducted according to the protocols approved by the Italian Ministry for Scientific Research in accordance with EC regulations. No special permission for behavioral research on wild animals such as this study is required in Italy.

Experimental design

The study was conducted during the beginning of Tunisian breeding season (November–December 2013). Camels were tested under three different housing systems:

1. Unexposed group (Unexpo): Camels were housed in single boxes measuring 5 × 3 m with 3-m-high solid walls to the rear and side (see Fatnassi et al. 2014) (Fig. 1). They were restrained with a rope on the fetlock of the forelegs and were able to walk inside the box. No full contact with other camels was possible. Visual and tactile communication with the neighboring camels was possible through the bars. The boxes were located far from the female's pen, preventing them from seeing and touching any female camels.
2. Continuous exposure (ConExpoF): Each camel was housed in a paddock (150 m^2). In this system, camels were also restrained with a rope and were able to walk inside the paddock and to interact visually with the neighboring male camels. The paddock lies adjacent to the female herd's pen, bordering by a 130-cm-high wall separating the two enclosures (Fig. 1). Camels have a visual and auditory contact with pregnant and youngest females from 4:00 p.m. to 9:00 a.m. when they were in the pen, and they were continuously exposed to another group of non-pregnant females soon after calving.
3. Re-unexposed to females (Re-Unexpo): Camels were housed again in their singles boxes without any contact with females. Conditions are similar to those of the Unexpo management system.

Each experimental situation lasted 6 days and was preceded by 2 weeks of habituation period.

Behavioral data collection

Dromedary camels were filmed by a video camera (Sony Camcorder digital video) during 30 min every morning at the same time from 7:30 to 8:00 a.m. throughout the experimental period, without being disturbed by the operator. The videos were analyzed, and a focal sampling ethogram was filled (Altmann 1974). The ethogram is reported in Table 1. The duration of the subsequent behavioral activities was calculated (s/30 min): feeding, rumination, resting, standing, stereotyping, walking, opening legs, and looking outside.

The videos were analyzed again as reported by Padalino et al. (2014) (Table 2) to calculate the duration and the frequency of locomotor and oral stereotypical behaviors. The duration of locomotor stereotypical behavior was added to

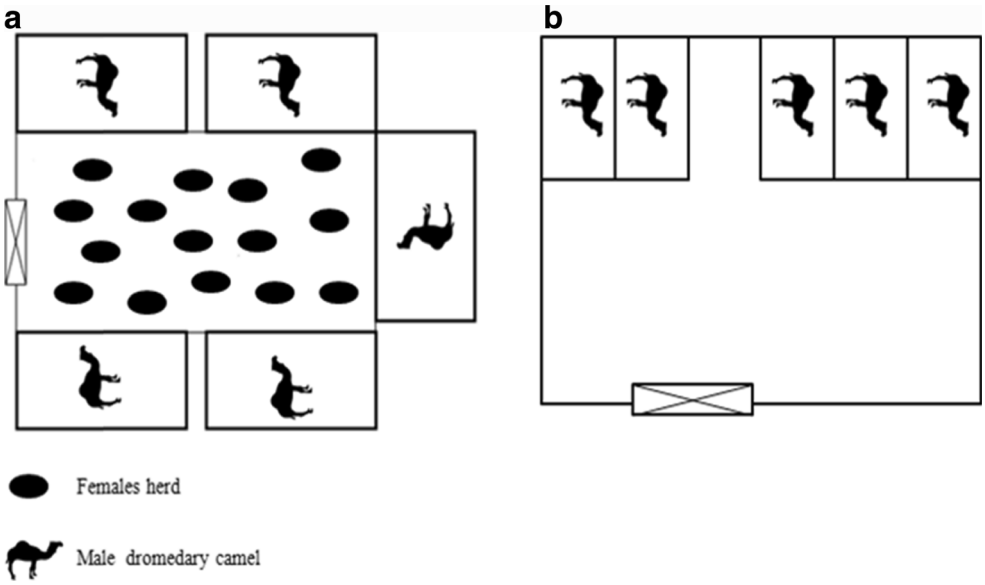

Fig. 1 The plan of housing systems of dromedary camels. **a** Continuous exposition to females (ConExpoF); each camel ($n = 5$) was housed in a paddock (150 m^2) with visual, auditory, and tactile contacts with females herd. **b** Housing in single boxes measuring 5 × 3 m with 3-m-high solid walls to the rear and side (Unexpo and Re-Unexpo systems)

the duration of the oral ones, and the sum was named "all stereotypical behaviors" duration. It was calculated (s/30 min) in the three different housing systems. The frequency (*n*/30 min) of the following behavioral events was recorded: locomotor and oral stereotypical behavior; the frequency of all stereotypical behaviors was also calculated, as the sum of locomotor and oral behaviors.

Statistical analysis

Behavioral activities and stereotypical behavior (both duration and frequency) were assessed through PROC mixed procedure (SAS, 9th version 1999). In the model, the random effect was camels. Management systems (Unexpo, ConExpoF, Re-Unexpo), period, and management systems × period interaction were specified as fixed factors. A least significant difference (LSD) test was used to perform statistical multiple comparison ($P < 0.05$). Results are presented in least square mean ± standard error (SE).

Results

The duration of all behavioral activities recorded during the 30-min observation period in the three different management systems is reported in Table 3. The effect of management systems on behavioral activities was significant except for resting ($df = 2$; $F = 0.74$; $P = 0.4786$). No significant difference was observed in the period and in the interaction between period and management systems except for standing behavior ($df = 10$; $F = 1.99$; $P = 0.04$).

Under the ConExpoF system, camels spent more time ($P < 0.05$) in looking and walking toward the females; they ruminated and ate less compared to Unexpo and Re-Unexpo systems. Rumination and standing behaviors were

Table 1 Ethogram used to score the videos

Behaviors	Description
Feeding	Picking up food with its mouth and chewing on it
	Feeding on hay or concentrate while either standing or resting
Rumination	Regurgitating food, chewing, and swallowing it again while standing or lying down/
Resting	Lying on floor
Standing	No movement
	Standing in stationary position on all four feet
Stereotyping	A repetitive, unvarying movement with no apparent goal (Mason 1991)
Walking	Moving around the box or in the pen
	Walking in no distinct pattern (not pacing)
Opening legs	Standing stationary with back legs opened
Looking outside	Camels put their heads outside the box through the window or between the bars of the gate

Table 2 Description of stereotypical behaviors shown by housed dromedary camels ($n = 5$) (adapted from Padalino et al. 2014)

Categories	Behavior	Description
Locomotors	Head shaking	Camel raised his head to the vertical with a very fast movement; it is often combined with pacing behavior
	Pacing in a circle	Camel walked to the other side of his box, following the same path which described a circle
	Balancing with back legs	Camel remains stationary but shifts its weight from one foreleg to the other and swings its head from side to side
Oral	Self-biting	Camel bit different parts of his own forelegs (right or left) from the shoulders to the feet
	Bar-mouthing	Licking, biting, or playing with the lips on the bars
	Wall licking	Licking wall with the lips or tongue

significantly greater in Re-Unexpo than in Unexpo and ConExpoF management systems.

Less stereotypical behaviors were observed in the ConExpoF system compared to Unexpo and Re-Unexpo systems. In these two latter systems, camels showed two different kinds of stereotypic patterns of behaviors, including locomotors like pacing in a circle, head shaking, and balancing with back legs and oral behaviors such as self-biting, bar-mouthing, and wall licking. The highest duration of all stereotypical behaviors was recorded in the Re-Unexpo system (Fig. 2).

When camels were continuously exposed to females, the frequency of all stereotypical and oral behaviors was lower ($P < 0.05$) compared to Unexpo and Re-Unexpo systems (Fig. 3). No significant difference was observed in the frequency of locomotor stereotypes among the three management systems.

Discussion

The current study aimed to evaluate the effects of three different management systems on the behavioral repertoire and particularly on the incidence of stereotypy in restrained male dromedary camels during the beginning of the breeding season. As hypothesized, the continuous exposure to female (ConExpoF) reduced the incidence of stereotypy. The benefit to rearing a male camel in a paddock with exposure to females is also supported by the significant increase in the duration of walking, opening legs, and looking outside activities in the ConExpoF system compared to Unexpo and Re-Unexpo housing systems. Our results are in agreement with the literature (Fatnassi et al. 2014; Bhakat et al. 2005); it has indeed found that 30 min of daily exposure of male to females had a positive impact on behavioral repertoire and mainly on rutting behaviors. Thus, rearing male camels in a system which increases their opportunities to social interaction with females seems to safeguard their well-being and stimulate also the expression of their natural rutting behaviors.

In the Re-Unexpo system, a significant increase in standing behavior was observed compared to other housing systems (ConExpoF and Unexpo), which could be explained by the lack of motivation and the poor situation of camels due to re-housing in single boxes. Horses also displayed motionless standing, when housed in a single stall, indicating their depressed state (Fureix et al. 2012). In response to individual housing, also dogs stood more and walked less (Beerda et al. 1999). In addition, changing management systems from ConExpoF to individual housing (Re-Unexpo) was associated with a significant increase in rumination behavior,

Table 3 Duration of the behavioral activities (s) recorded during a 30-min observation period in housed dromedary camels ($n = 5$) in three different management systems: housed in a single box for 24 h (Unexpo), continuous exposure to females (ConExpoF), and housed again in a single box (Re-Unexpo)

	Unexpo system	ConExpoF system	Re-Unexpo system
Feeding	312.0 ± 69.6^{a}	46.0 ± 69.6^{b}	246.0 ± 69.6^{a}
Rumination	100.0 ± 71.6^{b}	22.0 ± 71.6^{b}	294.0 ± 71.6^{a}
Resting	4.0 ± 11.4	20.0 ± 11.4	22.0 ± 11.4
Standing	128.0 ± 46.5^{b}	64.0 ± 46.5^{b}	266.0 ± 46.5^{a}
Stereotyping	490.0 ± 146.1^{a}	0.1 ± 146.1^{b}	624.0 ± 146.1^{a}
Walking	0.1 ± 73.4^{b}	206.0 ± 73.4^{a}	0.1 ± 73.4^{b}
Opening legs	440.0 ± 94.3^{a}	490.0 ± 94.3^{a}	178.0 ± 94.3^{b}
Looking outside	326.0 ± 93.7^{b}	925.0 ± 93.7^{a}	170.0 ± 93.7^{b}

In each row, different superscript letters indicate significant difference ($P < 0.05$)

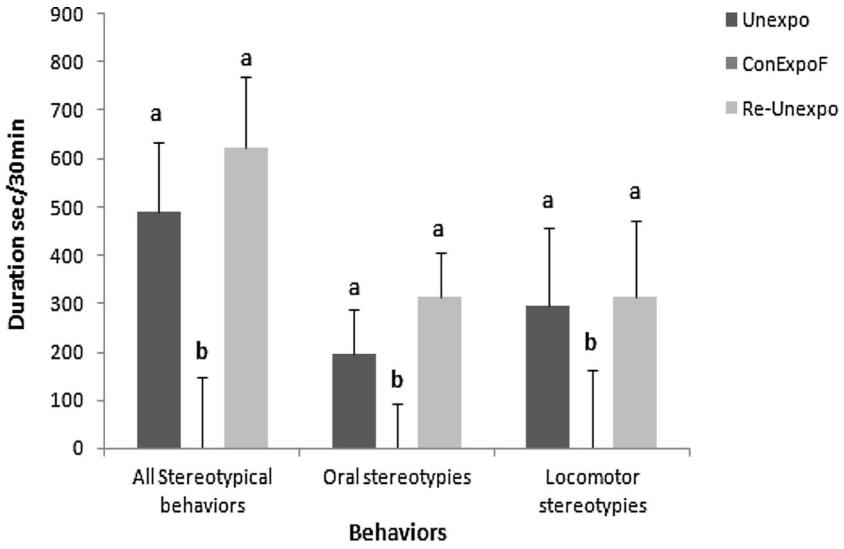

Fig. 2 Effect of three different management systems: housed in a single box for 24 h (*Unexpo*), continuous exposure to females (*ConExpoF*), and housed again in a single box (*Re-Unexpo*) on the duration (s/30 min) of stereotypical behaviors shown by male dromedary camels ($n = 5$). All stereotypical behaviors (the sum of oral and locomotor stereotypies) and oral and locomotor stereotypies. Different *superscript letters* indicate values with significant difference ($P < 0.05$)

which, in turn, linked to increased feeding time as shown in bulls (Hoyer 2013). Rumination has been defined as an anti-boredom activity, and its frequency may increase due to movement restriction and social isolation (Hoyer 2013). In H24 and H23 systems, Fatnassi et al. (2014) reported that male camels spend the majority of their time in rumination and feeding behaviors; however, the duration of these latter behaviors was significantly reduced when camels were regularly exposed to females for 30 min. Our data showed a similar situation; thus, the significant decrease in feeding and rumination behaviors in the ConExpoF system may be a response to sexual arousal of male camels due to the continuous exposure to females, mainly those non-pregnant which were probably in oestrus. Normally in the rutting period, camels become more excited and stimulated, showing a significant reduction in dry matter intake and, consequently, a decrease in their body weight, as reported previously in dromedary camels (Skidmore 2000; Bhakat et al. 2005).

Under Unexpo and Re-Unexpo management systems, camels spend most of the observation period performing stereotypical behaviors, with the highest duration recorded in the Re-Unexpo system. This might be explained by the boredom due to confinement and social isolation associated with the rearing condition of camel bulls, which is in agreement with the study carried out by Padalino et al. (2014). The latter authors reported indeed that the incidence of stereotypes was maximal when camels were housed in a single box (H24), considering as a suboptimal management system. After re-housing camels in a single box, they felt frustrated and disturbed, because in this condition, camels did not satisfy their normal need for moving and interacting with conspecifics, as observed in natural conditions. Thus, the manifestation of stereotypical behaviors could be a response to the lack of stimuli, the physical restriction of movement, and the frustrated

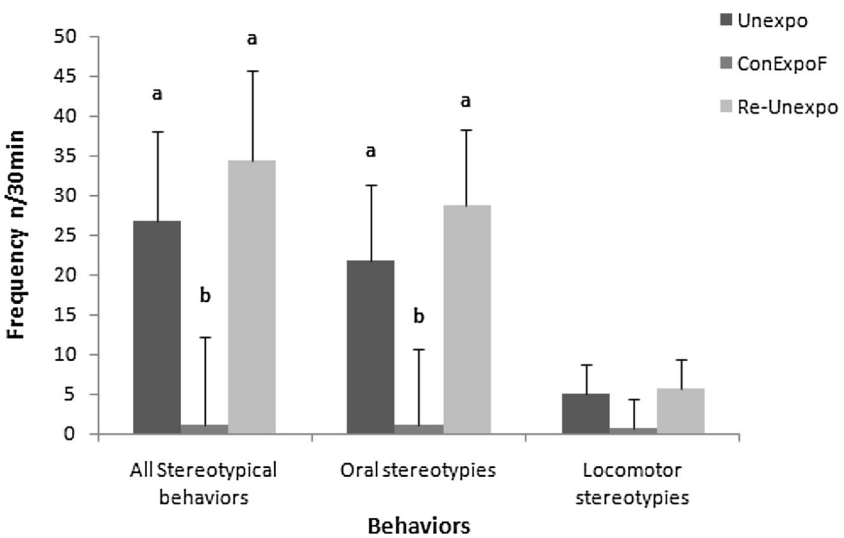

Fig. 3 Effect of three different management systems: housed in a single box for 24 h (*Unexpo*), continuous exposure to females (*ConExpoF*), and housed again in a single box (*Re-Unexpo*) on the frequency (*n*/30 min) of stereotypical behaviors shown by male dromedary camels ($n = 5$). All stereotypical behaviors (the sum of oral and locomotor stereotypies) and oral and locomotor stereotypies. Different *superscript letters* indicate values with significant difference ($P < 0.05$)

motivation of camels attempting to reinstate social contact. The expression of stereotypical behaviors was indeed significantly reduced during the ConExpoF system, confirming the importance of social contact with females on the suppression of these behaviors. These findings support the suggestion that increasing access to conspecifics and providing an opportunity to display natural behavior reduces stereotypical behavior, which is regarded as a sign of improved well-being (Cooper et al. 2000; Mills and Riezebos 2005; Wickens and Heleski 2010). More recently, Padalino et al. (2014) reported that spending 1 h of freedom in a paddock and interacting for 30 min with females significantly reduce the incidence of stereotypical behaviors in dromedary camels.

The frequency of stereotypical behavior (both stereotypical and oral) was significantly lower in the ConExpoF system compared to Unexpo and Re-Unexpo management systems; this is in accordance with our hypothesis and with a previous study of Padalino et al. (2014), who showed that the frequency of oral stereotypy such as bar-mouthing and self-biting decreased during exposure of male camel to females for 30 min, suggesting that exposure to females in the pen could be a better practice in managing dromedary camels. Contrary to our prediction, there is no significant difference in the frequency of locomotor behavior among the three management systems, because in these housing conditions, camels were tied with ropes to avoid injuries and accidents with the other males and also workers due to their aggressiveness. However, this situation could prevent their free movement, leading to the development of the frequency of locomotor stereotypical behaviors, which could be a response to the failed attempt of camels to break their enclosure. In the ConExpoF system, camels were not placed directly with females; they could see, smell, and/or touch them from the wall; nevertheless, the continuous presence of females can increase the desire of male not only to interact with females but also to have a full tactile contact with mating. Under this system, camels become extremely excited and the presence of a wall between the paddock and females allows the expression of such events of locomotor stereotypical behaviors like balancing and pacing, which are the result of frustrated attempt to escape from their situation.

This study is limited by the complete change of environment during the continuous female exposure, which does not elicit to distinguish between the effect of the paddock and the females. Notwithstanding this limitation, this study confirms that male camels show less stereotypy when reared in paddocks with the possibility to interact with females. Our finding is important to camel breeders and scientists, as scarce libido due to poor welfare condition is a common problem in camel breeding (El-Hassanein 2003; El-Bahrawy 2005). Based on our result, housing male camels used for artificial insemination for 24 h seemed to affect their well-being, rearing them in a paddock with the exposure to females appeared instead a suitable management practice, which could be applied in intensive production systems. To confirm this preliminary conclusion, further research is needed by increasing the time of observation period and testing the effect of ConExpoF system also on libido and semen quality in dromedary camel.

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Compliance with ethical standards Compliance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Conflict of interest The authors declare that they have no conflict of interest.

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