THE EFFECT OF HAY ON THE BEHAVIOUR OF CAGED RABBITS *(ORYCTOLAGUS CUNICULUS)*

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Abstract *Animal Welfare 1999, **8:** 149-157*

To examine the effect of hay on behaviour of caged rabbits, Oryctolagus cuniculus, *a study was carried out on 86 rabbits, kept in wire cages with no access to hay in one period and with access to hay in a second period. As the study was part of a larger experiment analysing the rabbits' behaviour in two different cage systems, the rabbits were equally distributed across two systems: a system with conventional barren wire cages, and an enriched system with boxes and raised height at the back of the wire cages. The rabbits' behaviour was recorded using direct scan sampling during the day and continuous registration based on video recording at night. When hay was available, the rabbits in both cage systems performed significantly less bar gnawing and excessive grooming. This applied especially to the rabbits kept in the conventional cage system which also showed a distinct decrease in their frequency of changing between different behaviours. This suggests that rabbits kept in cages where hay is available are less stressed than those kept in cages where it is not. Enrichment with hay should, therefore, be considered in attempts to improve the welfare of caged rabbits.*

Keywords: *animal welfare, behaviour, environmental enrichment, rabbits*

Introduction

In spite of many years of selective breeding of rabbits, several studies have shown that domesticated rabbits perform or try to perform many of the same elements seen in the behavioural repertoire of wild rabbits (Bell 1984; Vastrade 1986; 1987; Podberscek *et al* 1991; Love 1994; Held *et al* 1995).

In the wild, rabbits emerge from their burrows at dusk and spend most of the night above ground (Lockley 1961; Corbet & Southern 1977; Harkness & Wagner 1989; Fraser 1992; Gibb 1993). They spend much of their time and energy on foraging, mainly at dusk and dawn (Lockley 1961; Love 1994). By contrast, domesticated rabbits often receive food which is easy to consume and so their remaining time has to be occupied by other activities – yet the performance of other elements from the normal behaviour repertoire is often restricted in traditional cages. The temporal structure of their behaviour can be disrupted if the feedback from behaviour is not optimal because of environmental limitations on the full expression of the behavioural repertoire. This could result in an increased state of stress, in

an animal being more restless, ie changing its behaviour more frequently (Lehmann 1987; Metz 1987), and in it showing several kinds of abnormal behaviours such as bar biting, excessive grooming and stereotypic activity (Morton *et al* 1993; Love 1994).

Barren cage systems can be enriched by stimuli that will elicit patterns of behaviour which are otherwise limited in these systems, and the effect of stressors in the environment can be thereby ameliorated. It has been found that access to hay can provide such a stimulus in a number of species (Carson 1985). Access to hay can, therefore, be used for environmental enrichment, but it also offers additional benefits since the high fibre content of hay can reduce the incidence of diarrhoea (Adams 1987; Lidfors 1997).

The primary aim of this study was to investigate the effect of hay on the behaviour of caged rabbits. However, as the study was a part of a larger experiment, the data were also analysed for differences in the use of hay between the two cage systems.

Materials and methods

Subjects and cages

Forty-two female and forty-four male rabbits, all hybrids of New Zealand White and French Lop, were used in the experiment. All the animals were between 16 and 31 months old at the beginning of the observations. The rabbits were being concomitantly used in antibody production.

After weaning, all rabbits were singly housed in conventional cages until about 9 months before the beginning of the observations. At this time, half of the animals were housed singly in the enriched cage system. Animals were equally distributed between the two cage systems regarding sex, age and type of immunization.

The conventional cage was a wire cage, measuring 46x77x40 cm. A food-hopper, a water bottle and a brick of wood were attached to the front of the cage. A perforated plate of plastic was placed on the grid floor to avoid leg injuries. This plate covered the entire floor, except for approximately 16cm at the front of the cage to prevent the rabbits' drinking water from gathering. The enriched cage had the same construction, but, in addition, the rear 40cm of the cage was raised to 80cm in height and a wooden box (44x25x19 cm), with a roof of perforated plastic similar to the bottom plate, was inserted (for further details and a schematic drawing see, Hansen & Berthelsen [1996]). Twelve cages were placed in rows perpendicular to the central feed gangway in the animal house (a former stable).

Throughout the study, the rabbits were given 120g pelleted rabbit food rabbit^{-1} day^{-1} at 0730h (Kaninfoder DAKO, Chr Petersen A/S, Ringsted, Denmark), consisting of 15.2 per cent crude fibre. Tap water was always available. In the period when the rabbits had access to hay, it was available *ad libitum*. Ambient temperature in the stable in which the animals were housed varied from 11–12 °C during the experiment (and although this winter minimum was lower than current EU recommendations, veterinary inspections did not reveal any adverse effects on the behaviour or physical aspects of the rabbits). Light remained on between 0800h and 1600h (light cycle) and consisted of 12 fluorescent tubes supplying 0.8 W m^{-2}. The light intensity was further influenced by daylight from nine windows, each measuring 0.67 m^2. The dark cycle was between 1600h and 0800h, with dim light from three bulbs supplying 0.08 W m^{-2}.

Observations

The observations were performed over two discrete periods, during December 1995 and January 1996, respectively. During the first period the rabbits had no access to hay, while in

the second period hay was continuously present on top of the cages. The hay was made available a month before the beginning of the second observation period to allow the rabbits to acclimatize to it. One rabbit died in each cage system between the two periods. Observation times were adjusted around routine blood sampling and cage cleaning to minimize the effects of behavioural disturbance caused by these procedures.

Scan sampling was used in the daytime observations in order to allow a large number of animals to be observed. Behaviour was recorded by scanning the rabbits one by one, every 5min for 1h, five times a day between 0800h and 1600h (light cycle), over three successive days. To minimize disturbance to the animals, the observer waited in the stable for approximately 10min before walking slowly along the rows of cages and recording the behaviour of the animals which were approximately four cages away from the observer. The recordings were carried out with a Psion HC110© (Psion plc, Dataviz Inc, USA). During the dark cycle (between 1600h and 0800h), a video recording was made of 12 rabbits, 6 from each cage system. Red light was used during recording, since such light should not affect the behaviour of the rabbits (Horton *et al* 1974). The recordings were analysed using Observer©, version 3.0 software (Noldus Information Technology BV, Wageningen, The Netherlands), with continuous registration.

Ethogram

We developed an ethogram defining the behavioural elements to be recorded, based on Meijsser *et al* (1989), Gunn & Morton (1993) and Morton *et al* (1993). Its categories are elaborated below:

Active-head – sniffing at the surroundings with movement of the head and/or forelimbs. The hind limbs stay in the same place.
Ambulate – moving around the cage, although normal locomotory activity is not possible due to the confined space. This category also involves 'circling', where the rabbit attempts to run around in the cage.
Consumption – eating rabbit pellets from the food-hopper, drinking or coprophagy.
Gnawing – gnawing of the immediate environment such as bars, the wooden brick, nest box and plastic plate, occasionally interrupted by rapid scratching with the forelegs.
Grooming – licking, scratching or nibbling of the body.
Inactive – this was subdivided into three sub-categories:
- *Lying* – resting with the trunk on ground, and limbs tucked under the body or outstretched and belly exposed.
- *Rearing* – sitting/standing on the hind limbs with both forepaws off the ground.
- *Sitting* – rear end and forepaws on the ground with the forelimbs straight, the thorax and abdomen clear of the floor and visible. Ears down or erect.

Use of hay – stretching to reach hay, pulling straws down from the roof, eating hay while sitting. (In the conventional cage the rabbit could reach the hay while sitting stretched, but in the enriched cage the rabbit had to stand stretched.)

Statistical analysis

Data were analysed by two-way ANOVAs (Statistical Analysis Systems, version 6.10; SAS Institute Inc, Cary, North Carolina, USA) to compare the frequency (all observations) and duration (video recording) of behaviours and changes in behaviours recorded in the two periods, with or without hay available. The same tests were also used to analyse the behaviours for the effects of cage system, sex and time of observation.

The majority of the data had to be transformed (using a power transformation inherent in the SAS program) to meet the requirements for the parametric tests. If these could not be met, then Mann-Whitney *U* tests or Wilcoxon signed ranks tests were performed on the untransformed data.

Results

Scan sampling during the light cycle

The behavioural element 'Active-head' was performed at the highest frequency in both cage systems in the period when hay was available (all $P < 0.05$), while 'Grooming' was performed at the lowest frequency in both cage systems over the same period (all $P < 0.01$), see Figure 1. 'Consumption' and 'Gnawing' were also performed at their lowest frequencies when hay was available (all $P < 0.01$). This was mainly because of a decrease in their frequency of occurrence in the conventional cage system, and inferred from an interaction between period and cage system ($F = 4.5$, $df = 1$, $P = 0.08$). The relevance of these elements will be dealt with in the discussion. There were no significant differences between the frequencies of the remaining behavioural elements (Figure 1).

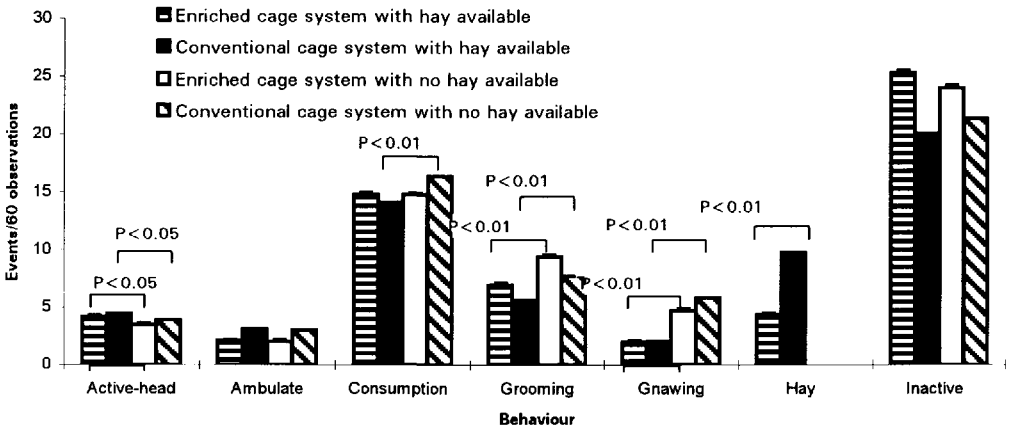

Figure 1 **Mean (± SEM) frequencies of behavioural elements individual^{-1} during scan sampling between 0800h and 1600h. The elements are divided into periods with (n = 84) and without (n = 86) access to hay and by cage system. Probabilities are as indicated: 'Consumption', 'Inactive' and 'Hay' were analysed by Wilcoxon signed ranks tests, all other comparisons by ANOVA.**

The rabbits kept in the conventional cage system made use of the hay ('Hay') with a higher frequency than rabbits kept in the enriched cage system ($P < 0.01$), see Figure 1. The frequency increased from 1315h to 1600h, particularly among the rabbits kept in the conventional cage system ($P < 0.01$), see Figure 2. There were no significant differences between the sexes in the frequencies with which they made use of the hay.

Video recordings during the dark cycle

The rabbits in the conventional cage system made use of hay for a longer mean duration than those in the enriched cage system ($P < 0.05$), see Table 1. 'Consumption' was performed for the longest duration in both cage systems in the period when hay was available ($P < 0.05$), see Table 1.

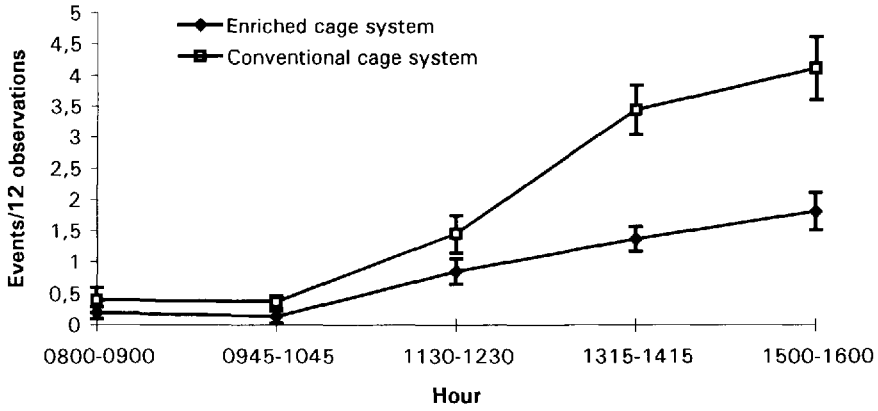

Figure 2 **Mean (± SEM) frequency individual^{-1} (n = 84) of the behavioural element 'Use of hay' during scan sampling between 0800h and 1600h, distinguished by cage system.**

The behavioural element 'Grooming' was performed for the shortest durations in both cage systems in the period when hay was available ($P < 0.01$), see Table 1. 'Gnawing' was also performed for shorter durations when hay was available, but the difference was not significant ($P = 0.08$). There were no significant differences in duration among the remaining behavioural elements.

In the period when hay was not available, the rabbits in the conventional cage system changed behaviour significantly more often than in the period when it was ($P < 0.05$), see Table 2. There was an interaction between period and cage system ($F = 4.2$, $df = 1$, $P = 0.06$).

Table 1 **Mean (± SEM) duration (min) of the behavioural elements individual^{-1} (n = 12) during video recording between 1600h and 0800h. The elements are divided into periods with and without access to hay, and by cage system.**

	Duration			
	Enriched cages		Conventional cages	
Behaviour	**Hay**	**No hay**	**Hay**	**No hay**
Use of hay	45.04 ± 1.89	-	84.26 ± 2.14	-
Active-head	23.98 ± 1.21	19.16 ± 0.94	22.5 ± 1.27	22.31 ± 1.27
Ambulate	8.04 ± 0.72	6.06 ± 0.71	10.19 ± 0.92	11.97 ± 0.93
Consumption[1]	74.56 ± 1.36	59.41 ± 1.98	60.48 ± 1.32	43.09 ± 2.21
Gnawing	1.16 ± 0.50	9.51 ± 1.37	4.61 ± 0.87	6.06 ± 0.94
Grooming[1]	152.48 ± 2.53	201.04 ± 1.89	176.27 ± 2.13	248.17 ± 2.98
Inactive[1]	653.15 ± 2.08	664.72 ± 1.97	601.31 ± 3.02	628.26 ± 2.93

[1] Wilcoxon signed ranks test used for comparisons, all other tests were by ANOVA.

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Table 2 **Mean (± SEM) frequency of changes between behavioural elements during video recording between 1600h and 0800h. The elements are divided into periods with and without access to hay, and by cage system (n = 12).**

	Frequency of changes (instances per 16h)	
Cage system	**Hay**	**No hay**
Enriched	531.83 ± 3.67	507.33 ± 5.13
Conventional	556.17 ± 4.49	721.00 ± 3.61

Discussion

Since hay had been placed on top of the cages every day for about 1 month before the beginning of the second observation period, the rabbits could be expected to have acclimatized to the hay. Thus, the observed changes in the behaviour could not be attributed to the animals being exposed to a new and unfamiliar stimulus.

Metz (1987) investigated the behaviour of rabbits in groups with and without access to hay, and found that rabbits made use of the hay in 11 per cent of the observations (over 24h). The data in the present experiment correspond with Metz's results, since the rabbits made use of the hay at a frequency of 7 per cent (of the 60 observations) in the enriched cage system and 16 per cent of the observations in the conventional cage system, respectively, during the light cycle (Figure 1). In the dark cycle, the rabbits made use of the hay for 5 per cent (enriched) and 9 per cent (conventional) of the total observation time (Table 1). The rabbits used the hay particularly in the afternoon (Figure 2) after the feeding pellets had been consumed. Although the restricted pellet allowance (120g rabbit^{-1} day^{-1}) agrees with the general recommendation of 90–150 g per rabbit^{-1} day^{-1} (Patton 1994), it is possible that some of the rabbits' use of hay was caused by hunger. If hunger had been the only reason for eating, one would expect the use of hay to have been similar in both systems, since the rabbits received equal amounts of pellets. However, this was not the case, and the rabbits in the conventional cage system made most use of the hay (Tables 1 and 2).

There could be several reasons for the differential use of the available hay. First, the hay was placed on top of the two cage systems in different ways: on conventional cages the hay was spread out on the roof of the cage, while on enriched cages it was placed only on the raised back 40cm of the cage where the rabbits had to stand outstretched to reach the hay. Thus, the access to hay was more difficult in the enriched cages and this in itself, could have decreased the frequency of its use. Second, the intensity and the duration of responses to a new stimulus are inversely proportional to the complexity of the animal's environment (Carson 1985). For pigs, Stolba and Wood-Gush (1980) found that the more barren the housing the stronger the reaction to a stimulus. Although the hay in this study was not a new stimulus, the rabbits kept in the barren system still reacted more strongly to the hay than those in the enriched system. This could indicate that hay provides a form of enrichment for rabbits, in which interest will not decline even after a longer period of exposure.

When the rabbits had experience of a more varied environment, ie access to hay and/or an enriched cage system, the frequency of changes between behavioural elements decreased (Table 2). Lehmann (1987) found an increased number of activity changes h^{-1} among caged rabbits as compared with rabbits housed under semi-natural conditions, and interpreted this as restlessness. Restlessness is evident when an animal does not complete ongoing activities, and interpreted as a behavioural sign of increased stress in the animal. Our results, therefore,

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suggest that hay can be used as an enrichment device to ameliorate the effects of a barren environment.

Several changes were seen in the rabbits' behaviours when they had access to hay. In the light cycle, exploring the surroundings ('Active-head') increased, as the rabbits were probably searching for straw which had fallen down to the bottom of the cage (Figure 1). Together with 'Use of the hay' and 'Consumption', foraging accounted for approximately 43 per cent of observations (in enriched and conventional systems) compared with 32 per cent of the observations in the period without access to hay. Access to hay, therefore, gave the rabbits the potential to perform a more natural behaviour, ie foraging, for a larger proportion of the 24h period.

The rabbits performed the behavioural element 'Inactive' for approximately the same duration in the dark cycle, whether hay was available or not; and the changes seen in the other behavioural elements did not indicate any significant change in activity within 24h (Table 1). Feeding in the mornings caused the rabbits to be active mainly during the day.

In caged rabbits, gnawing is mainly directed towards bars and wire in certain areas of the cage and is performed in a continuous and repetitive (or stereotypic) manner. Gnawing is therefore often characterized as abnormal behaviour (Morton *et al* 1993; Lidfors 1997). In this study, less than 1 per cent of the observed gnawing was directed at the brick of wood, the remaining 99 per cent being directed at the bars and plastic plate. When the rabbits had access to hay the frequency of 'Gnawing' decreased considerably and the difference between the cage systems vanished (Figure 1). The same effect has been observed in tethered pigs, where access to hay reduced biting of their stalls (Fraser 1975); and in calves kept in isolation, the frequency of stereotypies was reduced when hay was available (Broom 1982). 'Gnawing' made up a larger proportion of the total observations in the light cycle, compared with the dark cycle, (Figure 1, Table 1) and could be explained by the presence of humans working in the stable during the day which may have acted as a stressor to the rabbits.

The rabbits spent a large amount of their time grooming their fur when hay was not available – some 16 per cent (out of 60 observations) in enriched systems and 13 per cent of observations in conventional cages (Figure 1). This is much more than reported from studies of wild rabbits: Mykytowycz and Fullagar (1973) and Gibb (1993) reported grooming in between 0.6 and 2.7 per cent, respectively, of all observations over 24h, and in 2.59 to 3.15 per cent, respectively, of observations during evening watches. The excessive grooming in both cage systems might indicate an understimulation from the environment or, as Gunn and Morton (1995) have suggested, social deprivation. It is possible that some grooming was performed as a form of abnormal behaviour, with no distinct purpose. There was also a considerable difference in the intensity of grooming we observed: grooming with the mouth could occur with repeated, small licking/biting movements around the neck region without using glandular secretions, or as a more thorough operation on a larger part of the body after rubbing fore- or hind legs around the mouth region. We did not observe any fur pulling as has been reported in other studies (Morton *et al* 1993). Grooming activity decreased significantly when the rabbits had access to hay, with this decrease occurring in both the light and dark cycle (Figure 1, Table 1).

This study has demonstrated that the rabbits spent a considerable proportion of their time manipulating hay, when it was available. Therefore, we suggest that rabbits in the cages without hay were lacking adequate stimulation, and that this contributed to the abnormal behaviours observed. This applied especially to the rabbits kept in the conventional cage system which also showed a distinct reduction in their frequency of changing between

behavioural elements when they had access to hay. These behaviours were indicative of lower stress in the animals. Lidfors (1997) found that hay was the most effective object (among hay, grass-cubes, sticks, and a box) in reducing abnormal behaviour among caged rabbits and Morton *et al* (1993) also mention that hay can reduce abnormal behaviour.

Animal welfare implications

This study, in line with other investigations, indicates that hay provides environmental enrichment which has a positive effect on the behaviour of caged rabbits. We conclude that hay should, therefore, be considered as an option in any attempts to create environments which improve the welfare of rabbits.

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