THE EFFECT OF NOSE RINGING ON EXPLORATORY BEHAVIOUR IN GILTS

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Abstract

*Animal Welfare 2003, **12**:* 109-118

Outdoor sows with nose rings can perform most of their natural behavioural activities except rooting. The prevention of rooting through surgical intervention (nose ringing) may be detrimental to welfare, although the behavioural and welfare consequences of rooting deprivation are not well documented. The present experiment examines exploratory behaviour in unringed, ringed and deringed gilts by repeatedly exposing the gilts to a sandbox supplied with bark chips. Four months prior to the experiment, 16 gilts, eight with nose rings and eight without, were housed in four fields. Over a period of 12 days, the 16 gilts, in pairs from the same field, were walked to the sandbox; each gilt visited the sandbox six times in total. After deringing of the ringed gilts (and a control procedure for the unringed gilts), all of the gilts were exposed to the sandbox twice. During each visit, the exploratory behavioural patterns of rooting, sniffing, manipulating, and chewing were observed using 30 s scan sampling. The ringed gilts showed no rooting behaviour in the sandbox; on the other hand, their mean frequency of chewing behaviour was significantly higher than that of the unringed gilts (19.89 versus 13.54; $P < 0.05$). When all of the exploratory behavioural patterns were summed, no significant differences were found between ringed and unringed gilts. On the second day after deringing, the previously ringed gilts started to root, and no significant difference in the incidence of rooting behaviour between unringed gilts and newly deringed gilts was found. We discuss whether rooting behaviour can be substituted by chewing in order to explore an environment. Gilts that are prevented from rooting are found to explore as much as rooting gilts, and they achieved an adequate knowledge of the sandbox (as demonstrated by the fact that they did not show increased exploration after deringing), although rooting was the preferred exploratory behaviour. In this study, we did not find serious symptoms of chronically reduced welfare as a result of nose ringing.

Keywords: *animal welfare, exploration, gilt, nose ring, rooting, behavioural substitution*

Introduction

Sows that are housed outdoors have the opportunity to perform most of their natural behaviours. They can move around and wallow, they have social contact with other sows, they can maintain their individual distance from one another and they can root. It has been observed that domestic pigs kept outdoors spend about half of their active time exploring (Blasetti *et al* 1988; Edwards *et al* 1993; Tober 1996) and 40% of this exploration comprises rooting behaviour (Stolba & Wood-Gush 1984).

On most outdoor pig farms in Denmark, the sows have a ring in their nose to prevent them from rooting. The farmers wish their grass to remain intact, partly for environmental reasons (ie to prevent leaching of nitrate from faeces and urine) and partly in order to maintain the pasture for feeding. Furthermore, in France it has been shown that intact pasture correlates with higher piglet survival rate, seemingly because the farrowing hut stays cleaner and dryer (Berger *et al* 1998). From a welfare point of view, it seems regrettable to allow surgical intervention such as nose ringing in order to prevent sows from rooting, especially in a production system which otherwise allows the animals greater opportunity to perform their natural behaviours and thereby holds potential for improved welfare. The behavioural consequences of ringing of pigs are, however, not well documented.

Pilot studies (Studnitz, unpublished results) indicate that chewing of straw and stones increases in ringed gilts and may be a substitute for rooting. However, it is not known whether chewing and rooting are of equal efficacy for exploration — that is, whether chewing and rooting for equal periods of time result in similar levels of experience with the environment — so that chewing can to some extent satisfy the motivation involved in rooting.

To elucidate the way in which nose rings affect the expression and quality of exploratory behaviour, we examined the exploratory response in ringed and unringed gilts that were provoked to explore by being repeatedly subjected to a standardised experimental environment. The response was also studied after removal of the ring (deringing) of the ringed gilts.

Materials and methods

Sixteen non-pregnant gilts (Danish Landrace × Yorkshire) were allocated to one of four groups which were balanced according to live weight and litter of origin. In two of the groups the gilts were fitted with nose rings two weeks before they were put outdoors. The nose-ringing procedure was carried out in the manner specified for outdoor pig production systems, and the treatment did not conflict with the Danish requirements for care of experimental animals. From December until May the groups were kept in four fields totalling one hectare, at the Research Centre Foulum, Denmark (Figure 1). The gilts were fed daily at 1300h with roll-nuts according to Danish standards. The gilts weighed approximately 100 kg (91–105 kg) when they were put outdoors and they reached a live weight of roughly 200 kg by the end of the experiment.

In an adjoining sandbox the gilts' propensity to root was tested. Sand was chosen as rooting material and supplemented with bark chips to stimulate exploration. The sandbox measured 6 × 10 m, and was 30 cm deep filled with 10 cm of sand, 10 cm of bark chips and a further 10 cm of sand. It was surrounded by a 30 cm high electric fence. Some of the bark was (unavoidably) visible on the surface of the sand. After each visit, dung in the sandbox was cleaned out and the sand levelled.

On twelve observation days during the period 13–31 May, the gilts were walked in pairs from their field into the sandbox. This was repeated six times for each gilt. During the

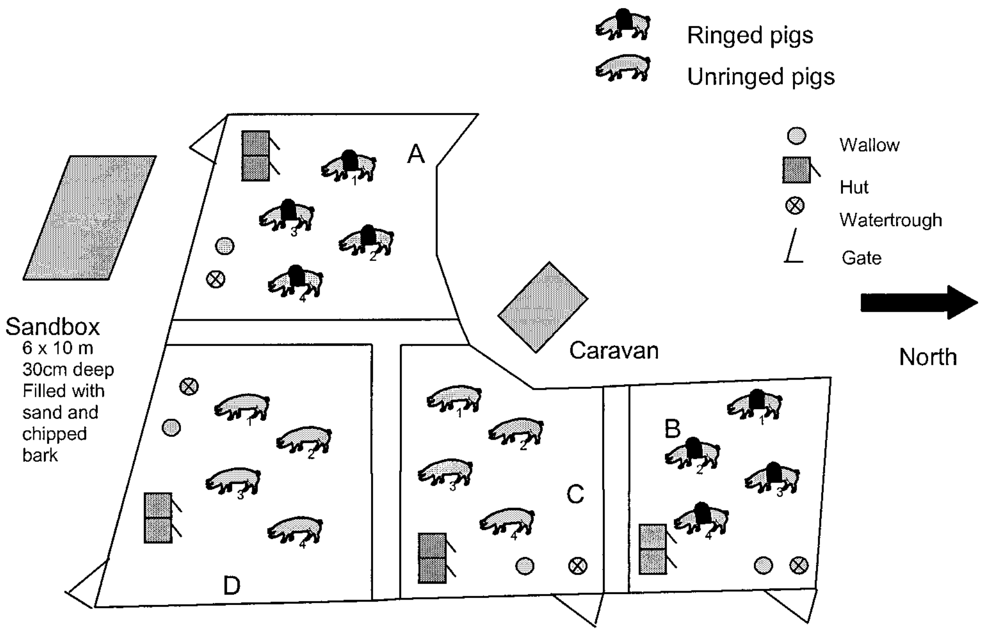

Figure 1 **Diagram showing the four fields, totalling 1 hectare, and the adjoining sandbox, where the eight ringed and eight unringed gilts carried out exploratory behaviour. Fields A and B housed the ringed gilts and fields C and D the unringed gilts. Huts, water troughs and wallows were placed with the same distance between them in all four fields. All fields were completely grass-covered when the pigs were first put outdoors.**

morning tests, in the periods 0930–1100h and 1100h–1230h, each of two pairs was observed for 3 × 16 min. In afternoon tests, 1500h–1600h and 1600h–1700h, each of two pairs was observed for 2 × 16 min. All four fields were represented on each day of observation and were split equally between morning and afternoon tests. Pairs were chosen randomly from the four gilts in each field (Table 1).

During the test in the sandbox, the behaviour of the gilts was scanned every 30 s of a period of 16 min duration. The various behavioural parameters are listed in Table 2. The wind speed and direction, rainfall and temperature were recorded whenever a new pair of gilts started a test in the sandbox.

In the week prior to the experiment all four gilts from each field were allowed two one-hour visits to the sandbox to allow them the opportunity to explore it. At the end of the testing period, the ringed gilts were deringed while being held in a nose sling. Similarly, the unringed gilts were held in a nose sling (but were not ringed). After 'deringing', the deringed gilts were tested twice in the sandbox during the period 10–13 June, and the unringed gilts were tested again as control gilts. All gilts were tested on the day of deringing and two days later.

Table 1 **The order in which the gilts were tested in the sandbox. Numbers 1–4 represent the individual gilts from each field. A and B represent ringed gilts coming from fields A and B respectively, and C and D represent unringed gilts coming from fields C and D respectively.**

Time	0930h–1100h	1100h–1230h	1500h–1600h	1600h–1700h
May				
13th	C (1 + 2)	A (2 + 3)	B (2 + 3)	D (2 + 4)
14th	B (2 + 4)	D (1 + 3)	C (1 + 4)	A (2 + 4)
16th	C (1 + 4)	A (1 + 3)	D (1 + 3)	B (1 + 4)
17th	B (1 + 3)	D (1 + 2)	C (3 + 4)	A (1 + 4)
20th	D (1 + 4)	B (1 + 2)	C (1 + 3)	A (1 + 3)
21st	A (1 + 4)	C (3 + 4)	D (3 + 4)	B (1 + 2)
23rd	B (1 + 4)	D (2 + 4)	A (1 + 2)	C (2 + 4)
24th	A (3 + 4)	C (2 + 4)	D (1 + 4)	B (3 + 4)
27th	C (2 + 3)	A (2 + 4)	B (1 + 3)	D (1 + 2)
28th	D (3 + 4)	B (2 + 3)	A (3 + 4)	C (1 + 2)
30th	D (3 + 4)	B (2 + 3)	A (3 + 4)	C (2 + 3)
31st	A (1 + 2)	C (1 + 3)	B (2 + 4)	D (2 + 3)
June				
10th	A (1 + 3)	C (1 + 2)	C (3 + 4)	A (2 + 4)
11th	B (2 + 4)	D (3 + 4)	D (1 + 2)	B (1 + 3)
12th	C (1 + 3)	A (1 + 2)	A (3 + 4)	B (1 + 2)
13th	D (2 + 4)	B (3 + 4)	B (1 + 2)	D (1 + 3)

Table 2 **Behavioural categories recorded during tests in the sandbox.**

Behavioural parameter	Definition
Rooting	Snout in the sand and regular forward head movements
Chewing	Chewing any object, eg bark chips
Manipulating	Touching and moving any object with the mouth or snout, not chewing
Sniffing	Moving the snout disc in a seesaw motion over the surface
Sniffing pig	Moving the snout disc in a seesaw motion over the companion pig
Snout contact	Snout in contact with companion pig
Aggression	Any aggressive attack on the companion pig
Lying	Any lying posture
Pawing	Standing scraping with foreleg

Statistical analyses

The data were summarised for each test in the sandbox for ringed and unringed gilts separately. The following individual variables were calculated, representing the mean number of incidences during two (afternoon) or three (morning) periods of 16 min of scanning: rooting, chewing, manipulating, exploring (rooting, chewing, manipulating or sniffing), and lying.

The variables were subjected to analysis of variance by mixed model methods with multiple error terms using the MIXED procedure in the statistical package SAS (Littell *et al* 1996). To fulfil the assumptions for analysis of variance, the variables were square-root transformed. As fixed effects, the model included: whether gilts were ringed (RING, +/–); day of observation of the same gilt (DAY, 1–8); interaction between these two effects; time of day at which testing was carried out (before/after 1300h); and interactions between rainfall

https://doi.org/10.1017/S0962728600025422 Published online by Cambridge University Press

(+/–) and temperature (higher/lower than 10°C). Random effects were the resident field (FIELD, 1–4) nested within RING, and DAY nested in the interaction between RING and FIELD. Individual gilts nested in the interaction between RING and FIELD were used as experimental units, and data from the same individuals on different days of observation were treated as repeated measures. The type of repeated-measures analysis used was autoregressive order, with heterogeneous variance on each observation day (AR(1)), assuming that the correlation between days decreased with time between days. Initial comparisons of the three most common types of repeated-measures analysis did not favour one over the others. The choice of type of analysis was therefore based on the generally accepted expectation of covariance structure for this kind of data.

The results of the statistical analyses are presented by the F-value and the degree of freedom for the investigated effect (df1) and of the error term in the denominator (df2). All analyses were performed as two-tailed tests.

Results

Behavioural observations demonstrated that the ringed gilts did not root in the sand. Thus, there was a significant difference between the mean incidence of rooting behaviour observed during 16 min intervals ($F_{1,2} = 83.27$; $P = 0.01$). The mean incidence of rooting behaviour in unringed gilts was 6.86 (SE = 0.97) during the 16 min observation periods, whereas the mean incidence in ringed gilts was 0.06 (SE = 0.09). The mean incidence of rooting behaviour in ringed and unringed gilts for all test days is shown in Figure 2.

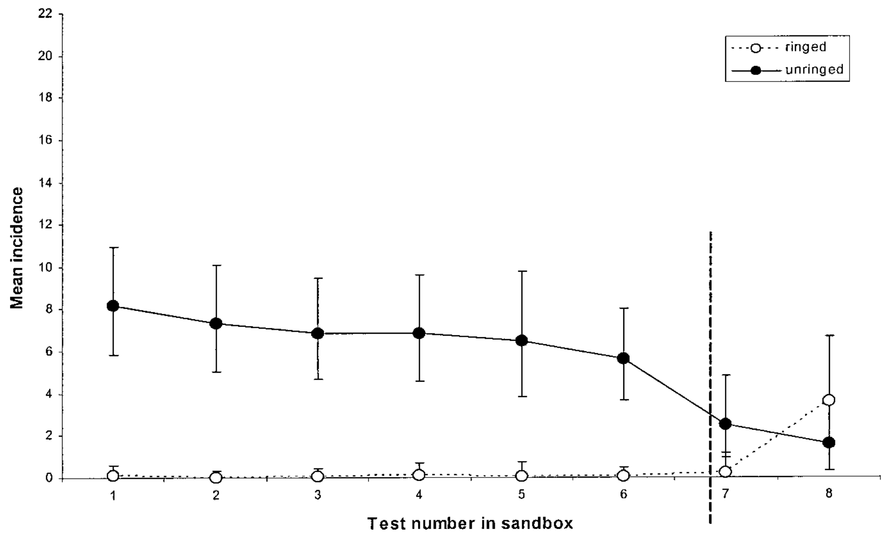

Figure 2 **Mean incidence of rooting behaviour observed by scanning every 30 s during two or three periods of 16 min. Error bars indicate the corresponding 95% confidence intervals. The ringed gilts were deringed on the day of the seventh test, indicated by the dotted vertical line.**

On the second day after deringing, the deringed gilts started to root, and no significant difference was found between the incidence of rooting behaviour in unringed and deringed gilts. On this day, the mean incidence of rooting behaviour was 3.61 (SE = 1.31) and 1.56 (SE = 0.87), respectively (Figure 2).

Figure 3 demonstrates a significant difference in the incidence of chewing behaviour between ringed and unringed gilts ($F_{1,2} = 31.20$; $P = 0.03$). The mean incidence of chewing behaviour in ringed gilts was 19.89 (SE = 0.90), whereas the mean incidence in unringed gilts was 13.54 (SE = 0.74). Furthermore, the incidence of manipulation was significantly higher in ringed gilts than in unringed gilts ($F_{1,2} = 19.35$; $P < 0.05$); the mean incidence of manipulation in ringed gilts was 0.28 (SE = 0.06) in the 16 min periods, whereas in the unringed gilts it was 0.04 (SE = 0.02).

When all types of exploratory behavioural activities are taken into consideration (ie total rooting, chewing, manipulating, and sniffing), the day of peak activity appeared to be delayed in the ringed gilts (Figure 4). However, no significant difference was found between the incidence of exploratory behaviour in ringed and unringed gilts. In addition, the 95% confidence interval for the difference on the square-root scale between the mean incidence of exploratory behaviour for ringed and unringed gilts was narrow [–0.19, 0.29].

Time spent lying in the sandbox was not affected by ringing. On cold rainy days (temperatures below 10°C), the gilts lay down less than on warm dry days. In general, the weather (rainfall and temperature) affected all behavioural activities (*P* in the range 0.01–0.19) and was therefore included in all statistical analyses.

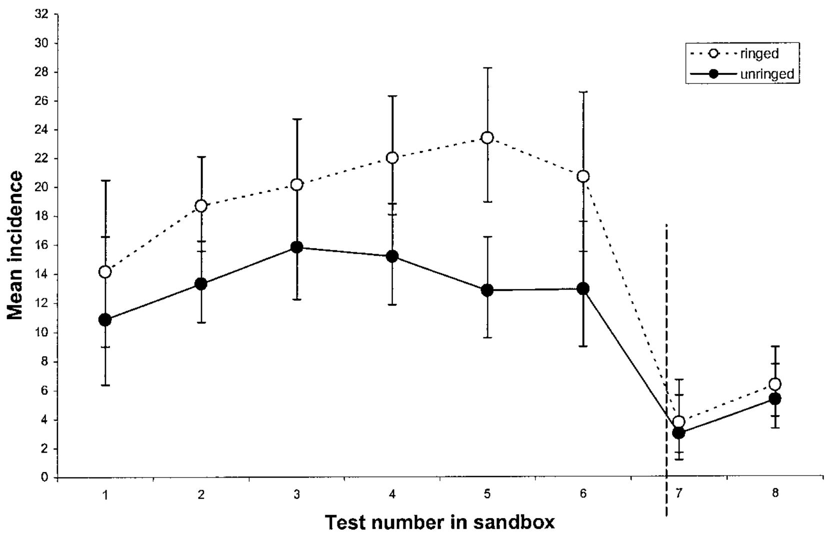

Figure 3 **Mean incidence of chewing behaviour observed by scanning every 30 s during two or three periods of 16 min. Error bars indicate the corresponding 95% confidence intervals. The ringed gilts were deringed on the day of the seventh test, indicated by the vertical dotted line.**

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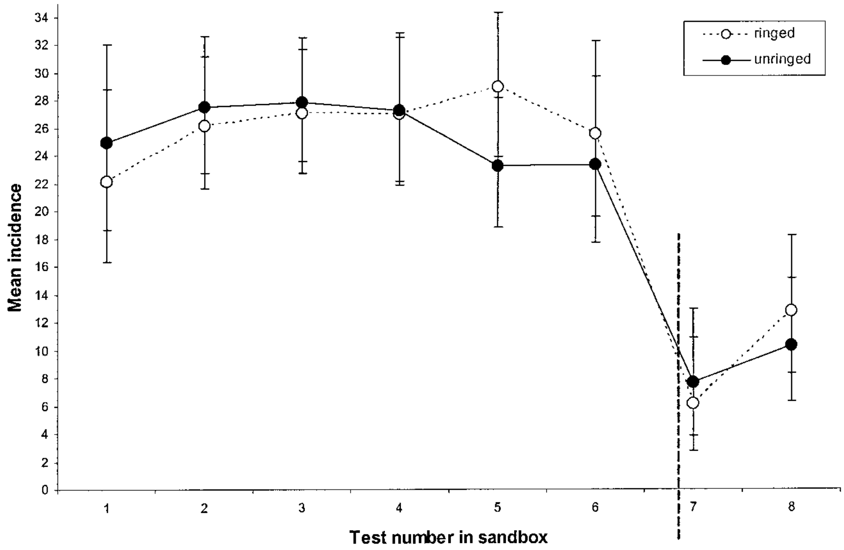

Figure 4 **Mean incidence of exploratory behaviour (including rooting, chewing, manipulating and sniffing) observed by scanning every 30 s during two or three periods of 16 min. Error bars indicate the corresponding 95% confidence intervals. The ringed gilts were deringed on the day of the seventh test, indicated by the vertical dotted line.**

Discussion

The present results demonstrate that rings prevent the gilts from rooting, even in the soft sand. Instead, chewing and manipulation behaviour increase. The total amount of exploratory behaviour (rooting, manipulating, sniffing, and chewing) was not significantly affected by ringing. As there was no significant difference between the rooting and chewing behaviour of unringed gilts and newly deringed gilts (two days after deringing), it seems that chewing may have substituted rooting behaviour to such an extent that the motivation to explore in deringed gilts was the same as in unringed gilts. This may be because the behaviour that substituted rooting provided the gilts with the same amount of knowledge of the sandbox as rooting behaviour did in unringed gilts. The effectiveness of chewing and manipulating as a means of obtaining knowledge of the environment might, however, be slightly lower than rooting, as indicated by the apparently, although non-significantly, delayed peak of exploratory behaviour in ringed gilts compared with unringed gilts. The fact that the gilts chose to root when they were given the opportunity shows that rooting is the preferred exploratory activity, which also indicates that rooting behaviour may be a more efficient way of exploring a new environment.

In indoor pigs, most frustration and abnormal behaviour is suggested to stem from inhibited appetitive behaviour (Appleby & Hughes 1997; Wood-Gush & Vestergaard 1989). Rooting is an appetitive behaviour, when it appears as a part of foraging, and it is therefore likely that frustration will arise when outdoor pigs are prevented from rooting. Experimental documentation of long-term aversive effects of the prevention of rooting by ringing is, however, scarce. In an experiment concerning the effectiveness of ringing as a method of preventing pasture damage, Edwards *et al* (1996) concluded that the welfare implications of long-term modification of foraging behaviour require further study. A'Ness *et al* (1996) demonstrated that ringed pigs stood inactively more than pigs without nose rings, and the authors suggested that this was a sign of reduced welfare of ringed pigs. However, according to Horrell *et al* (2000), ringing did not reduce welfare as much as indoor housing in that the pigs did not develop oral stereotypes.

It is likely that deprivation of exploration through lack of stimuli impairs welfare more than deprivation of rooting *per se*. In a study in which four-month-old pigs, housed in concrete pens or on pasture, were led to an open-field pasture test, Taylor and Friend (1986) found that the pen-housed pigs rooted, grazed, and chewed more than the pasture pigs. It was suggested that the pigs which had been prevented from grazing had accumulated a motivation to graze, chew and root — a rebound effect. However, the increased exploratory activity in the open-field arena may have been partly because the novelty value of the open-field arena was higher for the pen-housed pigs than for the pasture pigs, rather than because of a rebound effect after deprivation of exploration. The significance of novelty value on tendency to explore was also evident in the present experiment. General observations showed that initially the gilts went willingly into the sandbox when walked from their home field but, as the experiment progressed, they became increasingly reluctant. This apparent lack of interest appeared first in the unringed pigs and later in the ringed pigs, corresponding with the culmination of their exploratory behaviour in the sandbox. However, this increasing lack of interest in moving to another place contrasted with the apparently continuous entertainment value, noted by Studnitz and Jensen (2002) in an experiment on indoor pigs, of being moved from a home pen containing sphagnum moss to a smaller, barren pen with concrete flooring. Thus, the motivation to explore and the significance of novelty value seem to depend on the enrichment of the home environment, with barren environments increasing the motivation to explore and enriched home environments decreasing the significance of novelty. This is also confirmed by Wood-Gush and Vestergaard (1991), who demonstrated that 5–6-week-old pigs actively sought new stimuli but that the pigs' interest in a novel object decreased after examining the object. They concluded that pigs are curious animals, and that monotony must be avoided in order to secure the welfare of the animals (Wood-Gush & Vestergaard 1991).

We therefore believe that the welfare of ringed pigs depends on provision of the environmental stimuli necessary for replacing rooting behaviour with another relevant behaviour. The present experiment showed that ringing affected only the type but not the amount of exploratory behaviour. This indicates that if rooting is prevented, the pig can make use of a substitute behaviour, such as chewing. This interpretation is in accordance with an earlier study by Horrell *et al* (1997), which showed that provision of other opportunities for ringed pigs to root, such as peat, straw or stones, ameliorates the reduction in welfare, measured as standing inactively. Correspondingly, while the ground was frozen prior to our experiment in the sandbox, we observed that unringed gilts rooted in the huts while ringed gilts chewed straw in the huts. Once the ground thawed, the unringed pigs immediately started to root in the field, while the ringed gilts started to graze. If the gilts in the present experiment had not been provided with something to chew, they would presumably not have been able to substitute other relevant behavioural activities for rooting. In this case, it is likely that the results would have been different.

The high priority of rooting, which was evident in the present study by the re-establishment of rooting behaviour in deringed gilts, was also demonstrated by Horrell *et al* (1996) who found that if the pigs could not root with the plate of their snouts and the upper rims, they would use the lower part of their snouts. These examples demonstrate that if pigs cannot root they will opt for other activities; however, they will choose to root whenever they are given the opportunity.

The present study revealed a decrease in exploratory behaviour for both ringed and unringed gilts at the time of deringing. This drop in exploratory behaviour was probably an artefact resulting from climatic changes — for example, the summer weather may have dried out the bark chips, decreasing their exploratory value. However, as all treatments were subject to the same changes, they are still comparable.

In conclusion, the nose rings prevented rooting, even in a soft material such as sand. Gilts that were prevented from rooting explored as much as the rooting gilts. Instead of rooting, they chewed, manipulated and sniffed. Although it might have taken a little longer for the novelty of the sandbox to wear off, no accumulated motivation for rooting or exploring or impaired knowledge of the sandbox was evident when the gilts were deringed after six visits to the sandbox. The results imply that rooting behaviour, as a component of exploration, is given a high priority; however, if pigs are able to explore in another way, the inhibition of rooting behaviour might not in itself impair welfare.

Animal welfare implications

Domestic pigs kept outdoors spend about half of their active time exploring and a substantial part of this exploration comprises rooting. It could thus be expected that nose ringing would be detrimental to their welfare. The results indicate that rooting behaviour is given high priority as a component of exploratory behaviours. However, it is likely that deprivation of exploration through lack of stimuli impairs welfare more than deprivation of rooting *per se*. The provision of a stimulating environment in which ringed sows have the opportunity to substitute other relevant exploratory behaviours for rooting — for example, to chew different items and to graze — will reduce the negative welfare impact of ringing.

Acknowledgements

The authors thank Erik Luc Decker for compiling the behavioural records and Mette Giersing Linder, Birte Lindstrøm Nielsen and Mette Svendsen Herskin for reviewing an earlier version of this paper.

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