Effect of cage enrichment on the stereotypic behaviour of commercially kept pregnant sows

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Abstract

In this study, the effect of cage enrichment on the welfare of commercially kept pregnant sows and the possibilities to improve welfare were investigated. Forty-eight sows were observed. Twenty-for got an enrichment (a chain); the other twenty-four sows formed the control group. The behaviour of the sows was observed for five weeks, in order to determine both acute and long-term changes. The behaviour was scored with a scanning method. Before the intervention, the sows were spending 31.05±2.63% (enrichment) and 33.65±3.10% (control) of the observation time with stereotypic behaviour. When the chain was hanging low the enrichment sows showed 5.75% less stereotypic behaviour ($p<0.05$), a decrease of 19% regardless on which moment the observations where done (acute versus long-term effects). When the chain was low, the sows spent 25.05±2.08% of their time manipulating the chain versus 9.71±2.68% less ($p<0.05$) when it was hanging high. The interest in the toy disappeared in course of time with 7.05±2.68% ($p<0.05$).

The conclusion is that if a chain is used as a toy for individually kept pregnant sows, it might be a better solution to mount it near the floor of the cage; this because it comes closer to the natural foraging behavior of pig. It is difficult to state that a chain is useful as a toy to improve welfare of individually kept pregnant sows. However, considering the amount of time the sows spent with manipulating the chain, it is a cost–effective device. Furthermore, it was successful to reduce the amount of stereotypic behaviour of the sows for the period the observations were done.

Introduction

Welfare of farm animals is a big public issue nowadays. In modern systems of animal production, pigs are often confined within stimulus-poor, barren housing systems that offer little possibilities to accommodate their species-specific behaviours. The discomfort of not being able to express motivated behaviour can result in psychological distress and is associated with the expression of abnormal behaviours such as passiveness and stereotypic behaviour (*van de Weerd et al.* 2009). Although contemporary pigs are kept for numerous generations in confinement, studies have shown that there seem to be large similarities between the behaviour of domestic sows and their wild ancestors, when given the opportunity to express these. Free-ranging domestic sows are still able to expose pre-parturient nest building, early maternal behaviour and nursing behaviour. In general, domestic sows still

possess behaviour similar to the behaviour of the wild boar (*Gustafsson et al.* 1999, *Jensen* 1986,1989, *Stolba et al.* 1989). Nevertheless, the behaviour has changed quantitatively due to domestication. Domestic pigs are less aggressive, less active and less cautious towards potential predators. Domestic pigs are also less likely and less able to actively seek variety in their diet or food sources, but the foraging behaviour is in general comparable with their wild ancestors. In the current ways of commercial pig farming, expression of the complex normal foraging behaviours, like they would do under natural conditions, is not possible (*Jensen* 2009, *Mason et al.* 2006).

The aim of this study is to obtain more information about regular behaviour of pregnant non-lactating sows in their standard housing conditions and to investigate if their welfare can be improved by simple, practically applicable enrichments of their environment. Straw is presumed to be beneficial for the welfare of pigs (*Spoolder et al.* 1995). In previous studies it is shown that straw improves welfare, but it is also an expensive way to increase welfare. This is because of the costs of straw itself, the increased labour and the need for extra facilities to store straw (*Spoolder et al.* 1995, *Tuyttens* 2005).

This is the reason that the present study investigates another way to improve welfare: a chain. One of the suggested indicators of the reduced welfare of sows in individual housing systems is the occurrence of stereotypic behaviour (*McGlone et al.* 2004). It is well known that stereotypic behaviour occurs frequently in individually housed sows. The stereotypic behaviour seen with individually kept pregnant sows are essentially oral activities. Most of the stereotypic behaviour is oral because of the sows' intrinsic need to express foraging and explorative behaviour (*Schouten et al.* 1991a). Earlier studies have shown that vacuum chewing, bar biting or other orally related stereotypic behaviour are indeed the most occurring stereotypic behavior in pregnant individually stalled sows (*Cronin et al.* 1984, *Appleby et al.* 1987,1989, *Bergeron et al.* 1997). Stereotypic behaviour is less frequently seen in gilts and increases in frequency with parity. When performed at high frequency, the sows are strongly resistant to environmental changes (*Schouten et al.* 1991a, *Lawrence et al.* 1988). Stereotypic behaviour is, therefore, evidence that the sow has had somehow reduced welfare in the past, but it does not necessarily imply that the welfare is poor at the moment. However, stereotypic behaviour remains an important indicator that the environment is not providing sufficient opportunities for the sows to peform their normal behaviour (*Mason et al.* 2006, *Vieuille-Thomas et al.* 1995). In previous reports it is already described that the stereotypic behaviour is due to stress and this stress can be associated with food restriction.(*Appleby et al.* 1987, *Lawrence et al.* 1988;*de Leeuw et al.* 2004b, *Brouns et al.* 1994).

To keep non-lactating sows in an acceptable condition, restricted nutrient intake is necessary. When fed ad libitum, obesity and a reduced reproductive performance can be the result. Although sows are daily provided with enough food for maintenance and reproduction, they do not feel satisfied. Especially after feeding, the motivation to search for more food is high (*Appleby et al.* 1987, *de Leeuw et al.* 2004b, *de Leeuw et al.* 2004c). It is known that, this motivation can indirectly lead to stereotypic behaviour (*Lewis et al.* 2006, *Cabib* 2006).

In this study, a chain will be used to investigate its opportunities to improve welfare. Since most stereotypic behaviors are oral, a chain is attached in the cages so the sow can chew on,

and manipulate the chain with her snout. It is possible that the chain is a good alternative foraging substrate for the sows inherent need for food. But it is also known that the chain can lead to stereotyped chain-biting (*Bergeron et al.* 2006). Therefore, the chain is attached in the upper side or near the floor of the cage and this was switched every day.

Materials and methods

Animals

In this study forty-eight Large White x Landrace sows were observed. The sows were divided into two groups, twenty-four sows got the enrichment and the other twenty-four served as controls. The parity of the sows varied from 0 to 10 .The sows were in the same stage of pregnancy, the time of gestation varied from 40 to 46 days at the start of the experiment.

Housing

All the sows were individually housed in a metal cage measuring 2000x600mm. The floor was made of concrete which was 60% solid and 40% partly slatted. The sows were fed every morning at 08:30h using a semi-automatic feeder which dispensed fixed rations of the same gestation diet to each individual in a trough on ground level. The diet was a standard commercial pelleted sow food. When the animals finished the meal, water was supplied in the same trough. At 16.00h the sows got water for the second time.

Treatment

At the day the enrichment was applied, the twenty-four sows in the enrichment group received each a chain. In twelve of the enrichment cages the end of the chains were attached on top of the cages, at approximately 1 m above the floor. In the other twelve one the chains were attached near the floor of the cages, at approximately 10 cm above the floor. So the sows could move the end of the chain with their snout on the floor. Every day the position of the chain was switched from the upside to the floor and vice versa. The chain (diameter 5 mm, length 1200 mm) was mounted in between two cages. At the end of the chain, two bolts of varying sizes (80-120mm, diameter 8mm) were attached witch nuts to enlarge the attractiveness of the chain. The chain was attached in between two sows, so each sow got 600 mm of chain. When one sow started manipulating the chain, the chain of the neighboring sow started to move too in order to make it more attractive for the neighboring sow. After feeding in the morning, the position of the chain was changed. The chain was changed from position only once a day.

Behavioural observations

In the first week of the study, the behaviour of the enrichment and control group was observed on two consecutive days using 2-min instantaneous scan sampling for 5 h per day (see Table 1 for ethogram).

The first three hours of observing were between 9:00h and 13:00h, the last two hours were between 16:00h and 18:30h. Observations were made during the active periods after feeding. It is known that sows show little activity other than resting behaviour during darkness and it was assumed that lying was the only behaviour which occurred at night (*Barnett et al.* 1985).
In the second week, the chains were applied to the enrichment group to measure the acute behavioral changes. The observations were done in both groups for two days. In order to measure the long-term changes of the enrichment, the position of the chains was changed for another three weeks. The final long-term observations were done in the fifth week for two days again.
The collected data were sorted with Excel and statistical calculations were made with SPSS version 16.0 using the mixed models analysis. Data were tested for normality and if they were not normally distributed, a Log transformation was made. Models where made for the experiment and the control group with the factors day (pre-enrichment, acute effects, long-term effects), enrichment (chain high, chain low) and interaction between them. This resulted in five different models. The model with the lowest AIC is considered as the most plausible model. The individual sows were used as random effect to take in account dependent observations. Residual analyses where made to control if the data had a normal deviation with constant variation. Differences between groups are expressed as means ± SEM.

Results

Because there were from the beginning differences between the control and the enrichment group, the effects have been investigated within the enrichment and within the control group. So the effects on the pre-enrichment days are compared with the acute and the long-term effects. The sows received no chain on the pre-enrichment day. In Figures 1.1-1.4 the different type of postures of the sows during the entire experiment are presented. The posture kneeling is not shown in these figures because the sows were displaying this posture a neglectable amount of time.

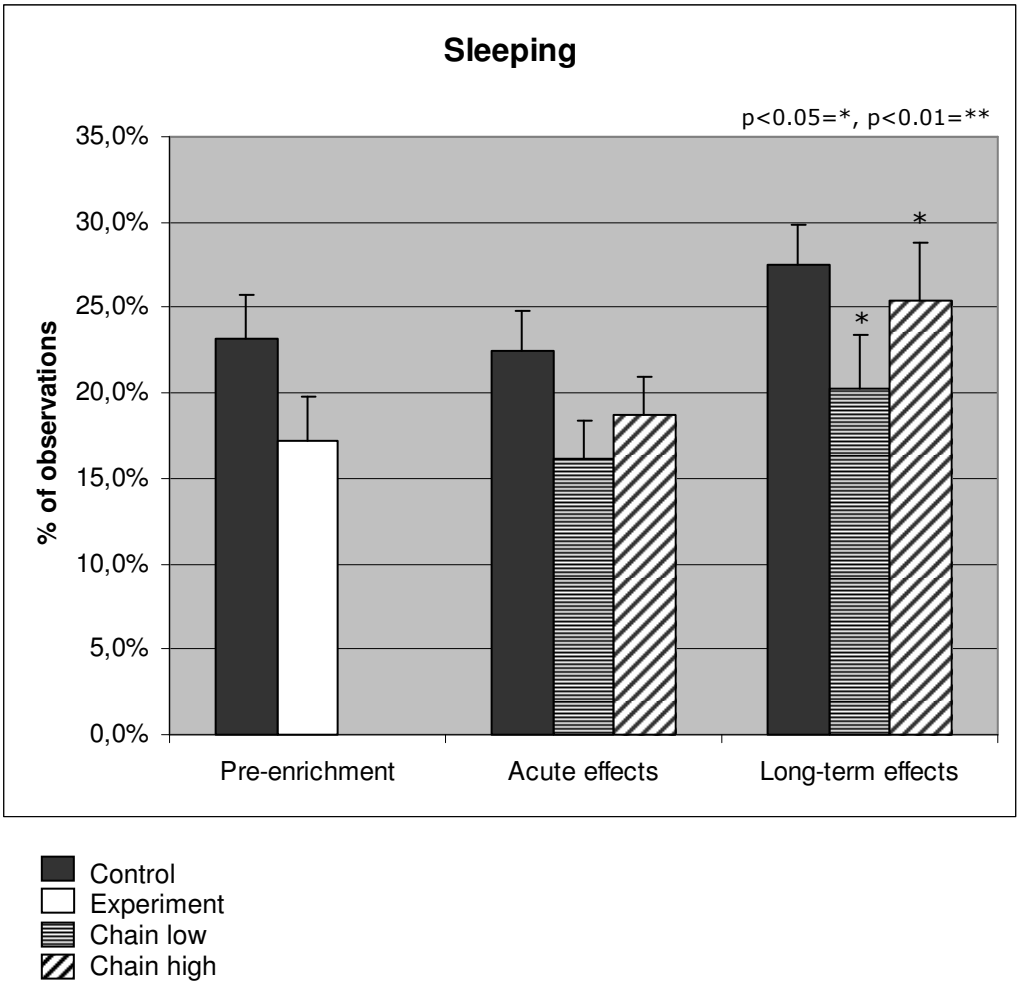

Fig 1.1 Sleeping (presented as a % of the observation time) of sows before (pre-enrichment), one day after (acute effects) and six weeks after (long-term effects) introduction of chain.

In figure 1 the amount of time the sows were sleeping (lying on side or belly with eyes closed) is presented. In the enrichment group, no differences were found between the pre-enrichment day and the first week with chain (acute effects). The enrichment group (chain low and chain high) was sleeping 5,58±2,8% more ($p<0.05$) during the long-term observations (week 6 after providing chain) in comparison with the pre-enrichment day. There was no effect of the position of the chain (high or low) on sleeping.

Time spent sleeping in the control group was not affected by week.

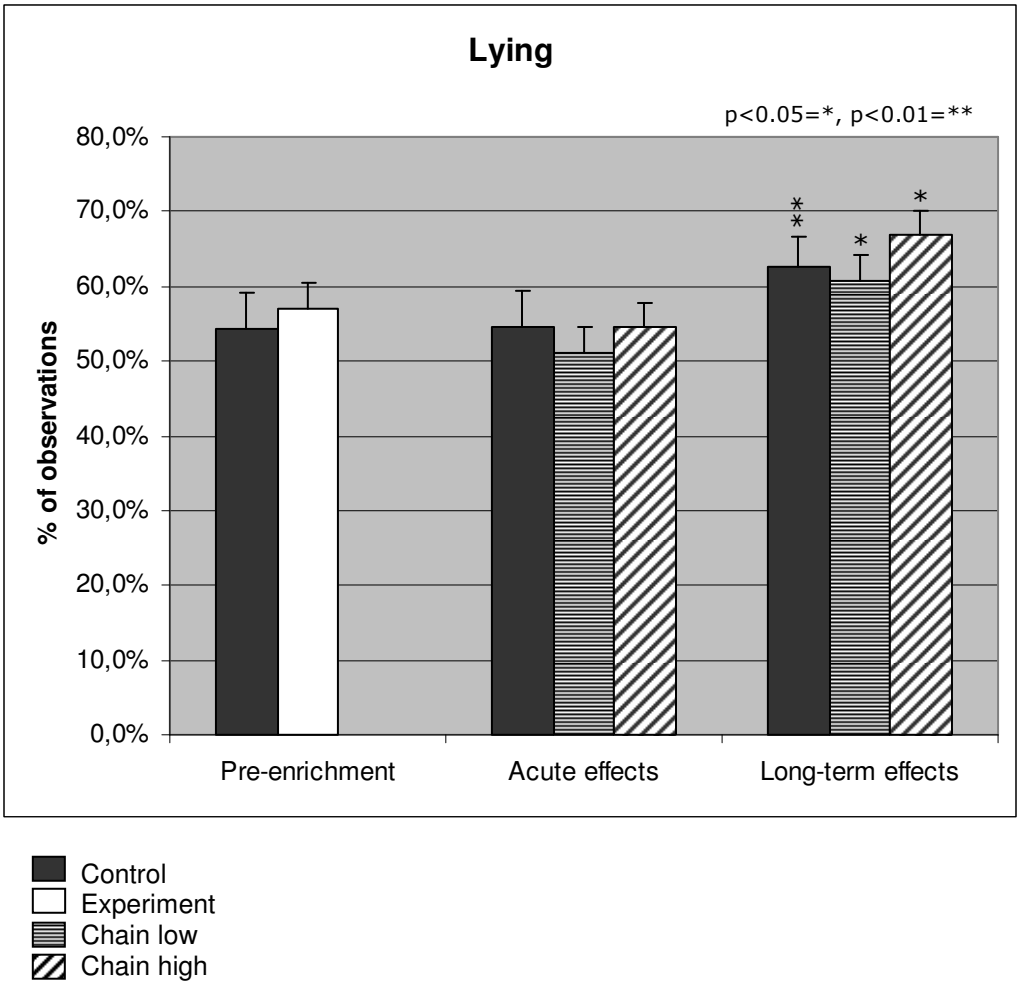

Fig 1.2 Amount of time the sow were in lying position presented as a % of the observation time

In figure 2 the amount of time the sows were lying on side or belly with eyes open or closed is presented. No differences were found between the pre-enrichment day and the acute effects. The enrichment group (chain low and chain high) was lying 9.11±3.63% more ($p<0.05$) during the long-term observations. No differences were found between the positions of the chain. The control group was lying 8.25±2.28% more ($p<0.01$) during the long-term observations.

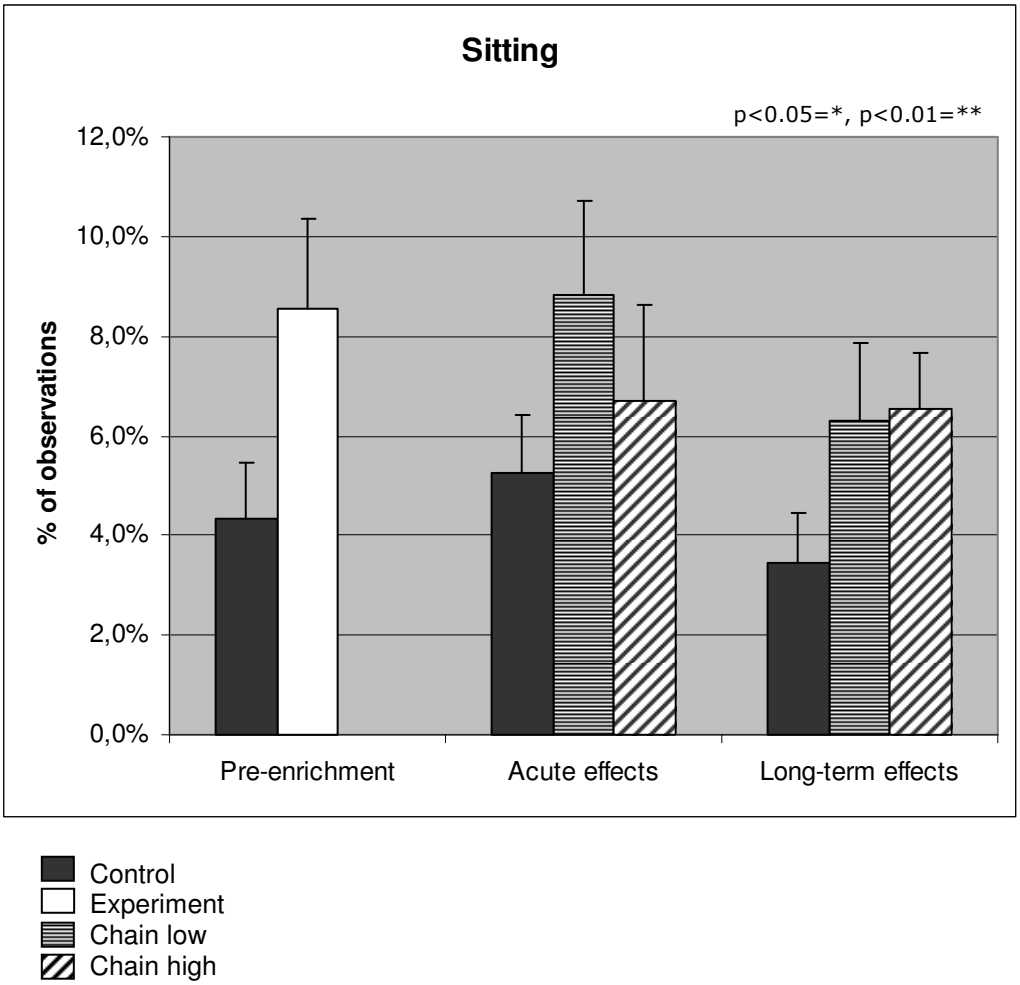

Fig 1.3 Amount of time the sow were in sitting position presented as a % of the observation time

No differences in time spent sitting where found within the enrichment group (chain low and chain high) and within the control group.

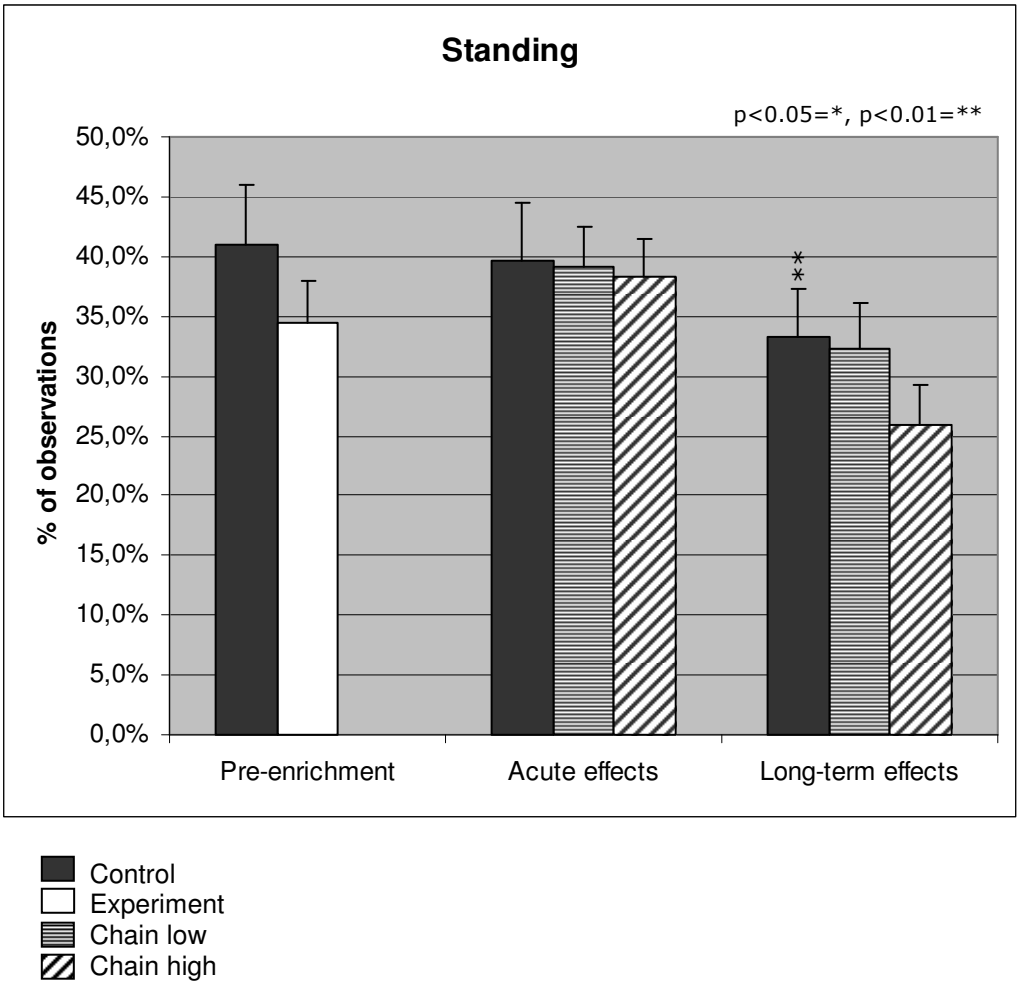

Fig 1.4 Amount of time the sow were in standing position presented as a % of the observation time

There were no differences found in time spent standing within the control group and within the enrichment group (chain low and chain high) comparing the pre-enrichment observations with the acute effects. Comparing the long-term effects with the control day, the sows were standing 5.46±5.89% less with a 95% confidence interval of -12.58-1.66% (p=0.13). No differences were found between the positions of the chain.

The sows of the control group were standing 41±4.57% of the observations, at the acute day no effects were found. On the long-term the control sows were standing 7.7±2.21% less (p<0.01) than during the pre-enrichment observations.

Stereotypic Behaviours

In fig 2.1-2.4 the different types of stereotypic behaviour are presented. In fig 2.1 the moments when the sows were performing chewing movements without any food or substrate are presented. The following behavioural combinations were combined: SCH, LCH, KCH and ZCH. In fig 2.2 the moments when the sows were chewing on any part of the pen are presented. The behavioural combinations SCO, ZCO, KCO and ZCO were combined. In fig 2.3 the moments when the sows were repeatedly rooting/sniffing the feeding trough are presented. The next behavioural combinations were combined: SSF, ZSF, KSF and LSF. Fig 2.4 contains the remaining behavioural combinations: SLG, SGA and SPW. These

behaviours are fixedly lifting the front gate of the pen with frontal part of the nose, repeatedly making gaping/yawning movements and obsessively drinking or orally manipulating water such as making bubbles. The meaning of the behavioural combinations are shown in table 1.

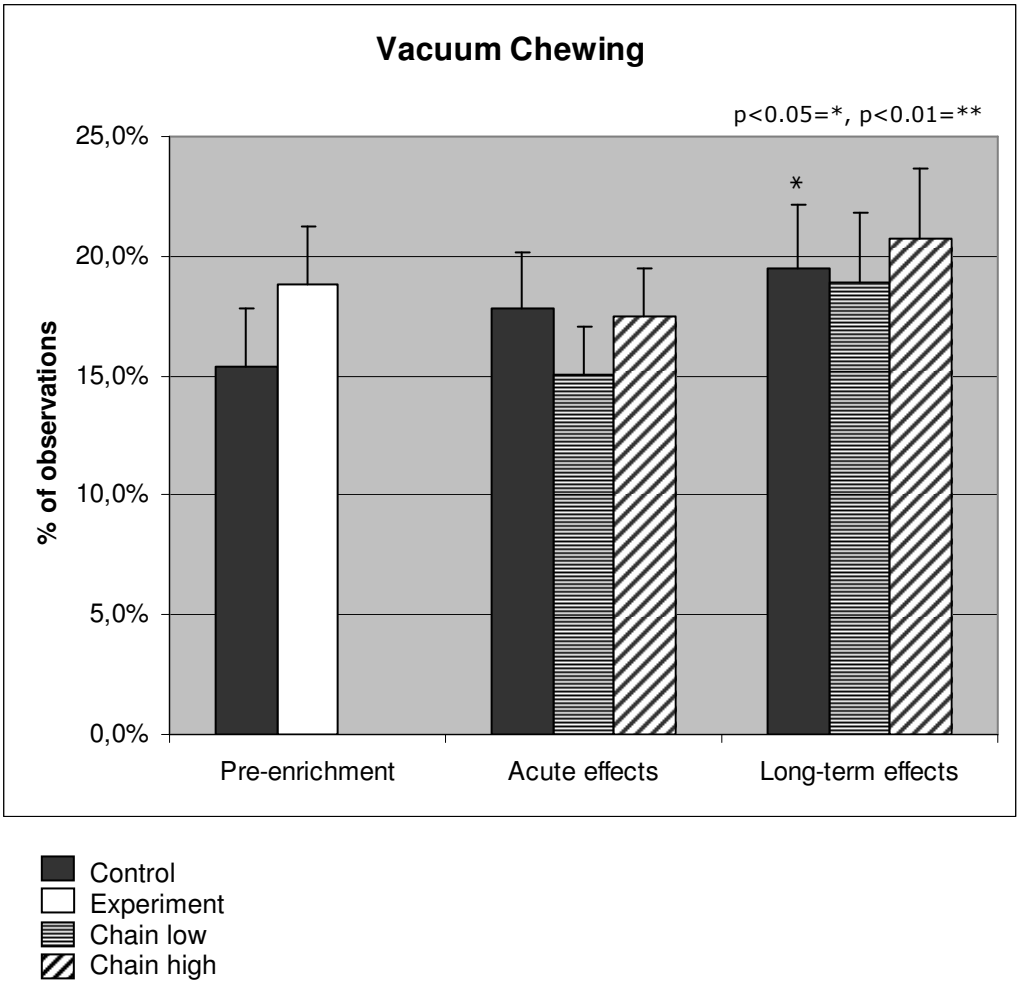

Fig 2. Amount of time the sow were performing vacuum chewing behaviour presented as a % of the observation time

In the enrichment group no differences were found in the amount of time the sows were vacuum chewing. There were also no differences between the position of the chain.

On the long-term the control sows were vacuum chewing 4.11±1.71% more ($p<0.05$) than on the pre-enrichment day.

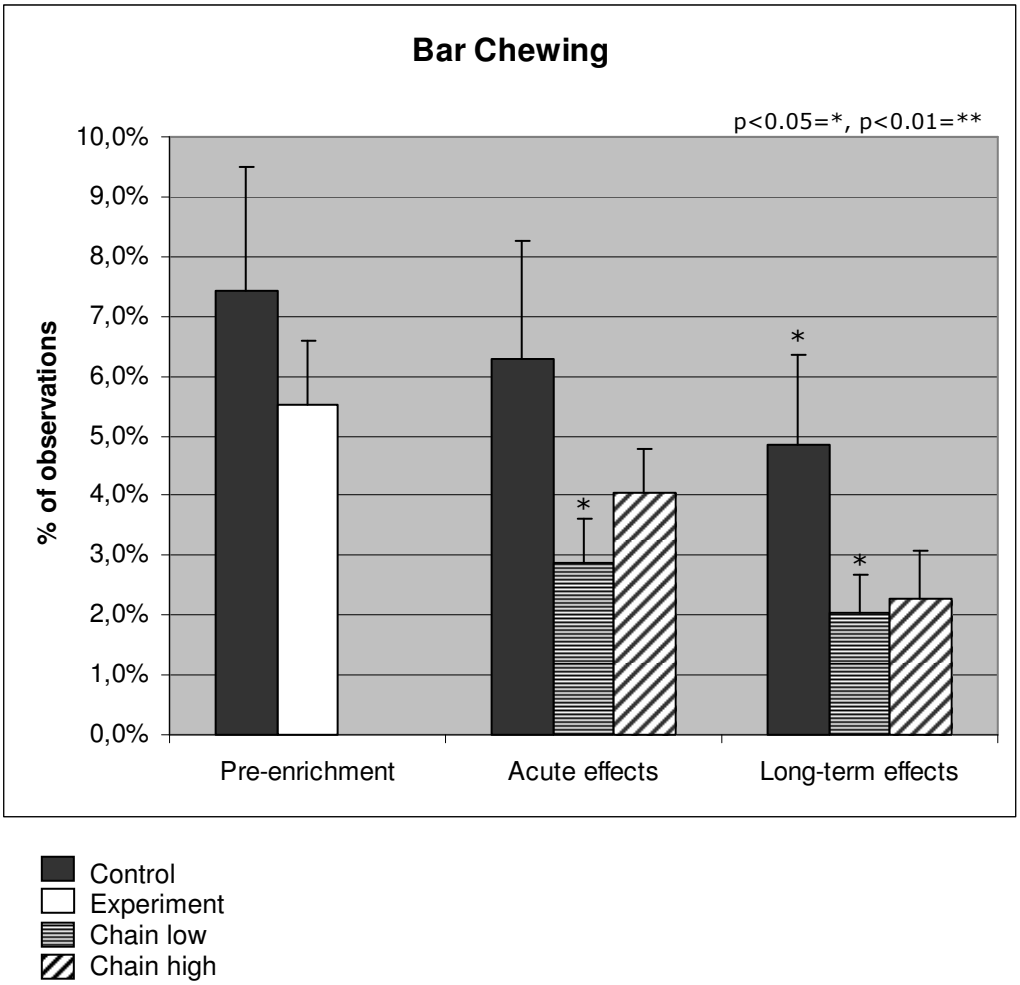

Fig 2.2 Amount of time the sow were spending with bar chewing presented as a % of the observation time.

When the chain was hanging low, the sows spent 3.05±0.65% less time with bar chewing ($p<0.05$). No influence was found of the moments of observation (acute versus long-term). The control group was spending 2.55±1.18% less time with bar chewing ($p<0.05$) on the long-term.

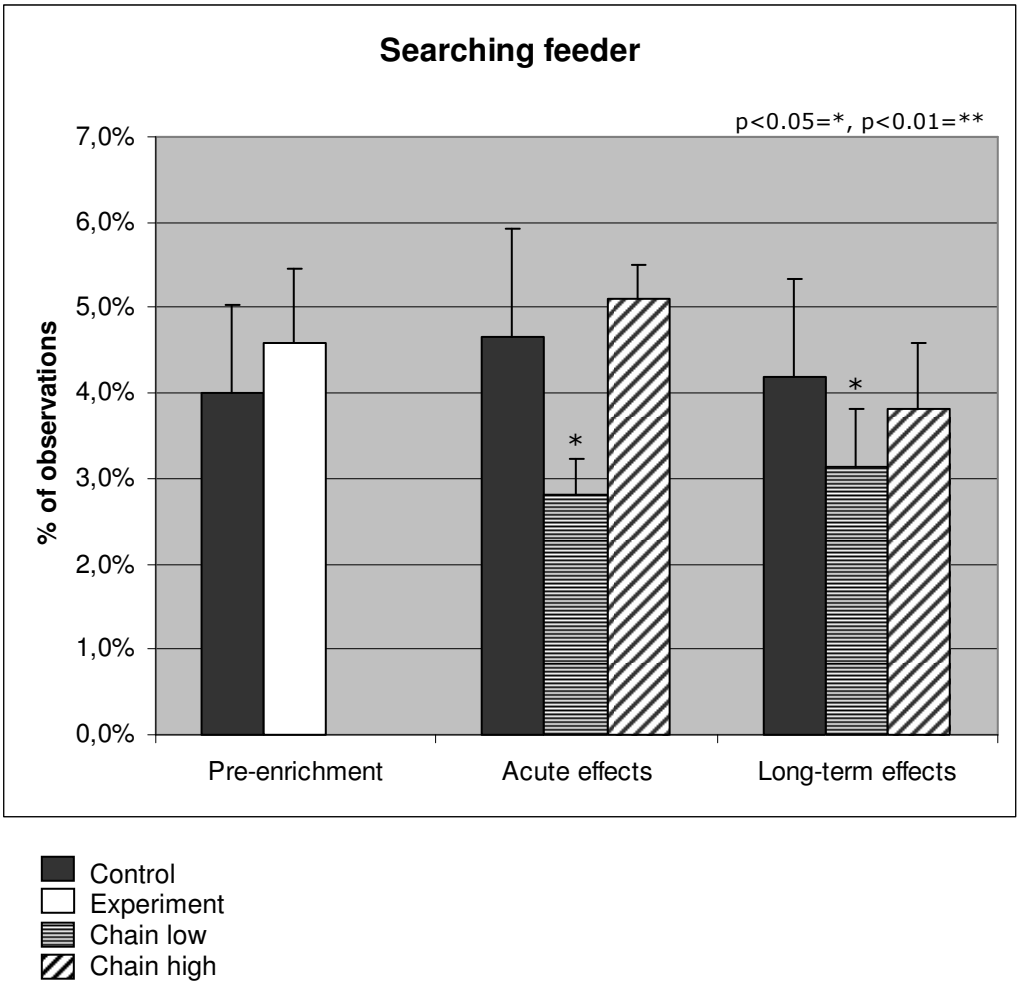

Fig 2.3 Amount of time the sows were spending with searching the feeding area presented as a % of the observation time

When the chain was hanging low the sows were spending 1.61±0.69% of the observation time less ($p<0.05$) searching the feeder independent of the days of observation (acute effects versus long-term effects). No differences were found when the chain was hanging high or in the control group.

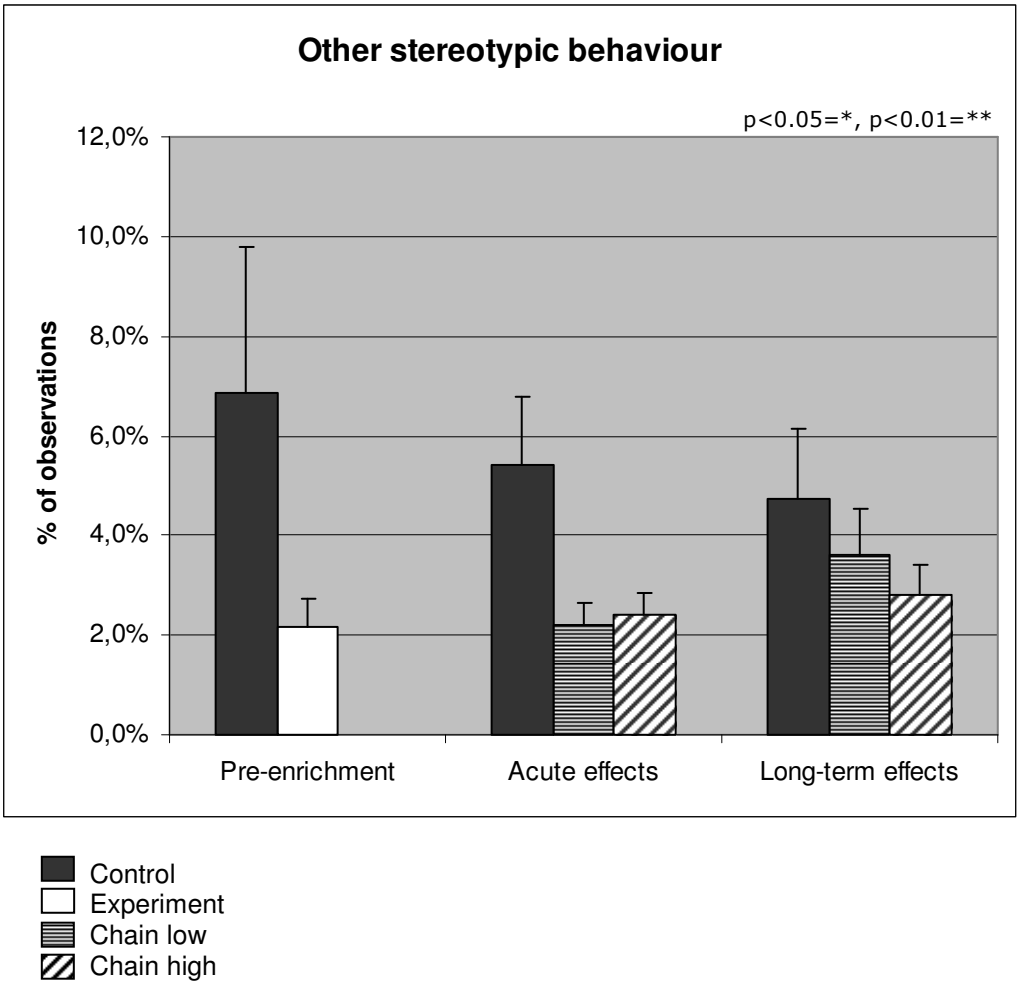

Fig 2.4 Amount of time the sows were spending with other stereotypic behaviour than in fig 2.1-3 presented as a % of the observation time

No differences were found in comparison with the acute effects. On the long-term the sows were spending 1.07±0.55% of the observation time more with other stereotypic behaviour (p=0.056) with a 95% confidence interval of -0.02-2.16%. There were no differences between the positions of the chain. In the control group no differences were found.

In figure 3 the total amount of stereotypic behaviour during the experiment is presented. The different types of stereotypic behavior shown in fig 2.1-2.4 are summed.

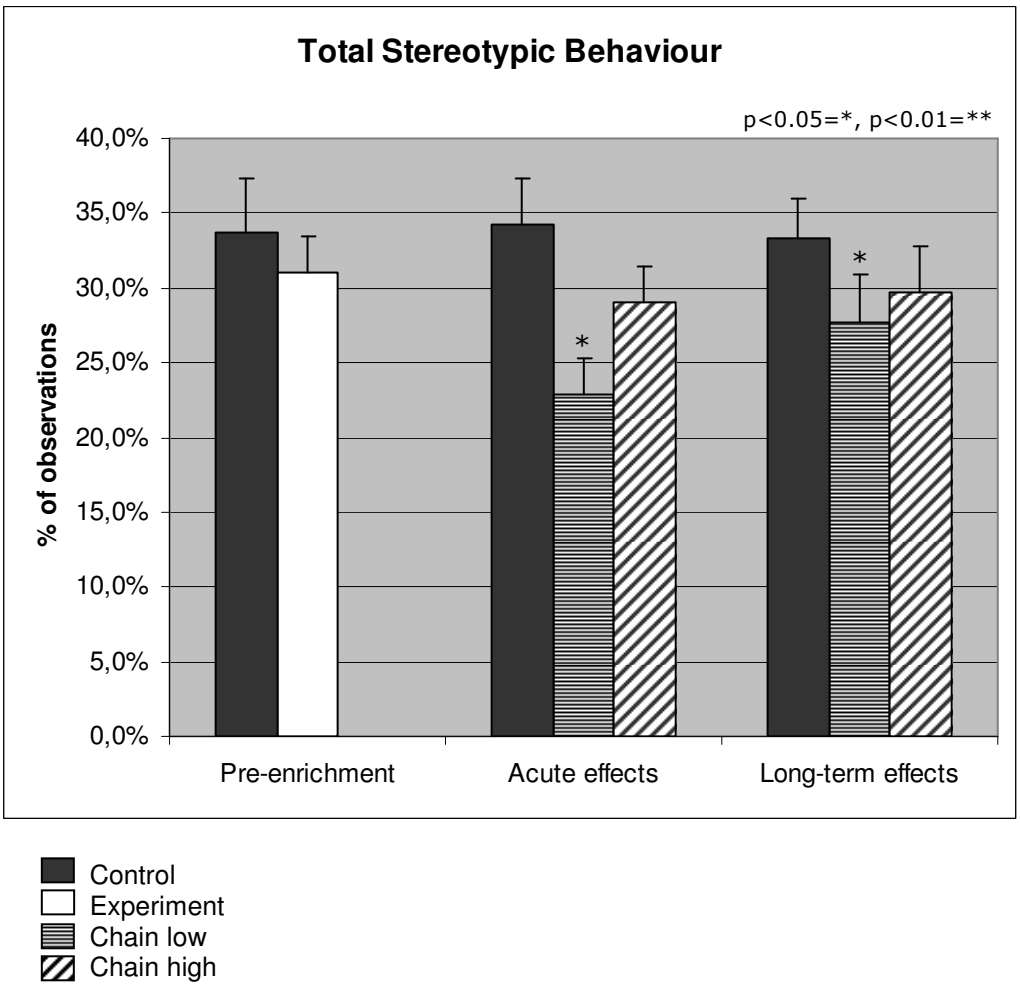

Fig 3. Amount of time the sows were spending with stereotypic behaviour presented as a % of the observation time

When the chain was hanging low the sows (enrichment group) showed 5.75% less stereotypic behaviour ($p<0.05$). No difference between the acute or long-term effects was found.

No differences were found in the amount of stereotypic behaviour the control group was performing.

In figure 4 the quantity of time the sows were nosing (NT) or chewing (CT) on the chain is presented. Difference is made between the positions of the chain.

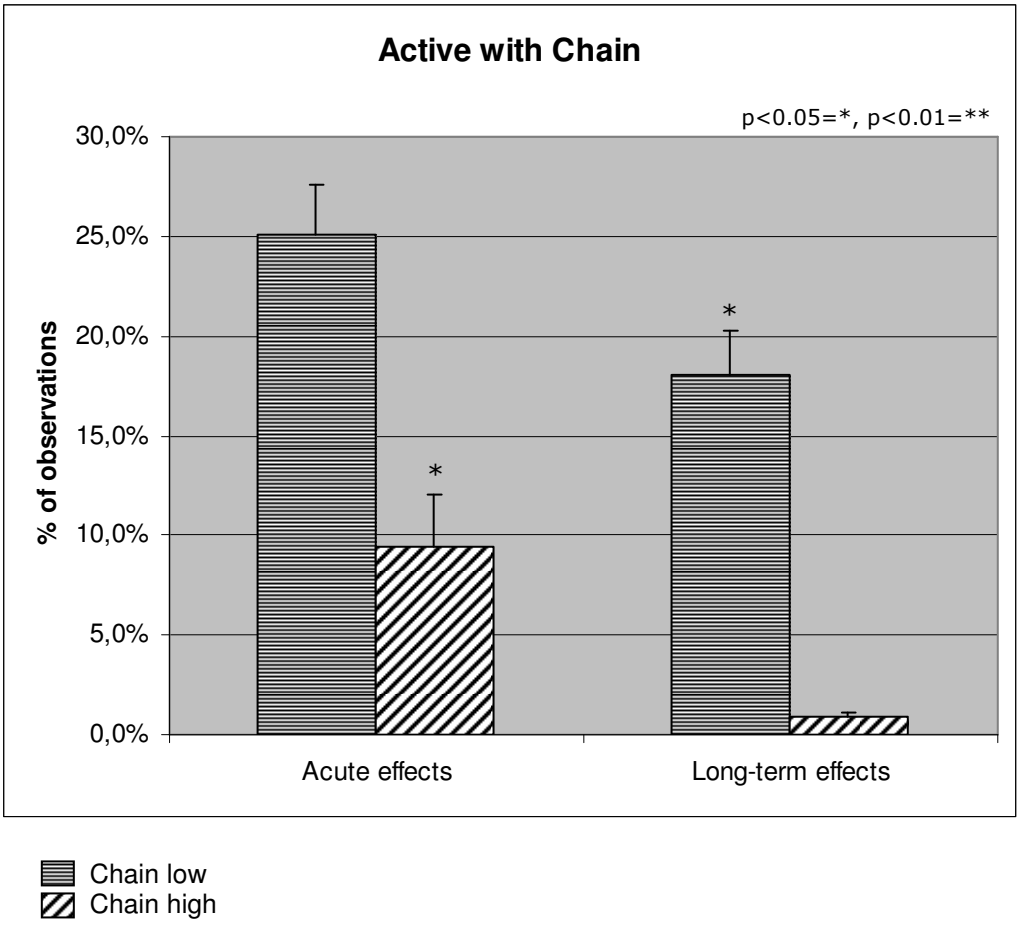

Fig 4. Amount of time the sow were manipulating the chain presented as a % of the observation time

When the chain was hanging high the sows spent 15.35±2.89% less of the observation time manipulating the chain ($p<0.05$) comparing the acute effects.

In the longer term the sows spent 7.05±2.68% of the observation time less manipulating the chain when it was hanging low compared with the acute effects ($p<0.05$).

Correlations

Relation	Control	Chain low	Chain high
Standing - vacuum chewing	-0.340**	-0.271*	-0.289*
Standing - bar chewing	0.623**	0.266*	0.334**
Standing - searching feeder	0.667**	0.401**	0.390*
Standing - other stereotypic behaviour	0.627**	0.236*	0.107
Lying - vacuum chewing	0.291*	0.117	0.165
Lying - bar chewing	-0.597**	-0.126	-0.263*
Lying - searching feeder	-0.613**	-0.324**	-0.350**
Lying - other stereotypic behaviour	-0.619**	-0.149	-0.086
Manipulating chain - bar chewing	-	-0.274*	-0.024
Manipulating chain - searching feeder	-	-0.200	-0.070
Manipulating chain – other stereotypic behaviour	-	0.198	0.076
Manipulating chain – vacuum chewing	-	-0.268*	-0.112

Tabel 1. Spearman correlations, p<0.05=*, p<0.01=**

Discussion

On the long-term the sows were lying more on side of their belly with eyes open or closed, there was no difference between the enrichment group and the control group or the position of the chain (fig 1.2). As a consequence the sows were standing less.

The control group was standing less during the long-term observations. The enrichment group was also standing less but this reduction was not significant (fig 1.4), probably because they where standing less and sitting more during the pre-enrichment observations. The reason why the sows were lying more during the long-term observations could be a result of habituation to human interaction. But also other factors such as ambient temperature may have an effect on the lying behaviour (*Huynh et al.* 2004).

It is also known that housing design may influence the posture of the sows (*McGlone et al.* 2004). The stall length and stall width relative to the length and width of the sow were directly related to the duration of postures (*Anil et al.* 2002). Sows spent less time standing and more time sitting in narrower compared with wider stalls. The proportion of lying time spent in lateral recumbancy was greater for larger than for smaller sows and larger sows made fewer postural changes (*Li et al.* 2007). The sows of this experiment spent more time in standing or sitting position than in other studies, this could be a consequence of the effect of housing design in relation to the size of the sow and the posture of the sow. But this study did not take the effects of housing design in account.

The pregnant sows of the present study spent more time in an active position (not-lying) than other studies. On average (long-term observations) an estimated 36.6% of the observation time. The pregnant sows of Brouns (1994) fed a standard commercial diet spent 30.2% of their day active and the sows of (*Buckner et al.* 1998) on average an estimated 21.7%. A reason for this difference could be the moment of observation, in the present study only the active periods after feeding and watering were observed. So probably, the management of the farm (amount of feeding/watering times) has influence on the postures of the sows. Also the length of observations could be a reason of this difference because in the present study only 5 hours during the active period were observed.

Other dissimilarities between the sows play probably also a role. For example the age of the sows has influence on the sitting and standing behavior. Others (*von Borell et al.* 1991) found that the total time the sows spent standing and sitting was positively correlated with age. In the present study this correlation was not observed.

Food restriction could be a cause why the sows spent more time in active position than other studies. It is know that gilts on low food levels spent a greater proportion of their time in the standing position than those on high food levels and they spent more time with stereotypic behaviour (*Appleby et al.* 1987).

Food restriction might also explain why the sows in this experiment showed stereotypic behaviour (*Lawrence et al.* 1988). Stereotypies are reduced because of increased satiety and partly because sows have more opportunities to perform eating and foraging behaviours (*De Leeuw et al.* 2004a).

Vacuum chewing is the most common stereotypic behaviour in pregnant sows (*Rhodes et al.* 2005, *Arellano et al.* 1992). This outcome is in accordance with the results of the present study. The sows were performing vacuum chewing behaviour independent of what kind of position they were, but mostly in a lying or sitting position. In both groups vacuum chewing was negatively correlated with standing (enrichment -0.271; control -0.340).

Other investigated stereotypic behaviours such as bar chewing, repeatedly searching the feeding area and the remaining stereotypic behaviours were positively correlated with standing. This outcome suggests that when sows are in a lying or sitting position they prefer vacuum chewing above other stereotypic behaviours. The amount of time the enrichment group was spending with vacuum chewing did not change during the experiment. The control group, however, was showing more vacuum chewing behaviour on the long-term (fig 2.1). This could be because the control sows were lying more during the long-term observations. The reason why the amount of vacuum chewing of the enrichment group not changed is not clear.

When the chain was hanging low the sows spent less time with bar chewing maybe because they were manipulating the chain more. The control group spent also less time with bar chewing so probably other factor may have played a role.

When the chain is hanging low, also the amount of time the sows were spending with obsessively searching of the feeding area dropped with 37%. Moreover, there was no difference between the acute and long-term effects. No changes were found when the chain was hanging high or within the control group of sows. So it could be possible that when the chain is hanging low some of the sows need to perform stereotypic behaviour, such as bar chewing or searching the feeding area, is replaced by the opportunity to manipulate the chain. However, manipulating the chain was only moderate negatively correlated with bar chewing and searching the feeding area (0.274; 0.268).

In total, the sows were spending 31.05% (enrichment), 33.65% (control) of the observation time stereotypic behaviour (fig 3). When the chain was hanging low, the enrichment sows showing 5.75% less stereotypic behaviour, a decrease of 19% regardless on which moment the observations where done (acute versus long-term effects). These results suggest that when the chain was hanging low, it was successful to reduce the amount of stereotypic behaviour of the sows.

It is difficult to state that a chain is useful as a toy to improve welfare of individually kept pregnant sows. It is known that metal objects, such as chains, are not suitable enrichment materials for pigs other toys such as rubber, rope, roughage and substrates may be sufficient; and straw and compound materials (combinations of objects and/or substrates) are best. A combination of ‘flexibility’ and ‘destructibility’ proved to be most interesting for pigs (*Van de Weerd et al. 2009)*. Nevertheless, when the chain was hanging low, it was successful to reduce the amount of stereotypic behaviour of the sows for this period of observation time. It is well known that once an animal has developed stereotypic behaviours they do not decline, even if the underlying cause of the formation of stereotypic behaviour is already gone (*Cabib et al.* 2006, *Mason et al.* 2006). The reason why, in this study, the amount of stereotypic behaviour declined is not clear. Maybe it is because a part of the bar chewing behaviour is

replaced by manipulating the chain. From previous studies it is known that in course of time, playing with a chain can lead to obsessive chain-biting (*Bergeron et al.* 2006, *Schouten et al.* 1991b). In the present study the manipulative behaviour of the sows on the chain is not counted as stereotypic behaviour, but it should be kept in mind.

During the experiment, the position of the chain was changed once a day. In commercial pig farms a chain is a well known toy for pigs. In this experiment the position of the chain was changed to enlarge the attractiveness of the chain and mounted in a way that sows could stimulate each other to manipulate the toy. In the enrichment groups it is shown (fig. 4) that the sows spent more time manipulating the toy when it is hanging low than otherwise 25.05±2.08% versus 9.71±2.68%. The interest in the toy disappears in course of time with 7.05±2,68%.

A reason why the sows are more active with the chain when it is hanging low may possibly be found in the natural the foraging behavior of pigs. The wild ancestor of the pig, *Sus Scrofa,* spent most his forage and exploring behaviour at ground level. It is known from earlier studies that behavior of free-ranging domestic pigs have a lot of similarities with his wild ancestors (*Gustafsson et al.* 1999, *Jensen* 1986, 2009). So when a chain is used as a toy for individually kept pregnant sows, it might be a better solution to mount it at ground level.

Table 1

Code	Behavior	Description
	Posture	
L	Lying	The pig is lying on side or belly with eyes open
D	Sleeping	The pig is lying on side or belly with eyes closed
S	Standing	Body support by four legs
K	Kneeling	Kneel (front legs bent, hind legs stretched vertically)
Z	Sitting	Sit (the pig is in upright position, with its back legs bent such that the pig supports its weight on its hind quarters)
	Activity	
NF	Nosing floor	Sniffing or touching the floor with the snout
SG	Scraping ground	Scraping ground with one of the front legs
NO	Nosing object	Sniffing or touching part of the pen above floor level
NT	Nosing toy	Sniffing or touching a toy (straw)
CH	Chewing air	To bite and grind with the teeth without any food or substrate in the mouth
CO	Chewing object	To bite and grind with the teeth with any part of the pen (non-food) in the mouth
CT	Chewing toy	Chewing a toy (chain)
CL	Climbing	Climbing onto part of the feeder
LG	Lifting gate	Lift the gate using snout
SF	Sniffing feeder	Sniffing and touching feeder with the snout
EE	Eating	eating from own feed trough or chewing feed with head in or above feeder
SB	Social behavior	Any positive social interaction such as touching or sniffing any part of the head/body of neighbour
FF	Aggressive behavior	Ramming or pushing neighbour, with or without biting
GA	Gaping/yawning	Opening mouth wide open
PW	Playing water	Oral activity others than drinking (making bubbles)
CB	Comfort behavior	Any kind of rubbing/stretching
DD	Drinking	Drinking water from trough
PO	Eliminating	Defecating or urinating
NA	No activity	No activity is being performed, usually when sow is sleeping

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