Australian Government
Department of Agriculture, Water and the Environment

AUSTRALIAN Pork

# Environmental Enrichment for Sucker and Weaner Pigs: The Effect of Enrichment Block Shape on the Behavioural Interaction by Pigs with the Blocks

**Final Report**
**APL Project 2015/069**

**November 2016**

**University of Sydney**
Jade Ashley Winfield
Faculty of Veterinary Science
Camden NSW 2570

## Acknowledgements

This project is supported by funding from Australian Pork Limited and the Department of Agriculture.

The authors would like to thank the Ridleys Company for their generous donation of sugar beet pulp blocks for this research, and Jade Winfield gratefully acknowledges the receipt of a student Honours Scholarship from Australian Pork Limited.

Supervisory panel:
Dr Greg M. Cronin and Dr Cormac O'Shea
School of Life and Environmental Sciences, University of Sydney, Camden NSW 2570

Dr Cameron R. Ralph
South Australian Research and Development Institute, Animal Welfare Science Centre, The University of Adelaide, Roseworthy Campus, Roseworthy SA 5371

Dr Evelyn J.S. Hall
Biometrics Group, Faculty of Veterinary Science, University of Sydney, Camden NSW 2570

Greg F. Macnamara and Ben L.F. Macnamara
May Farm Pig Unit, University of Sydney, Faculty of Veterinary Science, Camden NSW 2570

## Executive Summary

An enrichment block containing sugar beet pulp (SBP), originally developed as an enrichment device for sows during gestation, was reduced in size and thus weight to suit sucker and weaner pigs. This Honours experiment tested the effect of SBP enrichment block shape on oro-nasal contact by sucker and weaner pigs with the blocks, and whether pigs habituated to the blocks over time. Nineteen litters containing a total of 197 piglets were used, commencing from about 10 days of age. Each litter was allocated at random to one of 3 block-shape treatments: (1) Cube, (2) Brick, or (3) Wedge. Pigs were weighed weekly, when the SBP blocks were also weighed and replaced with fresh (new) blocks of the same treatment shape. Within litters, the number of pigs observed to behaviourally interact with the SBP block was recorded from video using a point sample technique to measure the frequency of oro-nasal interaction. In addition, four focal pigs per litter were marked enabling quantification from the video of the bout duration of interactions with the blocks. Brick-shaped blocks attracted more oro-nasal contact (17% probability during observations) compared to the cube and wedge shapes (13.2% and 12.7%, respectively; $P = 0.002$). While oro-nasal contact with the blocks was relatively infrequent before pigs were about 25 days old, thereafter there was a steady increase in interactions until the experiment concluded at about 9 weeks. Further, the frequency of oro-nasal contact with blocks was greater ($P < 0.001$) if the blocks were "fresh" (i.e. during the first 24 h) compared to four days old, suggesting habituation to blocks occurred. From 25 to 60 days of age, the duration of oro-nasal bouts by focal pigs with the blocks was always longer ($P = 0.014$) during the first 30 min of exposure to a fresh block, than for the remainder of the first 24 h or on the fourth day after block replacement. The findings thus suggest habituation to blocks may have occurred as quickly as 24 h after the block introduction. Although the decrease in block weight within weeks was not affected by block shape ($P > 0.05$), the decrease was not associated with pig weight change ($P > 0.05$). Block weight decrease was assumed to be mainly due to ingestion of the material by the pigs. However, in some litters, particularly litters aged 7-8 weeks old, scouring was observed which may have been due to higher levels of consumption of the blocks. The latter was anecdotally observed in some pens, but there was no significant correlation with pig growth ($P > 0.05$). Nevertheless, the latter observation should be investigated further.

It was concluded that oro-basal contact by sucker pigs with the blocks predominately commenced in the fourth week of lactation. The finding thus suggests that SBP blocks may not need to be provided in the sucker stage until the fourth week of lactation. Further, sucker and weaner pigs seemed to "prefer" the brick-shaped rather than the cube- or wedge-shaped blocks. The latter finding may be due to the wider surface available for oro-nasal contact, where more than one pig could simultaneously interact with a brick-shaped block, and stimulating facilitation of rooting/nosing behaviour. We speculate that simultaneous interaction with the brick-shaped block may be similar to a litter co-operatively massaging the sow's udder prior to suckling bouts.

## Contents

## List of Tables

## List of Figures

## 1. Introductory Technical Information

Environmental enrichment is provided to captive zoo animals to assist in improving welfare by increasing the frequency and diversity of (natural) behaviours performed (Newberry, 1995; Wells, 2009; Morris et al., 2011). There is public expectation that intensively farmed animals such as pigs should also receive environmental enrichment to ensure sufficient species-specific behaviour is performed to allow pigs to enhance their behavioural repertoire (Bracke et al., 2006; Oostindjer et al., 2011). Although most pigs are housed in groups enabling social interaction, whether positive or negative, critics suggest social living *per se* does not satisfy pig welfare requirements (Jensen et al., 2010). Indeed, Bracke et al. (2006) concluded that commercial pigs require inanimate objects for "proper investigation and manipulation" to ensure good welfare. Thus, social living combined with the provision of extra space do not necessarily ensure good welfare status for pigs, for example if the pigs perceive the environment is "barren". According to De Jong et al. (2000), pigs require manipulable objects or bedding for stimulation. However, under commercial conditions in Australia, bedding is problematic since the conventional indoor, pig-pen environment is not compatible with straw or other bedding material. Straw may block drains, pipes and pumps located under the slatted flooring, resulting in effluent collection systems failing (Scott et al., 2006). Nevertheless, the review by Bracke et al. (2006) and the subsequent EC Directive (Directive 2008/120/EC) conclude that there should be permanent provision of material such as straw to pigs. While Van de Weerd et al. (2003) listed the characteristics of alternative, inanimate objects pigs find to be enriching as 'ingestible', 'odorous', 'chewable', 'deformable' and 'destructible', it is also recognised that pigs may quickly lose interest in, that is habituate to, inanimate objects in their pen.

The literature is not conclusive that the provision of enrichment objects necessarily result in improved welfare of sucker/weaner pigs, for example compared to the provision of a chain to chew (Nannoni et al., 2016). Nevertheless, many studies have focused on increasing the diversity of species-specific behaviours, as some believe this contributes to improved welfare of animals (see Hemsworth et al., 2015). Previous studies on pigs have concentrated on foraging as an important species-specific behaviour (Van de Weerd et al., 2006). Habituation is less likely to occur if the enrichment object motivates the animal to perform behaviours that are relevant to survival, such as ingesting food or avoiding predators. Hence, pigs may quickly lose interest in enrichment devices provided in their pen if the devices are not "relevant" (Van de Weerd et al., 2003). Key questions therefore include how to ensure pigs interact with enrichment devices provided, and how to stimulate re-investigation or continued use of enrichment devices?

Food is an important motivator for pigs, often being more effective than social interaction (Hemsworth et al., 2011). Foraging is a series of appetitive behaviours whereby pigs investigate the environment with the goal of seeking food to ingest, which presumably rewards them for their behaviour. Providing an occasional food reward would seem to be important when attempting to reinforce foraging behaviour in an animal which is directed to an inanimate "enrichment" object. The reward encourages the animal to interact with the object again, which decreases the chances of habituation (Van de Weerd et al., 2003). In Australia, a "lick block" made from sugar beet pulp has been developed by Ridleys for adult sow enrichment in the gestation housing phase of commercial production. Sugar beet pulp is a fibrous, non-nutritive "waste" product of the sugar-beet refining process. Some molasses remains after the sugar beet has been processed to extract (refined) sugar, thus providing a potential reward to reinforce the foraging behaviour of pigs towards the block. In theory, the molasses residue may motivate sows to continue to interact with the blocks, preventing habituation. Currently, these blocks are produced as a cube for adult sows, with blocks measuring about 26×26×26 cm and weighing ~20 kg. It is not known whether smaller pigs, such as suckers and weaners, are able to root/bite/chew these heavy cube-shaped blocks. If sugar beet pulp blocks are provided to smaller pigs that are incapable of manipulating them due to the large size and mass, or due to inappropriate shape, it is a risk that pigs may habituate to the blocks when provided in their pens and there will be no potential benefit to welfare. In this experiment we aimed to investigate the effects of block shape on the occurrence of oro-nasal contact by sucker and weaner pigs with the blocks, and to determine whether habituation to the blocks occurred, for example if pigs could not root, chew or bite the blocks, or were otherwise not stimulated to interact with the blocks.

## 2. Research Methodology

### *2.1 Litters and housing*

The experiment was conducted under approval of the University of Sydney Animal Ethics Committee. A total of 197 piglets from 19 litters were used. The dams were crossbred Large White-Landrace sows, and litter size ranged from 7-15 piglets. Litters were randomly assigned to treatments, and the experiment was conducted over 3 replicates in time corresponding to farrowing batches in the pig unit. Litters were not mixed during the experiment. During the sucker stage, litters were housed with their dam in conventional farrowing crates in an environment-controlled room containing 8 farrowing crates (measuring 1.6 × 2.2 m with fully-slatted, tri-bar metal flooring). An area of solid flooring (0.5 × 1.8 m) was provided for the piglets in the heated creep area. At weaning the litters were transferred to an adjacent, heated weaner room containing 8 raised pens (2.35 × 1.2 m). The weaner pens had 1.55 × 1.2 m of solid flooring and 0.8 × 1.2 m of tri-bar slatted flooring. Feed and water were provided *ad libitum* in the weaner pens.

### *2.2 Sugar-beet pulp block shape treatments*

Full-sized sugar beet pulp (SBP) blocks obtained from Ridleys were cut into three shapes: a cube, a brick, and a wedge, as represented schematically in Figure 1.

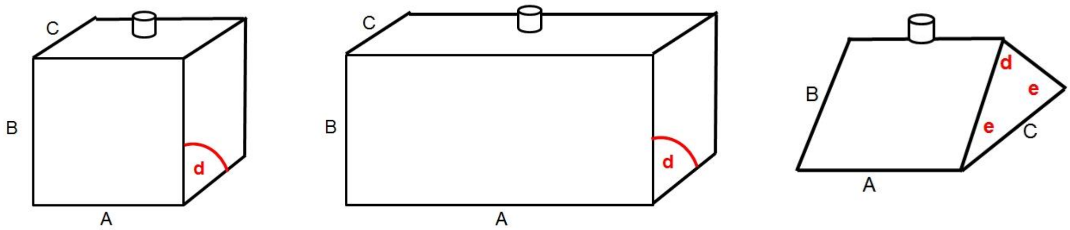


*Figure 1. Sketches of the three block shapes used in the experiment. From left to right: cube, brick and wedge, respectively. The position of the attachment skewer, using a 10 mm diameter metal pin inserted vertically through the block, is also shown in the diagrams. The different letters shown with the shapes refer to respective measurements of side length (black) or corner angles (red). The measurements are provided in Table 1 for blocks prepared for sucker compared to weaner pigs.*

*Table 1. Dimensions and angles identified in Figure 1 for the different shaped blocks provided for sucker and weaner pigs in the experiment. Measurements shown are approximate.*

| **Shape:** | **Cube** | | | | **Brick** | | | | **Wedge** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | d | A | B | C | d | A | B | C | d | e |
| Unit | cm | cm | cm | deg | cm | cm | cm | deg | cm | cm | cm | deg | deg |
| Sucker | 8 | 8 | 8 | 90 | 8 | 16 | 8 | 90 | 8 | 8 | 11 | 90 | 45 |
| Weaner | 13 | 13 | 13 | 90 | 13 | 26 | 13 | 90 | 13 | 13 | 18 | 90 | 45 |

The logic of comparing pig responses to the three block shapes were as follows:

(1) The **cube** would potentially provide enough space for a single sucker or weaner pig only to interact with one surface of the block, and adjacent surfaces would be separated by right angles that piglets might find difficult to mouth or bite. Thus, the cube shape served as a control treatment for the other shapes.

(2) The **brick** shape might enable multiple pigs to interact with the block, for example in a co-operative manner similar to how littermates might massage the sow's udder. Thus, the brick shaped block served as a treatment that potentially allowed facilitation of co-operative group behaviour.

(3) The **wedge** shape had two edges of 45 degrees, which we assumed would enable smaller pigs to mouth or bite into the block (compared to a right angle edge). Thus, the wedge shape block served as a treatment that potentially allowed especially piglets to more easily taste and/or ingest block material through mouthing/biting the narrow edge, thereby rewarding oro-nasal contact with the block through taste or consumption of the material.

The number of litters receiving the three treatment block shapes is shown in Table 2.

*Table 2. Number of litters in each block shape treatment per replicate (farrowing batch).*

| **Shape:** | **Cube** | **Brick** | **Wedge** |
|---|---|---|---|
| Replicate 1 | 3 | 2 | 3 |
| Replicate 2 | 1 | 2 | 2 |
| Replicate 3 | 2 | 2 | 2 |
| **Total litters** | 6 | 6 | 7 |

### *2.3 Presentation of treatment block shapes to the sucker and weaner pigs*

Each shaped block was drilled through using a 10 mm diameter drill bit, which enabled the block to be skewered on 10 mm-thick metal rod. Thus, the blocks could be fixed on the vertical rods within crates/weaner pens to facilitate observation via video cameras. In addition, the shaped blocks were raised 20 mm above the slatted floor via a spacer located under the block, through which the metal rod passed. All blocks were positioned above slatted rather than solid flooring to facilitate attachment of the lower end of the vertical metal rod from below the floor.

Blocks were weighed (after drilling out the hole for the rod) prior to placement and were removed and re-weighed after 7 days to determine consumption or disappearance rate. Each week a new (fresh) block of the appropriate treatment shape was placed in each crate/pen (Table 2). In the event that the block was consumed within the 7 days, a new block of the same shape was prepared, weighed and placed in the pen. The initial weights of the different shaped blocks provided to the sucker pigs averaged 0.89 kg, 1.71 kg and 0.48 kg for the cube, brick and wedge, respectively. When the piglets reached the weaner phase, larger block sizes were used, with mean weights of 2.79 kg, 5.31 kg and 1.40 kg, respectively. Weaning occurred on a set day of the week (Thursday) in the fourth week of lactation. Average weaning age was about 26 days.

The treatment blocks were first introduced to the sucker pigs in farrowing crates when the litters averaged 10.7 days old (± 2.13 std dev). Replicate 1 concluded when the weaner pigs averaged 66 days old. However, due to the wedge-shaped blocks being "destroyed" daily by some litters of weaner pigs in replicate 1 once the litters were about 40 days old, it was decided to conclude the observations in the subsequent two replicates once litters were about 7 weeks old (average 46.5 days ± 1.92 (std dev) for the second and third replicates). Replicates 1, 2 and 3 included 8, 5 and 6 litters, respectively.

### *2.4 Pig growth measurement*

All pigs were individually identified using ear notching that had been performed when the piglets were 2 days old. During the experiment pigs were weighed weekly, coinciding with weighing of the SBP blocks. While pig live weight data were collected to investigate the effects of block shape on growth of the litters, weight gain data were also monitored to determine whether growth was associated with weight change of the sugar beet pulp blocks within weeks.

### *2.5 Video recording*

All farrowing crates and weaner pens were monitored using low-light video cameras (AHDI Mega Pixel Cameras, CCTV Central, Mount Waverley, Victoria) with 3.6 mm fixed lenses. Cameras were mounted above the respective locations to provide a clear view of the SBP enrichment block. Sound was not recorded. Video data were continuously recorded using a 16 Channel AHD 1080P Digital Video Recorder (CCTV Central, Mount Waverley, Victoria). Digital video data were then down-loaded from the DVR unit to external hard drives in the format of AVI files, which were viewed on a lap-top computer for collation of behaviour data. All behaviour data were collated by one observer (JAW). Lights were left on in the farrowing and weaner rooms to facilitate video recording at night.

### *2.6 Behaviour observations*

#### *2.6.1 Duration (bout length) of interactions*

In each litter, four piglets were randomly chosen (2 males and 2 females) to be focal pigs. Focal pigs were marked with a number and/or a colour on the back for easy recognition on the continuous video record. Identifying individual (focal) pigs on the video record enabled the quantification of the duration of oro-nasal contact (i.e. bout length) by specific pigs with the SBP block shape in their pen. Data were collated from the video record during 3 time periods per week, related to the time of introduction of the fresh SBP block:

- The first 30 min after placement of a fresh block (First 30 min)
- The first 5-min per hour over the next 23 h (Day 1)
- The first 5-min per hour on the fourth day after placement of the block (Day 4)

### 2.6.2 *Frequency of interactions*

The number of pigs (focal or non-focal) per litter performing oro-nasal contact with the treatment block was recorded using a point sampling technique at predetermined time points from the video record to provide a quantitative measure of the frequency of interaction with the blocks:

- On each minute over the first 30 min after placement of a fresh block (First 30 min)
- On each minute over the first 5-min per hour over the next 23 h (Day 1)
- On each minute over the first 5-min per hour on the fourth day after placement of the block (Day 4)

The Day 4 data were assumed to assist in determining whether habituation to the blocks occurred, that is compared to the first 30 minutes after fresh blocks were provided, or on Day 1. The frequency data also permitted assessment of the "popularity" of the three block shapes, by counting the number of pigs performing oro-nasal contact with each block shape at each time point, even though each litter in their crate or weaner pen was only exposed to one block shape (treatment) throughout the experiment. A pig was considered to perform oro-nasal contact with the block if the snout was close enough to the block for rooting, biting or chewing to occur, and there was no obvious signs of inactivity such as the pig was sleeping, fighting with another pig, or biting the metal rod rather than the SBP block. If the observer was uncertain whether oro-nasal contact had occurred between the pig and the block, the video would be continuously watched for up to five seconds after the observation point to clarify the pig's actions.

## 3. Results

There were no differences in litter size on day 10 of lactation due to block shape treatment (P = 0.646). The mean litter sizes were 9.8, 9.5 and 10.1 pigs, respectively, for the cube, brick and wedge treatments.

### *3.1 Effect of block shape on frequency of oro-nasal contact by pigs with the blocks*

Averaged across observation sessions within and between weeks, the probability that a pig was performing oro-nasal contact with the block when observations were collated from the video record was 31% greater for the brick shape compared to the other shapes (P = 0.002). The probability of contact with the brick-shaped block was 17.0% (back-transformed mean), compared to 13.2% and 12.7% for the cube and wedge shaped blocks, respectively.

As mentioned previously, fresh blocks were placed in the pens at the start of each week and observations were collated from the video record during three time periods: (1) every minute over the first 30 minutes, (2) for the first 5 min per hour for the next 23 hours (Day 1) and (3) for the first 5 min per hour over 24 h on the fourth day (Day 4). The likelihood that pigs performed oro-nasal contact with the different shaped blocks during each of the 3 time periods respectively, is shown in Figures 2a, b and c, across the weeks of the experiment.

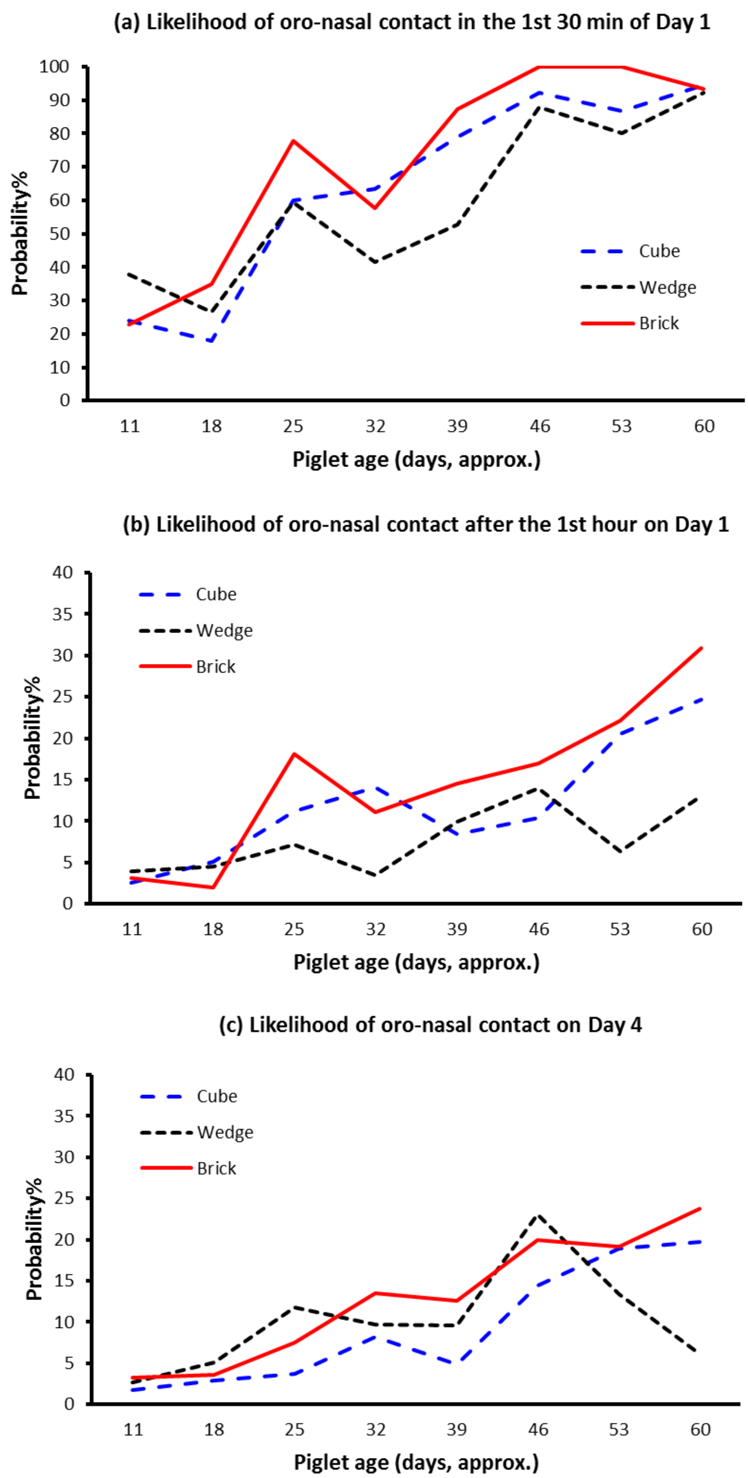


*Figure 2. Oro-nasal contact by pigs with sugar-beet pulp enrichment blocks of the three shapes during (a) the first 30 min after replacement in the pen, (b) during the next 23 h (Day 1) or (c) on the fourth day (Day 4). Values shown are the raw mean probability per treatment (shape) over time.*

The frequency of oro-nasal contact with the blocks was strongly influenced by age of the litter (P < 0.001). However, there were statistical interactions between litter age and SBP block "age" (P < 0.001). The relationship between these factors is represented in Figure 3. Pigs were more likely to be observed performing oro-nasal contact with a "fresh" block (i.e. on Day 1) than the same block when it was four days old. Further, as litters grew older the slope of the line representing the level of oro-nasal contact with a "fresh" block (i.e. on Day 1) was slightly steeper than that for a four day old block. Within weeks, the lower likelihood that pigs performed oro-nasal contact with the block on Day 4 compared to Day 1, is suggestive of habituation to the blocks.

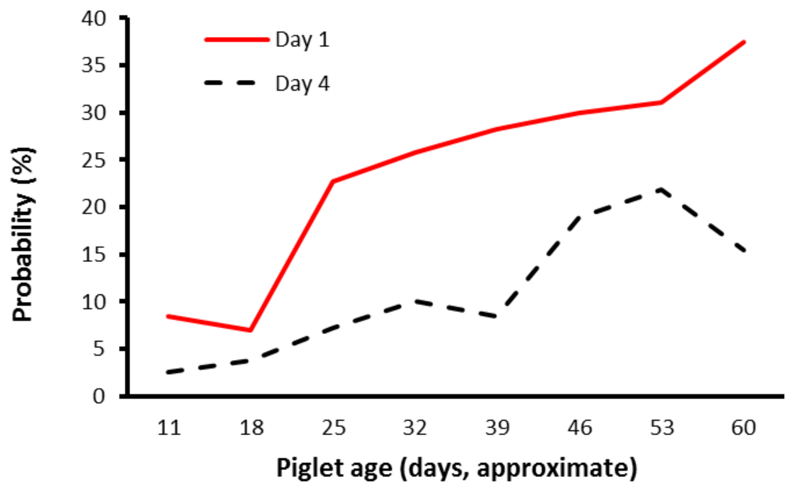


*Figure 3. Likelihood that a pig(s) was/were performing oro-nasal contact with the blocks when observed, on the first (Day 1) compared to fourth day (Day 4) that blocks were available within weeks. The values shown are back-transformed means expressed as proportions. Litters were weaned between days 25 and 32, depending on the litter.*

### *3.2 Effect of block shape on duration of oro-nasal contact by pigs with the blocks*

The duration of contact with blocks (bout length) by the focal pigs was not affected by block shape (back-transformed means: 1.7, 1.7 and 1.5 min, respectively for the cube, brick and wedge shape; P = 0.580). Mean bout length however was significantly longer (P < 0.001) during the first 30 min of access to a fresh block (2.9 min), compared to the first 24 h (1.5 min) or on the fourth day (1.1 min) that the block was in the pen, and there was a significant interaction (P = 0.014) between the "freshness" of the block and age of the litters, as represented in Figure 4.

The data in Figure 4 may also be useful to estimate whether pigs had habituated to the blocks within weeks of age, by visually comparing the duration of oro-nasal contact by pigs with the blocks between the initial 30 minutes (1$^{st}$ 30 min), the first 24 hours (Day 1) and for a 24-hour period 4 days after the block entered the enclosure (Day 4).

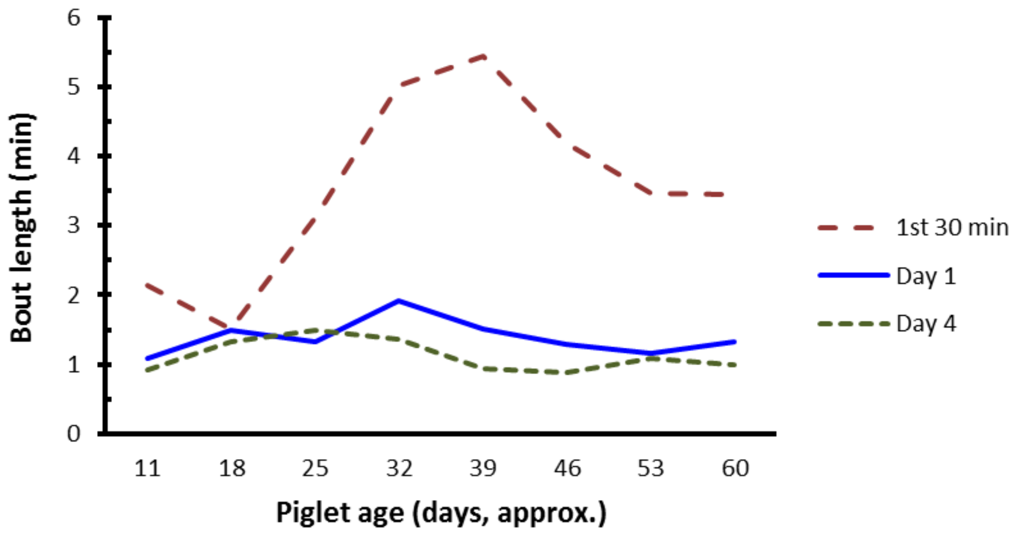


*Figure 4. Mean bout length of oro-nasal contact with the shaped blocks by focal pigs in the experiment. The data presented are back-transformed mean values, showing bout duration in the first 30 min of placement of a fresh block, the first 24 hours (Day 1) and the fourth day after the block was provided (Day 4).*

### *3.3 Change in SBP block weight compared to pig growth*

There were no effects of SBP block shape on relative weight change of the blocks within weeks (P = 0.347), that is the residual weight of the block divided by the starting weight expressed as a percentage of weight loss. The mean loss in weight (i.e. disappearance of SBP block material) expressed as a proportion of initial weight was 52, 51 and 60% for the cube, brick and wedge shape treatments, respectively. Relative weight change (loss) of the different shaped blocks over the course of the trial is shown in Figure 5. There were significant block shape × week interactions ($P < 0.001$).

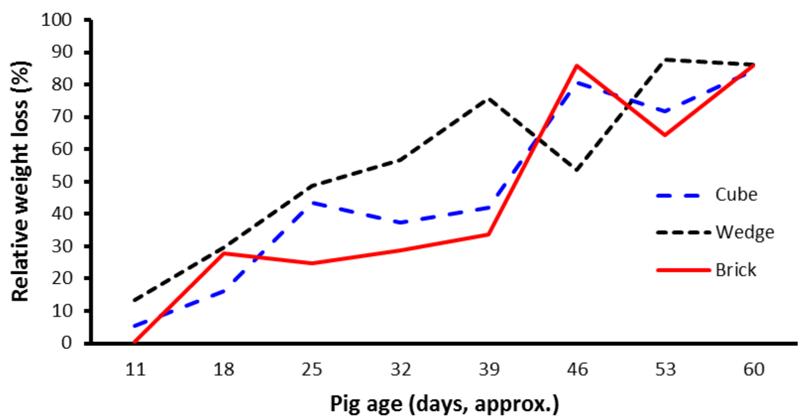


*Figure 5. Relative weight loss of the shaped blocks over the course of the experiment. The values shown are mean percentages adjusted for number of pigs in the litter.*

While relative weight loss is a useful measure to describe the rate of disappearance of the SBP blocks, a more relevant variable might be the absolute weight loss, since this may more accurately reflect consumption of the SBP material by the litter of pigs. After adjusting for number of pigs in the litter, there was a difference in absolute weight loss of the SBP blocks over the course of the experiment (Figure 6). Significantly more material disappeared from the brick-shaped blocks than from the cube or wedge (mean weight loss from the brick, cube and wedge treatments were 2.2, 1.5 and 1.1 kg per week, respectively; P = 0.045, average sed 0.3551).

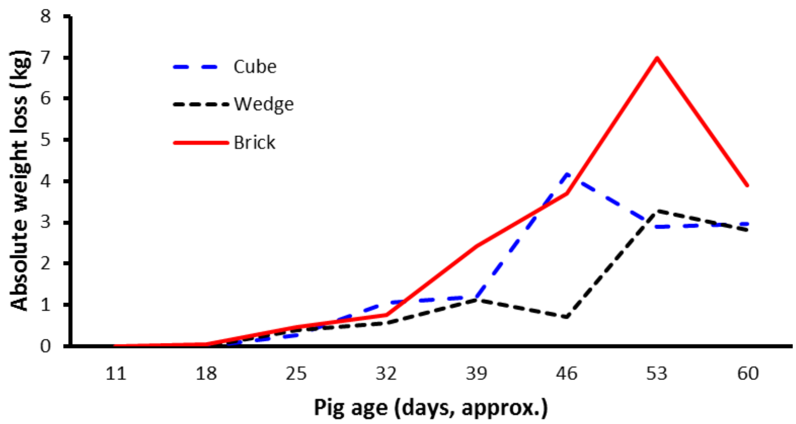


*Figure 6. Absolute weight loss of the shaped blocks over the course of the experiment. The data are predicted means adjusted for number of pigs in the litter.*

The data for absolute weight change in the SBP block (per pen) compared to growth of the pigs, after adjusting for litter size, were modelled in REML. There was no significant association between pig weight gain and SBP block weight reduction per week of the experiment (P = 0.322).

## 4. Discussion

Two hypotheses relating to increased oro-nasal contact by pigs with the sugar-beet pulp blocks were proposed in this experiment. Oro-nasal contact with blocks would be increased firstly, if smaller-sized pigs could bite or chew the block, and secondly, if facilitative (co-operative) group behaviour could be stimulated.

We predicted that the wedge-shaped block would receive more oro-nasal contact from the pigs than the cube, as the 45-degree angled edges on the wedge should make the object more easily manipulable, especially by young sucker pigs. Oro-nasal contact should provide opportunity for positive feed-back to the pig performing the chewing or biting, especially if a molasses reward could be obtained. However, there was no significant difference between the probability of contact with two shapes (13.2% and 12.7% for cube and wedge, respectively), suggesting that the hypothesis was not supported by the findings.

The brick-shaped block however, was more "popular" than either cube or wedge shaped blocks. The probability of oro-nasal contact was 31% greater for brick compared to the cube or wedge shapes, suggesting that the hypothesis was supported. This finding may be related to the physical size of the brick block, in which the dimension of one surface of the brick was wider than for the other shapes (see Figure 1). In theory, the brick-shaped block could enable multiple piglets to stand shoulder-to-shoulder to perform the typical behavioural pattern of piglets attempting to massage the sow's udder and stimulate suckling behaviour in the sow. It has been reported that multiple piglets need to be present, co-operatively massaging the udder (Fraser, 1973; Jensen et al., 1991) for a suckling bout to be successful and result in milk ejection. Thus, the greater level of contact with the brick may have been related to the width of the block, which facilitated multiple pigs rooting, nosing or biting the block simultaneously. Alternatively, as the brick was larger in size than the other shapes, more pigs could have simultaneously interacted with it, regardless of whether they were positioned shoulder-to-shoulder.

A key finding from this experiment however, was that there was relatively little oro-nasal contact with any of the blocks until the litters were between 18 to 25 days of age (see Figures 2 and 3). The increased level of interaction with the blocks by day 25 of age may be due to the sows having reached their peak of milk production, which according to Hartmann and Holmes (1989) occurs by about day 21 of lactation. After peak milk production is reached, piglets' appetite for milk would be expected to continue to increase as the pigs grow. The general increase in oro-nasal contact with the blocks as the pigs grew may have been a result of increased foraging behaviour. Foraging is relevant to survival, in that animals are motivated to seek food (McFarland, 2006). In the farrowing/lactation environment, creep feed was not supplied and hence the only source of food for sucker pigs was the sow's milk. Presumably, as lactation progresses there is an increasing gap between appetite of the piglets and available milk from the sow, which motivates piglets to perform increased levels of foraging behaviour. The lack of oro-nasal contact in the earlier weeks of the trial however, may suggest that the ideal time to introduce blocks is between day 18 and day 25 of age.

While the frequency of pigs contacting the blocks increased with pig age, the performance of oro-nasal behaviour directed at the blocks was also significantly greater in the first 24 hours after fresh blocks were provided, compared to 4 days later. Habituation to the blocks however did not seem to occur long-term, probably as the blocks were replaced weekly. Nevertheless, on the fourth day after fresh blocks were provided there appears to be some evidence of habituation (see Figure 3). Trickett et al. (2009) reported that the regular replacement, or rotation of different enrichment objects did not prevent habituation, but slowed the rate of habituation.

In the present experiment mean bout length (duration) of oro-nasal contact with blocks by the focal pigs was longer when the blocks were fresh. This was especially noticeable in the initial 30 minutes compared to the first 24 hours after exposure, and on the fourth day after exposure. Mean bout length during the initial 30 minute period after exposure to blocks was more than double that recorded for the remainder of the first day or on the fourth day, in all weeks after day 25 of age. This result suggests that while fresh blocks provided some degree of novelty, pigs habituated to blocks possibly as soon as 24 hours after exposure (Figure 4). Based on the present experiment, in which a fresh block was provided each week, it could be concluded that the SBP blocks provided less stimulation, or were less enriching, compared to the enrichment that sustained piglet interest for 5 days in the study by Van de Weerd et al. (2003). Nevertheless, the SBP blocks used in the present study are more practical and economic compared to the multifaceted enrichment proposed by Van de Weerd et al. (2003).

The enrichment block and pig weights were recorded at the beginning of each week so that associations between block weight loss and pig growth (weight gain) could be identified. As the litters grew (i.e. the pigs aged) the amount of block degradation per week typically increased. Presumably much of the weight loss from the blocks was due to ingestion of the material. Although some litters of weaner pigs in this trial exhibited scours in weeks 7 or 8 of the experiment, there was no apparent decline in growth rate. A reduction in growth rate was reported by Lizardo et al. (1997), in a trial investigating sugar beet pulp and digestion of high-fibre diets by pigs. The ileostomised pigs that had been fed SBP in the trial by Lizardo et al. (1997) had reduced growth rate compared to control pigs. This may be due to the high-fibre content of SBP or due to shifts in gastro-intestinal micro flora, such as those found by Hang and Zhu (2012), who tested the effects of SBP on weaned piglet ileal and colonic contents. Thus, while reduced weaner pig growth was not found in the present trial, research to investigate the potential adverse impact of "excessive" ingestion of sugar beet pulp would be advised.

This experiment indicated that while a brick-shaped enrichment block containing sugar beet pulp was more attractive to sucker and weaner pigs than a cube or wedge shaped block, it was probably not necessary to provide the blocks to pigs until at least 25 days of age.

## 5. Literature cited


Bracke, MBM, Zonderland, JJ, Lenskens, P, Schouten WGP, Vermeer, H, Spoolder, HAM, Hendriks, HJM and Hopster H (2006). Formalised review of environmental enrichment for pigs in relation to political decision making. *Applied Animal Behaviour Science* **98**, 165-182.

De Jong, IC, Prelle, IT, van de Burgwal, JA, Lambooij, E, Mechiel Korte, S, Blokhuis, HJ and Koolhaas, JM (2000). Effects of environmental enrichment on behavioural responses to novelty, learning, and memory, and the circadian rhythm in cortisol in growing pigs. *Physiology & Behaviour* **68**, 571-578.

EC Directive 2008/120/EC available at: [http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0120&from=EN](http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0120&from=EN) sighted 17 Nov 2016.

Fraser D (1973). The nursing and suckling behavior of pigs. I. The importance of stimulation of the anterior teats. *British Veterinary Journal* **129**, 324-335.

Hang, S and Zhu, W (2012). Gut bacterial and Lactobacilli communities of weaning piglets in response to mannan oligosaccharide and sugar beet pulp *in vitro* fermentation. *Journal of Integrative Agriculture* **11**, 122-133.

Hartmann, PE and Holmes, MA (1989). 'Review: Sow Lactation', (JL Barnett and DP Hennessy) *Manipulating Pig Production II – Proceedings of the Biennial Conference of the Australasian Pig Science Association (A.P.S.A) held in Albury, NSW on Nov 27-29, 1989,* Australasian Pig Science Association, Werribee, Victoria 3030, Australia, pp. 88-89.

Hemsworth, PH, Smith, K, Karlen, MG, Arnold, NA, Moeller, SJ and Barnett, JL (2011). The choice behaviour of pigs in a Y maze: Effects of deprivation of feed, social contact and bedding. *Behavioural Processes* **87**, 210-217.

Hemsworth, PH, Mellor, DJ, Cronin, GM and Tilbrook, AJ (2015). Scientific assessment of animal welfare. New Zealand Veterinary Journal 63: 24-30.

Jensen, MB, Studnitz, M and Pederson, LJ (2010). The effect of type of rooting material and space allowance on exploration and abnormal behaviour in growing pigs. *Applied Animal Behaviour Science* **123**, 87-92.

Jensen P, Strangel G and Algers B (1991) Nursing and suckling behaviour of semi-naturally kept pigs during the first 10 days postpartum. *Applied Animal Behaviour Sci* **31**, 195-209.

Lizardo, R, Peiniau, J and Aumaitre, A (1997). Inclusion of sugar-beet pulp and change of protein source in the diet of the weaned piglet and their effects on digestive performance and enzymatic activities. *Animal Feed Science Technology* **66**, 1-14.

McFarland, D (2006). Oxford Dictionary of Animal Behaviour. Oxford University Press, University of Oxford, UK.

Morris, CL, Grandin T and Irlbeck NA (2011). Companion animal symposium: Environmental enrichment for companion, exotic, and laboratory animals. *Journal of Animal Science* **89**, 4227-4238.

Nannoni, E, Sardi, L, Vitali, M, Trevisi, E., Ferrari, A, Barone, F, Barbieri, S and Martelli, G (2016). Effects of different enrichment devices on some welfare indicators of post-weaned undocked piglets. *Applied Animal Behaviour Science* **184**, 25-34.

Newberry, RC (1995). Environmental enrichment: Increasing the biological relevance of captive environments. *Applied Animal Behaviour Science* **44**, 229-243.

Oostindjer, M, van den Brand, H, Kemp, B and Bolhuis, EJ (2011). Effects of environmental enrichment and loose housing of lactating sows on piglet behaviour before and after weaning. *Applied Animal Behaviour Science* **134**, 31-41.

Scott, K, Chennells, DJ, Campbell, FM, Hunt, B, Armstrong, D, Taylor, L, Gill, BP and Edwards, SA (2006). The welfare of finishing pigs in two contrasting housing systems: Fully-slatted versus straw-bedded accommodation. *Livestock Science* **103**, 104-115.

Trickett, SL, Guy, JH and Edwards, SA (2009). The role of novelty in environmental enrichment for the weaned pig. *Applied Animal Behaviour Science* **116**, 45-51.

Van de Weerd, HA, Docking, CM, Day, JEL, Avery, PJ and Edwards, SA (2003). A systematic approach towards developing environmental enrichment for pigs. *Applied Animal Behaviour Science* **84**, 101-118.

Van de Weerd, HA, Docking, CM, Day, JEL, Breuer, K and Edwards, SA (2006). Effects of species-relevant environmental enrichment on the behaviour and productivity of finishing pigs. *Applied Animal Behaviour Science* **99**, 230-247.

Wells DL (2009). Sensory stimulation as environmental enrichment for captive animals: A review. *Applied Animal Behaviour Science* **118**, 1-11.