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Research

Fur chewing and other abnormal repetitive behaviors in chinchillas (*Chinchilla lanigera*), under commercial fur-farming conditions

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ABSTRACT

Fur chewing is a behavioral disorder frequently reported in chinchillas kept for fur-farming purposes. Rodents kept in barren cages usually develop some form of abnormal repetitive behavior, which can indicate a past or present welfare problem. Fur chewing may not be the only form of abnormal repetitive behavior present but is the one reported because of its direct repercussion on fur production. The aim of this study was to describe the frequency of occurrence of fur chewing and the distribution of time dedicated to it in chinchillas diagnosed as presenting this behavior. A secondary aim was to determine the presentation of other abnormal repetitive behaviors. Ten chinchillas, 5 fur chewers and 5 controls, were video recorded for 24 hours with an infrared camera. Behavioral analysis was done with The Observer XT from Noldus (The Netherlands). Focal sampling and continual recording were used, the 24-hour time budget was calculated, and abnormal repetitive behaviors were analyzed in terms of time dedication and frequency of presentation. A paired *t* test was used to compare differences in the amount of nocturnal versus daytime abnormal behavior. When normality was not met, a 2-sample *t* test and randomization test were used to compare data between treatments. No differences were observed between the time budgets of fur-chewing and control chinchillas, and all individuals exhibited more than one abnormal repetitive behavior. The amount of time devoted to abnormal repetitive behaviors was significantly higher during night in both groups and reached its lowest level between 13:00 and 17:00 hours. Fur chewing is not the only abnormal repetitive behavior developed by chinchillas in fur-farming systems, although it is the only one reported by the producer. The presence of bar chewing, cage scratching, and backflipping should also be welfare concerns. The higher presentation of abnormal repetitive behaviors at night may be associated with the lack of recognition by the producer, especially because these abnormal behaviors do not result in direct product loss as does fur chewing.

Introduction

The chinchilla (*Chinchilla lanigera*) is a hystricomorphic rodent endemic from the central and northern area of Chile (Cortés et al., 2002). The fur of chinchillas is one of the most valuable in the world, and the chinchilla has been domesticated, selected, and bred for its quality (Grau, 1986). The establishment of intensive chinchilla fur-farming systems has led to the development of fur-chewing or fur-biting behavior, where the chinchilla either continuously or intermittently chews its own fur from the lumbar area down to the tail (Ponzio et al., 2007). The chewed areas are usually covered by short hair and the skin turns darker because of hyperpigmentation, resembling the distinctive lesions of hyperadrenocorticism in dogs (Tisljar et al., 2002). By 1962, it was estimated that 30% of chinchillas in fur-farming systems were affected by this abnormal behavior (Rees, 1962). Tisljar et al. (2002) reported an incidence of 15%-20% in Croatia, but more recent studies estimate that between 3% and 15% of chinchillas are affected in Poland and Chile (Lapinski et al., 2014; Tadich et al., 2013). The etiology of the behavior is still unknown. Several theories have been postulated among which malnutrition, bacteriologic, mycological, and parasitological theories have been rejected. Environmental stress and hyperadrenocorticism remain as possible causes (Ponzio et al., 2007; Tisljar et al., 2002).

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Abnormal repetitive behaviors (ARBs) have been associated with barren and restrictive conditions that may contribute to fear, stress, or frustration (Mason, 1991). The development of these abnormal behaviors may be partially due to effects on the time budget of these individuals, which restricts allocation of behaviors within (Kiley-Worthington, 1987). Most rodent species develop ARBs when kept in barren cages (Würbel, 2006). Among different rodent species, there are differences in the frequency and type of behaviors shown. Approximately 50% of laboratory mice develop some kind of these repetitive abnormal behaviors, being the most common bar biting. Reports for rats remain anecdotal (Würbel and Stauffacher, 1994). ARBs are also common in gerbils (*Meriones unguiculatus*) (Wiedenmayer, 1997) and bank voles (*Clethrionomys glareolus*) (Ödberg, 1986) but less frequently observed in guinea pigs (*Cavia porcellus*) (Würbel, 2006).

ARBs are important because they may have a deleterious effect on the animal's welfare, health, productive, and reproductive performance. It has been established that 68% of the situations that favor the development of ARBs are also causal factors of poor welfare (Mason and Latham, 2004) and can be used as welfare indicators (Parker et al., 2008). In the case of chinchillas, fur chewing has been studied because of the economic consequences in the fur production system. Because of their nocturnal habits, chinchillas may develop other ARBs in response to environmental stress, and these behaviors would not be observed by the producer. Accordingly, the aim of this study was to describe the time budget of chinchilla behaviors and quantify the presentation of ARBs in chinchillas diagnosed as fur chewers, compared with those not identified by the producer to exhibit such behavioral disorders.

Materials and methods

Animals

The experiments were performed in a chinchilla farm located in central Chile. The farm fulfilled all the requirements for fur production, holding a valid permit under the Servicio Agrícola y Ganadero. To establish whether fur chewing was the only ARB present in the fur-farming system, the amount of time dedicated to ARB and the distribution or the time spent performing ARB (day or night), 2 groups of animals were used: group 1 (fur chewing) included 5 chinchillas classified as severe or moderate fur chewers, whereas the second group (control) included 5 chinchillas classified as nonfur chewers. Each chinchilla was categorized during preexperimental trials as described by Ponzio et al. (2007).

Behavioral observations

Behavioral data were collected using focal animal and continual sampling over 24 hours. Each animal was videoed using infrared cameras. Chinchillas were kept in their individual cages, under their normal husbandry practices, and with a day/night cycle of 11:13 hours. The video information was captured and stored using a digital video recording system and an external memory drive.

The behaviors of interest were classified either as maintenance or ARBs according to preexperimental observations. See Table 1, Table 2, and Figure 1 for further descriptions of the behaviors recorded. The duration of each behavior was individually documented by the same observer using the software The Observer XT 2011 (Noldus Software). The behaviors were analyzed in terms of duration (behavioral states) and in terms of frequency (behavioral events) according to Martin and Bateson (2007).

Table 1
Ethogram of maintenance behaviors observed in chinchillas kept in commercial fur-farming systems

Category	Behavioral patterns included
Resting	Sleeping, sitting, lying down
Feeding	Caecotrophy, exploration of feed, eating pellets or alfalfa, drinking
Locomotion	Climb, crawl, walk
Self-directed	Rolling, grooming, shaking, face washing, dust bath
Other behaviors	Play, exploring nonfeedstuff materials, urination, defecation

Statistical analysis

The time budget was analyzed using descriptive statistics and included both maintenance and ARBs. To compare differences among and within groups, the sum of the minutes dedicated to ARB for each individual was classified depending on whether they occurred in the day or in the night. Data were log transformed. To determine differences in the amount of ARB between day and night, we used a paired t test. Finally, to determine differences among groups, we used a 2-sample t test and a randomization test when the assumptions of normality were not met. We accepted a level of $P < 0.05$ as significant. All the analyses were performed using R version 3.0 (R Foundation for Statistical Computing, Vienna, Austria) (R Core Team, 2012).

Results

A total of 7200 minutes (120 hours) were analyzed for the 10 chinchillas. The overall time budget for 24 hours of both groups is shown in Figure 2. Resting and feeding were the main activities for both groups, accounting for over 80% of the time, followed by ARBs, regardless of whether the chinchilla was considered to be in the fur-chewing group. No significant differences between the time budgets of fur-chewing and control chinchillas were found (ARB, $P = 0.42$; self-directed, $P = 0.15$; resting, $P = 0.09$; other behaviors, $P = 0.69$; locomotion, $P = 0.64$; feeding, $P = 0.13$).

Fur-chewing and control chinchillas presented more than one ARB. The time dedicated to, and the frequency of presentation for each behavior is described in Table 3. Although fur-chewing behavior was present in both groups, the number of events was higher in the fur-chewing group. Bar chewing was the most frequent ARB in both groups of chinchillas, in terms of time dedication and number of events. No significant differences were found between control and fur-chewing chinchillas for the time dedicated or the number of events per day for each ARB registered ($P > 0.05$, Table 3).

When comparing the temporal allocation of ARB, both groups showed differences in the pattern of presentation (Figure 3), but their total daily amount of time spent performing the ARB was

Table 2
Ethogram for abnormal repetitive behaviors observed in chinchillas kept in commercial fur-farming systems

Behavioral pattern	Description
Bar chewing, bar gnawing	Subject bites cage bars while holding bars with their paws
Scratching cage or box	Subject scratches cage actively, usually with forepaws and usually in a crouch posture
Backflipping	Subject actively propels itself with its hind legs from the floor to either the wall or ceiling, then drops head first with front feet contacting the floor first
Fur chewing	Subject chews its own fur from the lumbar area down to the tail, either continuously or at intervals

Figure 1. Illustration of some of the abnormal repetitive behaviors observed in 10 chinchillas kept in a fur-farming system: fur chewing, backflipping, and cage scratching, respectively.

similar (permutation test, Z = 1.0772, $P = 0.317$). The fur-chewing group peaked in ARB between 19:00 and 00:00 hours, whereas the control group peaked between 1:00 and 6:00 hours. The ARB decreased in both groups during the day reaching the lowest levels between 13:00 and 17:00 hours. When day/night regimes were compared, both groups showed significantly higher amounts of time devoted to perform the ARB during the night (paired *t* test; fur-chewing group, $t = -8.05$, $P = 0.0012$ and control group, $t = -7.39$, $P < 0.001$) (Figure 4). Comparisons of the groups' within day regime revealed no significant differences either during the day (permutation test, Z = 1.74, $P = 0.09$) or the night (permutation test, Z = 0.59, $P = 0.58$).

Discussion

Fur-chewing (fur-biting) behavior in chinchillas kept in fur-farming systems has been widely studied (Kersten, 1997; Tisljar et al., 2002; Ponzio et al., 2007, 2012), mainly because of the negative economic effect it has on the productive system.

This behavioral disorder is easy to recognize by the producer because fur can be observed as shorter, darker, and in the more severe cases it can affect a large portion of the animal's body (Rees, 1962). On the contrary, other behavioral disorders may pass unnoticed by the producer because no evident productive effect is perceived or because they are not recognized as a disorder. Regardless, these behavioral disorders may be affecting the welfare of the individuals. The inability of producers to recognize any ARB that differs from fur chewing as a behavioral disorder is supported by our results. We found that even chinchillas selected as control chinchillas by the farmer presented more than one ARB.

In the present study, we obtained the 24-hour time budget (Figure 2) of a group of control chinchillas (not fur chewers) and a fur-chewing group. Chinchillas dedicated most of their time to resting behaviors (>60%), followed by feeding. The proportion of time dedicated to resting is similar to the percentage of time reported by other authors (Lanski and Sepesi, 1996; Dzierzanowska-Goryn et al., 2005), where it was also observed that this behavior occurred mainly during daylight hours. These results were expected considering the nocturnal habits of chinchillas (Jiménez, 1995). Time allocated to feeding behavior was also similar to previous studies in captive chinchillas (Lanski and Sepesi, 1996; Dzierzanowska-Goryn et al., 2005), but no time budgets for wild chinchillas were found in the available literature, so we cannot know if production systems have significantly altered this behavior.

An unexpected finding was that both groups spent more time in ARBs than in locomotion, self-directed, and other behaviors. This confirms that fur chewing is not the only behavioral disorder developed by chinchillas in fur-farming systems. Among the ARB observed, bar chewing (wire gnawing, bar mouthing) was the most common in both groups (Table 3). Bar chewing has also been reported as the most frequent ARB in rodents (Würbel and Stauffacher, 1994), followed by fur chewing, backflipping, and cage scratching (Figure 1). No significant differences in the time allocation or number of events between groups were observed, although the total number of events of fur chewing was lower in the control group, and probably executed at a lower intensity. The lower intensity at which the behavior is performed could explain inapparent fur damage and may be the reason why these chinchillas were not classified as fur chewers by the producer.

Most rodents develop ARB when kept in cages (Würbel, 2006), and these behaviors that have been well documented for those kept for research purposes (Würbel and Stauffacher, 1994; Wiedenmayer, 1997; Ödberg, 1986). In fur farming, housing conditions usually consist of barren cages and restricted social contact, as in laboratories, it is not surprising that these behaviors also occur in this industry.

ARBs occurred in a significantly higher frequency during night, with a peak between 23:00 and 01:00 hours (Figure 3). This

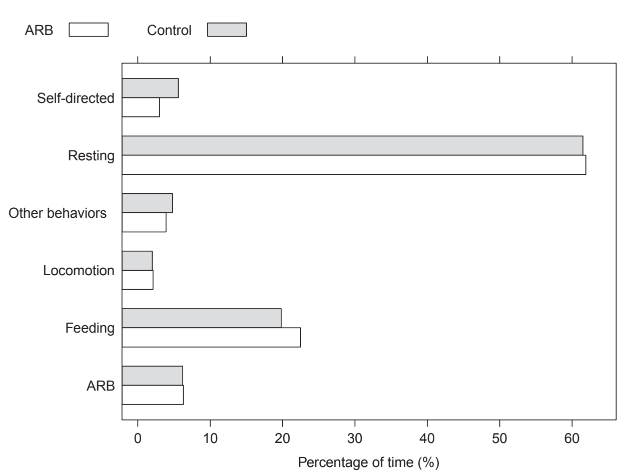

Figure 2. Time budget for control and fur-chewing chinchillas represented by the percentage of time allocated to each behavioral category. ARB, abnormal repetitive behavior.

Table 3
Average time dedication (%) and average number of events per day of abnormal repetitive behaviors for each group (control and fur chewing)

Behavioral pattern	Daily time dedication (%)			Total N events (24 h)		
	Control (n = 5)	Fur chewing (n = 5)	*P*-value	Control (n = 5)	Fur chewing (n = 5)	*P*-value
Bar chewing	4.6	4.5	0.38	335	343	0.40
Scratching cage	0.03	0.06	0.40	37.2	26.8	0.18
Backflipping	0.13	0.23	0.35	62.2	69.6	0.19
Fur chewing	1.57	1.52	0.42	133.4	173.2	0.33

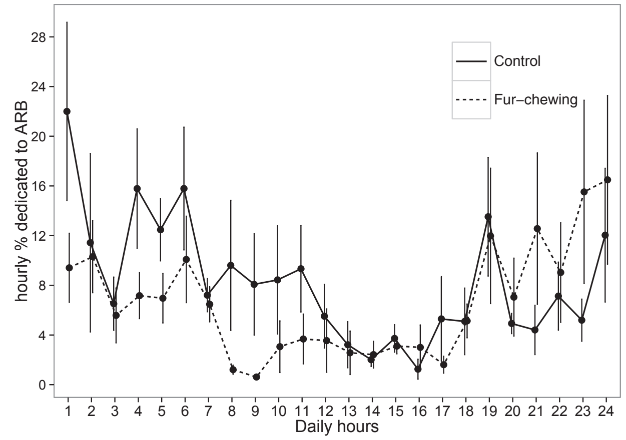

Figure 3. Daily patterns of abnormal repetitive behavior (ARB) in a group of chinchilla categorized as fur chewers (n = 5) and in a control group (n = 5). Represented are the mean and standard error.

periodicity could be related to the nocturnal habits of chinchillas, when they are more active. A similar finding was reported for tigers, where stereotypic behavior peaked during day hours (10:00-11:00 hours and 15:00-16:00 hours), concordant with the peaks in activity of these animals (Mohapatra et al., 2014). These authors propose that the activity patterns result from the interaction of the individuals' endogenous rhythm, entrainment mechanisms, and cues from the environment (Mohapatra et al., 2014). The greater and more frequent presence of humans during the daytime, and daytime management practices, could act as an environmental negative cue for the performance of ARBs in chinchillas which works together with a general reduction of activity during this period, because of their nocturnal endogenous rhythm. Humans are a known stressful stimulus, causing fear and anger, and together with loud noises and visits by guests, have been documented as possible triggers of fur chewing in particular (Tisljar et al., 2002; Ponzio et al., 2007). Such factors could also be involved in the development of other ARBs. Chinchillas could respond to the stressful stimulus present during day with a reduction in activity as a fear response, and then increase the performance of ARB during night hours.

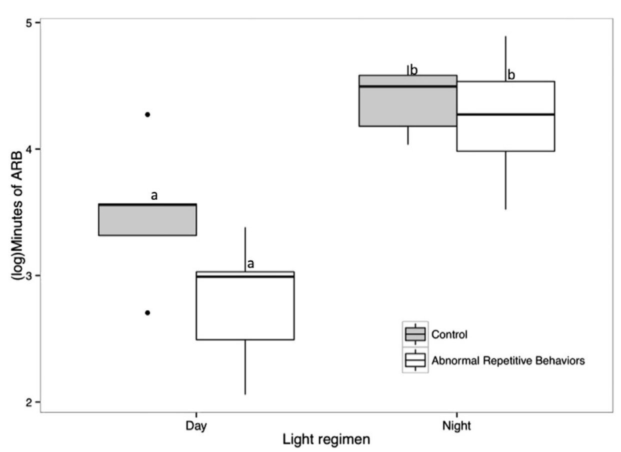

Figure 4. Total daily time dedicated to abnormal repetitive behaviors (ARB) (log transformed) in 2 groups of chinchillas categorized as fur chewers (n = 5) and a control group (n = 5). Within each group, the behaviors were categorized whether they occurred during the day or night. Different letters denote significant differences within group, between day and night.

The particular pattern of the ARB which develops can be associated with specific motivational states (Würbel et al., 1998). A better understanding of these motivational states can help us identify the behaviors triggered and their origin. For example, gerbils (*Meriones unguilatus*) develop stereotypic digging in the corner of cages when prevented from retreating into a burrow (Wiedenmayer, 1997), whereas bank voles (*Clethrionomys glareolus*) show locomotory stereotypies as response of escape attempts from cages (Ödberg, 1986).

Backflipping, bar chewing, and cage scratching have also been associated with escape attempts from the cage (Würbel et al., 1996; Gross et al., 2011a). In the case of bar chewing (wire gnawing), the most frequent behavioral disorder observed in this study, Würbel et al. (1996) concluded that its origin was related to intention movements of escape behavior, a theory that was later supported by experimental studies (Würbel and Stauffacher, 1997). Gnawing is a normal rodent behavior, for which twigs and other substrates are usually used in the nature. Inclusion of enrichment in the standard cages could facilitate this species-typical behavior and possibly decrease the frequency of development bar chewing in chinchillas, as has been described in laboratory mice (Würbel et al., 1998). Gross et al. (2011b) have also proposed that provision of nesting material could attenuate ARB development and other anxiety-related behaviors in mice, by encouraging behaviors as nest building, providing shelter, and facilitating thermoregulation. These factors may also be associated with the causes of fur chewing in chinchillas (Tisljar et al., 2002).

The condition of the housing system is considered an important risk factor for welfare problems. Single housing has been associated with an increased risk of ARB in other fur-farming animals such as foxes and mink (Ahola et al., 2002; Jeppesen et al., 2000). Chinchillas used for fur production are housed individually despite of their gregarious nature. This is also the case for laboratory rabbits, for which social stimulation (housing in pairs) has been shown to be biologically important and significantly reduces the rate of abnormal behaviors (Chu et al., 2004). Ponzio et al. (2007) reported 6 risk factors that influenced fur-chewing development in chinchillas: breeders' experience, total volume of the facility, space index, number of breeding rooms, allocation of different rooms for fur production and reproduction, and wood shaving changes per week.

Although the presentation of an ARB does not necessarily determine the presence of a welfare problem (Mason and Latham, 2004), Ponzio et al. (2012) found a significant increase of cortisol in female chinchillas that presented very severe fur-chewing behavior. This combination of data supports the concept that this particular behavior is stress related. The presence of these ARBs could then indicate an adaptative behavioral response by chinchillas, in attempt to cope with their internal or external environments (Garner, 2005).

Further studies should be undertaken to understand the factors involved in the development of these behaviors in chinchilla fur-farming systems and their possible negative effects on the animal, beyond the productive repercussions. Endogenous factors should also be considered, such as possible underlying genetic mechanism, because many owners have reported the perception of a hereditary predisposition to fur chewing (Lapinski et al., 2014).

ARBs and fur chewing in particular have been chosen by the WelFur Project as animal based measures for foxes and mink (Mononen et al., 2012), and could also provide a valid welfare measure for chinchillas in fur-farming systems. Because most of the time dedicated to ARBs is during night time hours, these disorders go undetected or underestimated. This is a particular concern for individuals who engage in bar biting, backflipping, and cage scratching, but who do not chew fur. The nocturnal habit of chinchillas should be taken into account when designing a welfare protocol in this specific fur-farming system. This becomes an important welfare concern, since no changes in husbandry practice can be undertaken if the behaviors are not detected.

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Ethical considerations

This study has been approved by the Bioethics Committee of the Facultad de Ciencias Veterinarias y Pecuarias, Universidad de Chile.

Conflict of interest

The authors declare no conflict of interest.

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