Polyunsaturated fatty acids (PUFA) are essential for the development of the nervous system in animals, and increased concentration of n−3 PUFA in maternal diet improves the cognitive development of mammalian foetuses. In this study the effect of maternal diet fatty acid composition in pigs on the development of the central nervous system, monitored as behaviour of piglets, was investigated using three behavioural tests: recognition of the mother's faeces, back test, and hidden door test.

Twenty-seven multiparous Yorkshire sows were split into four groups and fed diets with different content of fat and PUFA throughout pregnancy and lactation. LF (n = 6) was fed a standard diet, HFS (n = 4) a high fat and low PUFA diet, HFO (n = 7) a high n−6 PUFA diet, and HFL (n = 10) a high n−3 PUFA diet.

Three behavioural tests were performed on 5–7 randomly chosen piglets per litter (n = 167). Recognition of the mother's faeces was tested in a maze two days after birth. Back test was performed twice (2–4 d and 4 w) and a hidden door test was performed at 4 w. In addition, the brain content of docosahexaenoic acid (22:6 n−3, DHA) of the newborn piglets was determined in treatment groups. Data from the tests were analysed with linear mixed models for each of the tests.

Piglets from HFL treatment had significantly higher content of DHA (P < 0.001) and the ratio of n−6/n−3 PUFA significantly lower in brain tissue (P < 0.001), compared to piglets from the other treatments. In parity 3, means for recognition for mother's faeces were for diets LF, HFS, HFO and HFL; 22.2, 37.0, 26.4 and 18.0%, respectively (P < 0.05), but no other significant effect of diet was found. Piglets in HFS treatment had the shortest latency to make escape attempts and HFO piglets the longest latency in the back test (P = 0.030). No significant effect of sow diet was found on piglet performance in the hidden door test, but intermediate piglets weighing 1410–1619 g had a lower probability of success in hidden door test than piglets weighing < 1410 g (P = 0.028), and ≥ 1875 g (P = 0.027), respectively.

It was found that sow diet influenced the DHA content in the piglet brains, but there was no clear effect of sow diet on piglet behaviour. In order to draw any conclusions about possible enhancements of the behavioural development of the piglet more studies need to be performed.

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1. Introduction

A great challenge in commercial pig production is how to improve the survival of the piglets. Piglet survival could be
seen as the complex outcome of interaction between the sow, the piglet and the housing environment (Edwards, 2002). It has been suggested that the general selection for more lean tissue growth in pigs has resulted in breeding of heavier piglets that are less mature at birth (Herpin et al., 1993). Reduced physiological maturity in the piglets is a major risk factor for mortality (Tuchscherer et al., 2000), whereas increased physiological maturity makes the piglet reaching the udder more quickly and the piglet will probably be better in avoiding crushing by the sow (Zaleski and Hacker, 1993). Thus, factors that promote organ development, including the nervous system, are probably beneficial. Such neural maturation, followed with improved behavioural development, can plausibly provide the piglet with increased ability to survive.

Polyunsaturated fatty acids (PUFA), in particular docosahexaenoic acid (22:6 n−3, DHA) are essential to normal development of vision and the nervous system, as well as, cognitive development, in mammals (Willatts and Forsyth, 1998; Willatts et al., 1998a,b; Lauritzen et al., 2001). The PUFA content in the diet is reflected in the PUFA content in body fat of pigs and reindeer (Högberg et al., 2001, 2002; Wiklund et al., 2001), and it is also reported that PUFA are transferred to the foetuses of pregnant mammals (Campbell et al., 1997, 1998; Haggarty et al., 1997; Hamosh, 1998, Rooke et al., 1998, 2001a; Lauritzen et al., 2001). It has previously been found that high content of PUFA in the diet increases the PUFA content in the nervous system of the piglets, either via formula given directly to the piglets or via the sow milk (Arbuckle et al., 1991; Fritsche et al., 1993). Rooke et al. (2001b) found that feeding salmon oil to sows decreased birth weight of the piglets but piglet survival was increased. It has been found that increased PUFA in sow diet promotes the structural development of the nervous system of piglets (Leskanich and Noble, 1999). It has also been shown that improved cognitive or behavioural performance in humans, rats and dogs is associated with increasing concentrations of DHA in the brain (Greiner et al., 1999; Gamoh et al., 2001; Ng and Innis, 2003; McCann and Ames, 2005; Heinemann and Bauer, 2006).

The aim of this study was to investigate if giving dietary supplemented PUFA to the pregnant sow would increase the cognitive ability of her piglets. Our hypothesis was that sows fed diets with high content of C 18 n−3 PUFA, increasing the possibility of desaturation and elongation towards DHA, would get piglets with improved development of the central nervous system monitored in behaviour, compared to piglets from sows given diets with n−6 PUFA or less PUFA. This improved development may be manifested as increased modulation of the sensory threshold or increased cognitive skills. Therefore the effect on the piglets’ behaviour was investigated in three behavioural tests, the recognition of the mother’s scent in piglets, the piglets’ reactivity in a back test, and a test for solving a spatial task.

The specific hypotheses were that:

Piglets from sows fed diets with high content of n−3 PUFA would have a higher recognition for the mother’s scent.

Piglets from sows fed diets with high content of n−3 PUFA would have a higher reactivity in a back test, measured as time to first vocalisation and number of vocalisations during the test session.

2. Animals, materials and methods

2.1. Animals

Twenty-seven multiparous purebred Yorkshire sows (Sus scrofa f. domestica) were used in the experiment, from weaning of the previous litter until weaning of the experimental litter. The sows were inseminated with Yorkshire semen from eight different boars and the different boars were used 1, 2, 2, 3, 3, 4 and 10 times, respectively.

2.2. Housing and handling of piglets

During the service and pregnancy periods the sows were group housed in large pens (52 m²) on deep straw bedding, with maximum of 16 sows per group. The different treatment groups were housed together but fed separately in individual feeding stalls. Three weeks before expected farrowing the sows were moved to individual farrowing pens (8.5 m²) with partly drained (2.5 m²), partly littered and heated floor. The sows were not tethered and farrowing crates were not used.

Farrowings were supervised and all piglets were weighed individually at birth. Litters were not equalized in order to keep the piglets with their own mother. The male piglets were castrated on day 3–7.

2.3. Diets and feeding

The sows were split into four groups according to feeding regime. All four groups were fed a diet based on wheats and barley (with soy as protein enhancement), supplemented with low or high fat oat and/or linseed oil, respectively. Sows had free access to water. Sows in group LF (conventional feed, n = 6) were fed a standard Swedish sow diet with 3% fat and conventional content of polyunsaturated fatty acids (PUFA), sows in group HFS (increased saturated fat, n = 4) were fed a 6% fat diet with a low content of PUFA, sows in group HFO (40% of high-fat oats was included, n = 7) were fed a 6% fat diet with a high content of n−6 type of PUFA, and sows in group HFL (20% of high-fat oats and linseed oil as a source of n−3 fatty acids, n = 10) were fed a 6% fat diet with a high content n−3 type of PUFA. The linseed oil (Alternativ Förädling AB, Glanshammar, Sweden) was added by hand at feeding time, as a top-dress at a rate of 1% by weight. The contents of fat and fatty acid composition in the diets were analysed according to Pickova et al. (1997). The fatty acid composition of the four diets used in the experiment is presented in Table 1.

Sows were fed twice daily according to a theoretical model of energy requirement based on Simonsson (1994) and on evaluation of back fat. From weaning until service the daily allowance was 4 kg (approximately 50 MJ ME). During pregnancy, the sows were fed according to live weight and back fat at service. The daily allowance was 28 MJ ME for sows with live weight less than 140 kg, 33 MJ ME for the sows weighing 140 to 180 kg, 35 MJ ME for sows weighing 180 to 220 kg, and 37 MJ ME for sows weighing more than 220 kg. Sows with back fat thinner than 14 mm were fed 5 MJ ME.
extra per day during weeks 4–13 of pregnancy. From the day after farrowing, the allowance was increased by 1 kg (corresponding to 12.3–12.8 MJ ME) daily until reaching the full allowance of 101 MJ ME ± 7.6 MJ ME per piglet deviating from a litter size of ten (Simonsson, 1994).

2.4. Sampling and lipid analysis of piglet brains

Immediately following birth, the third piglet born in every litter was culled and used for evaluation of fatty acid content of the brain. The piglet was stunned by CO₂, bled to death and dissected. The brains from a sample of the newborn piglets (20 animals, 5 per treatment) were collected and stored in −80 °C until analyses. Brain lipids were extracted according to Hara and Radin (1978) to analyse fat content and fatty acid composition in the main lipid fractions, triacylglycerols (TAG) and phospholipids (PL) by using the thin-layer chromatography (TLC) methodology, which was performed in the solvent system hexane: diethylether:acetic acid (85:15:1, v/v/v). Methylation of the PL and TAG muscle lipids was performed with dry methanol and BF₃ addition, described by Appelqvist (1968) and resulting fatty acid methyl esters (FAME) were stored in hexane at −80 °C until further analysis. The analysis of FAME was performed by using gas chromatography.

The study reported in this paper was a sub-study of a larger project ("Polyunsaturated fat in diets for sows"). In this study only results regarding docosahexaenoic acid (22:6 n–3, DHA) of the brains of the newborn piglets are used.

2.4.3. Behavioural tests

To investigate the effects of PUFA on different aspect of behavioural development three different tests were used.

2.5.1. Recognition of the mother’s faeces

The recognition of the mother or the mother’s scent in piglets has previously been investigated by Horrell and Hodgson (1992a,b) and Morrow-Tesch and McGlone (1990), who found that the piglets are able to show preference for the mother scent at an early age, i.e. within two days. In order to detect differences in scent recognition between piglets from sows in the different dietary groups, we tested the piglets when they were one day old.

During the first 24 h after farrowing we randomly chose five piglets from each litter to be tested, consecutively, in a T-maze. The T-maze was placed in an adjacent room and it had solid walls, except for the end of right and left arms which were covered with a wire mesh. Outside the right and left arm the mothers’ faeces or the faeces from an alien sow was presented. The top of all end arms were partially covered with wire mesh to avoid piglets from jumping out. The test piglet was placed in the start area (indicated by an X in Fig. 1) in the maze and was then left to move freely. The maze was artificially divided into five areas and the piglet’s position in the maze was recorded every 5 s during the 600 s the test lasted. To be recorded as having recognized its mothers faeces the piglet should be in the area in the end of the arm where the mother sows manure was placed outside. All piglets were tested twice and as the piglets from one litter were tested

### Table 1

Analysed content of energy, protein and fat (g per kg feed), and fatty acid composition (percentage of total) of the four diets used in the experiment.

<table>
<thead>
<tr>
<th>Diet</th>
<th>ME (MJ/kg)</th>
<th>CP (g/kg)</th>
<th>Lysine (g/kg)</th>
<th>Methionine + cystine (g/kg)</th>
<th>Threonine (g/kg)</th>
<th>Total fat (g)</th>
<th>SAFA (saturated fatty acids)</th>
<th>MUFA (monounsaturated fatty acids)</th>
<th>PUFA (polyunsaturated fatty acids)</th>
<th>PUFA n–6</th>
<th>PUFA n–3</th>
<th>Fat composition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LF (low fat)</td>
<td>12.3</td>
<td>153</td>
<td>7.0</td>
<td>5.6</td>
<td>5.2</td>
<td>30</td>
<td>6.18</td>
<td>7.8</td>
<td>15.78</td>
<td>14.46</td>
<td>1.31</td>
<td>3</td>
</tr>
<tr>
<td>HFS (high fat saturated)</td>
<td>12.8</td>
<td>150</td>
<td>7.2</td>
<td>5.9</td>
<td>6.0</td>
<td>60</td>
<td>25.8</td>
<td>17.22</td>
<td>16.38</td>
<td>14.94</td>
<td>1.40</td>
<td>6</td>
</tr>
<tr>
<td>HFO (high fat oats)</td>
<td>12.6</td>
<td>154</td>
<td>7.1</td>
<td>6.4</td>
<td>5.3</td>
<td>60</td>
<td>11.52</td>
<td>25.62</td>
<td>22.38</td>
<td>20.52</td>
<td>1.88</td>
<td>6.2</td>
</tr>
<tr>
<td>HFL (high fat linseed)</td>
<td>12.6</td>
<td>154</td>
<td>7.1</td>
<td>6.3</td>
<td>5.2</td>
<td>60</td>
<td>10.02</td>
<td>19.14</td>
<td>30.72</td>
<td>20.34</td>
<td>10.44</td>
<td>6.2</td>
</tr>
</tbody>
</table>

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singly one after the other the tested piglet were returned to its siblings between the two test times and were then tested again when the other piglets had went through the test. The position of the faeces from the mother was swapped between test sessions after the maze had been cleaned.

2.5.2. Back test

The back test, or the tonic immobility (TI) test, has previously been used for mice, domestic fowls and pigs. The basic principle is that an individual animal is restrained on the back and thereafter the reactions of the animal, such as struggling, turning and vocalisations, are recorded. The test has frequently been used in different studies of pig personality, where the reactivity has been associated with other behavioural patterns (Erhard and Mendl, 1999; Erhard et al., 1999; Ruis et al., 2000). In our study we used the back test as a reactivity test.

The back test (modified after Hessing et al. (1993) and Ruis et al. (2000)) was performed on all piglets in all litters at 2–4 days of age, i.e. previous to castration of male piglets. The test was then repeated on all individual piglets at 4 weeks of age. Before testing the whole litter was removed from their home pen into an adjacent room. Back test was then performed on individual piglets, i.e. they were put on the back and they were restrained in a supine position. The test person placed an arm over the chest of the piglet and then held the left front leg of the piglet between the index finger and the middle finger of the very same arm. Thus, the hind part of the pig was not constrained. During the test period of 60 s the number of escape attempts and the length of the struggles were recorded. Furthermore, time to first vocalisation and the number of vocalisations were recorded during the test session. All records were made directly.

2.5.3. Test for solving a spatial task

Spatial tests have previously been used for testing cognitive skills of animals, e.g. domestic fowl (Gunnarsson et al., 2000: Freire et al., 2004). Cognitive tests for pigs have been performed to investigate the spatial memory of pigs (Mendl et al., 1997; Croney et al., 2003). Increased problem solving capacity may reflect enhanced development of the brain.

A hidden door test was performed on all piglets in the litters at 4 weeks of age. The pigs were moved from their home pen to an adjacent room, where they were put into a temporary test pen. This test pen was 3.75 m × 1.25 m with three compartments, equally sized; starting pen, target pen and a pen where the rest of the litter was kept. The middle compartment had three solid walls (including walls of the corridor) the forth wall facing the litter was made of metal bars (Fig. 2). One piglet at a time was transferred from the litter into the starting pen. The starting pen consisted of four solid walls, but in the middle of the wall facing the middle pen a section (25 cm × 40 cm; w × h) of the wall had been made up like a swing door fastened with hinges from the top of the door. The task for the piglet was to detect the door and push it open so that it could enter into the middle pen and so reinstate contact with the other piglets that were maintained in the opposite part of test pen, separated from the target pen with metal bars. In the starting pen the piglet could hear and smell, but not see the other piglets of the litter. The time taken for the test pig to pass the hidden door was noted. If the pig had not passed the door within 600 s the test was terminated.

2.6. Ethical note

The study was approved by the local Ethical Committee of the Swedish National Board of Experimental Animals in Uppsala (Uppsala djurförsöksnärmnd, Diary No C11/2 2002). The Committee assesses the welfare of the animals in relation to the purpose of the study and the possibility for the addressed problem to be solved without the use of experimental animals, and ascertains that the experiment is not an unnecessary repetition of previous experiments.

2.7. Statistical analysis

Data were recorded from 167 piglets in 27 litters of 27 sows. Editing, descriptive statistics created and some model validation was performed in the JMP Statistical Discovery Software.
Software (Release 6; SAS Institute Inc., Cary, NC, USA). Descriptive statistics are presented in Table 2.

The statistical analysis of fatty acid content in piglet brain tissue was performed with a least squares analysis using the GLM procedure of SAS statistical package (SAS, 2003). The effect of diet was included in the model as fixed effect.

Mother recognition (242 observations in 121 piglets in 27 litters; 2 replicates per piglet) and escape time in the back test (161 observations in 161 piglets in 27 litters at 2 days) were analysed by linear mixed modelling. Screaming in the back test (286 observations in 165 piglets in 27 litters; 1–2 replicates per piglet at 2 days and 4 weeks) was analysed by generalized linear mixed modelling assuming a Poisson distribution. A Weibull proportional-hazards model was used for analysing the hidden door time (125 observations in 125 piglets in 26 litters). We used the MIXED, GLIMMIX and NLMIXED procedures of SAS statistical software package (version 9.1 for Windows, SAS Institute Inc., Cary, NC, USA).

The following independent variables were created and tested for inclusion:

- **Diet**, fixed effect of the diet fed (LF, HFS, HFO, HFL).
- **Parity**, fixed effect of parity of the sow (2, 3, 4, 5, 6, 7).
- **Sex**, fixed effect of piglet sex.
- **Weight**, fixed effect of piglet bodyweight at birth (categorized in quartiles; <1410, 1410–1619, 1620–1874, ≥1875 g).
- **Litter size**, fixed effect of the size of the litter (continuous variable).
- **Replicate**, fixed effect of the replicate number of the test (1, 2).
- **Piglet**, random effect of piglet indicating blocks of the R matrix, assumed unstructured covariances.
- **Litter**, random-intercept effect of litter, assumed to follow a Normal (linear mixed models) or log-Normal (Weibull model) distribution.

The three linear mixed models were built by testing fixed effects and first-order interactions in manual backward stepwise elimination, including effects with \( P \leq 0.05 \), while retaining relevant random effects of piglet and/or litter. Satterthwaite denominator degrees of freedom were used. The Weibull model was built by testing fixed effects by backward stepwise elimination. In the model of mother recognition fixed effects for feed type, piglet sex, piglet weight, sow parity, litter size, and replicate number were tested, retaining random piglet and litter effects. The final model contained diet, parity, diet by parity interaction, weight, replicate, piglet and litter. In the model of escape time fixed effects for feed type, piglet sex, piglet weight, sow parity and litter size were tested, retaining a random litter effect. The final model contained diet, parity and litter. In the model of screaming in back test fixed effects for feed type, piglet sex, piglet weight, sow parity and litter size were tested, retaining a random litter effect. The final model contained diet, weight, replicate, piglet and litter. In the model of hidden door time fixed effects for feed type, piglet sex, piglet weight, sow parity and litter size were tested, retaining a random litter effect. The final model contained diet, weight and litter.

To interpret results, least-squares means of mother recognition were calculated for all combinations of diet and sow parity. Coefficient estimates were back-transformed to obtain risk ratios of screaming in back test, and exponentiated to obtain hazard ratios of push-door time.

### 3. Results

#### 3.1. General

- **Litter size at farrowing** and piglet birth weight of the litters used in the study is presented in Table 2. There was no significant effect of treatment \((P = 0.83)\) or of parity number \((P = 0.85)\) on the litter size. Furthermore, there was no significant effect of treatment \((P = 0.07)\) or of parity number \((P = 0.61)\) on the piglet birth weight.

#### 3.2. Lipid content of piglet brain tissue

The brain lipid content of docosahexaenoic acid \((22:6 \text{ n}-3, \text{DHA})\) % of total lipid content) for diets LF \((n = 5)\), HFS \((n = 5)\), HFO \((n = 5)\) and HFL \((n = 5)\) was 9.32, 9.32, 9.14 and 10.65%, respectively. HFL piglets had a significantly higher DHA content than the other treatments \((P < 0.001)\). The ratio of \(n-6/\ n-3\) in brain tissue was significantly lower for piglets in the HFL treatment group \((P < 0.001)\).

#### 3.3. Behavioural tests

##### 3.3.1. Recognition of the mother’s faeces

Median percentage of time spent in area close to their mothers’ faeces was 15% and ranged from 0 to 58%. Of the total variation 12% resided at the litter level, nothing at the piglet level, and 88% was due to differences between replicates. Due to interaction between diet and parity, the effect of diet varied with litter number. In parity 3, least-squares means for diets LF, HFS, HFO and HFL were 22.2, 37.0, 26.4 and 18.0%, respectively. LF differed from HFS piglets \((P = 0.0004)\), HFS from HFO \((P = 0.019)\) and from HFL \((P = 0.0001)\), and HFO differed from HFL \((P = 0.011)\). No other significant differences between diets, including other parities, were found. The time spent close to mother faeces was 6%–units longer in replicate 1 than in replicate 2 \((P = 0.0003)\). The residuals were reasonably normally distributed.

##### 3.3.2. Back test

**3.3.2.1. Escape time.** Median time to first attempt to escape was 4 s, ranging from 0 to 13 s. Of the total variation in time to first escape attempt, 7.7% resided at the litter level, and the remainder was due to differences between piglets. The model

<table>
<thead>
<tr>
<th>Table 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sow diet</td>
</tr>
<tr>
<td>Litter number</td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>Litter size</td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>Piglet birth weight ((\text{kg}))</td>
</tr>
<tr>
<td>Mean ± Std. dev.</td>
</tr>
<tr>
<td>Piglets in tests</td>
</tr>
</tbody>
</table>

*Inter quartile range.*
predicted HFS piglets to have the shortest and HFO piglets to have the longest escape time, 2.8 and 4.5 s, respectively. LF (3.5 s) and HFL (4.2 s) diets were intermediate. The difference between HFS and HFO was significant ($P=0.030$) and there tended to be a difference between diets HFS and HFL ($P=0.078$). Piglets of sows in parity 4 had the longest (5.3 s) and those of sows in parity 5 the shortest escape time (2.2 s) ($P=0.0335$). The residuals were reasonably normally distributed.

3.3.2.2. Screaming. Observed mean ($\pm$SD) number of screams per test session was 4.3 ($\pm$5.3), with a median of 2 and ranging from 0 to 30. Of the total variation in number of screams, 13% was estimated to reside at the litter level, 15% at the piglet level, and the remainder to be due to differences between replicates. There was no difference between diets. Piglets with birth weights of 1620–1874 g had the lowest mean number of screams per test session (rep1: 2.2, repl. 2: 4.1), and piglets weighing $\geq$1875 g the highest (rep1: 1; 4.4; repl. 2: 5.9) ($P=0.0203$; full model). In replicate 2, the model predicted a 2.5-fold higher number of screams than in replicate 1 ($P<0.0001$). There was no overdispersion.

3.3.3. Hidden door test

Among 125 studied piglets, 90 finished the hidden door test while 35 (28%) did not pass through the door. The observed median hidden door time was 234 s (range 14–584 s). The likelihood of solving the test increased during test period (shape parameter 1.5). The estimated variance of the random litter effect was 0.19 (Kendall’s $\tau$ 0.086), indicating slight clustering by litter. The model predicted piglets weighing 1410–1619 g to have a 1.7-fold lower probability of success in the hidden door test than those with a weight $<1410$ g ($P=0.028$), and a 1.8-fold lower probability than those weighing $\geq$1875 g ($P=0.027$). Other studied effects were non-significant.

4. Discussion

Analyses of fatty acid content from piglets deriving from the same litters as the test piglets showed that piglets from HFL had significantly higher concentration of DHA and a significantly lower ratio of n−6/n−3 compared to piglets in LF, HFS and HFO, which is in line with results on muscle lipids from the same experiment (Panella-Riera et al., 2007). Thus, the sow dietary fatty acid composition was distributed from the sow to the piglets.

According to our hypothesis piglets which had a higher concentration of DHA (i.e. HFL piglets) would have a better functional neural development and behave differently than the other piglets in the behaviour tests. However, this was not supported by our results and instead most differences between treatments were found between the HFS piglets and the other treatments. For example in the recognition of the mother’s faeces test there was an effect of sow diet in piglets from third parity sows, where piglets from HFS spent more time close to their mothers faeces and in the back test the piglets from the HFS treatment differed from some of the other treatments and had the shortest time to start escape. Ng and Innis (2003) demonstrated that piglets that had a low concentration of DHA in the frontal cortex performed less exploratory behaviour and were more fearful. Piglets spending more time closer to their mothers faeces may be interpreted as being more fearful but on the contrary a short latency in tonic immobility tests are generally considered to reflect lower fear levels. Even if the back test has been frequently used in different studies of pig personality, the relevance of using the back test for evaluating stress and personality in pigs has been questioned (e.g. Jensen et al., 1995; Forkman et al., 2007). However, the behaviour of the piglets in the back test could also reflect reactivity (van Erp-van der Kooij et al., 2003). Therefore, an alternative interpretation could be that the results reflects that the HFS piglets were more reactive, as they both tried to regain contact with their mothers and also were the first to start with an active response in the back test. However, the reason why the diet of the HFS piglets would lead to this higher reactivity would need to be further investigated as their more reactive behaviour compared to the HFL piglets were contrary to our hypothesis and there was no difference in their DHA levels from the LF and HFO treatments.

In the analysis of screaming in the back test we found no treatment effect, but the piglets were screaming more at 4 weeks compared to when tested shortly after birth. This may be due to learning from experience of being restrained previously or could be an effect of increased age. In the back test there was also partial effect of birth weight, as piglets with an intermediate weight at birth were screaming less and piglets with a weight $>1875$ g were screaming more. Similarly, in the hidden door test at 4 weeks of age we did not find any significant effect of sow diet, but we found a lower success rate in piglets that had an intermediate birth weight, i.e. 1410–1619 g, compared to piglets with a low or high birth weight ($<1410$ g and $\geq$1875 g). Since piglets in the same weight class also differed in their screaming in the back test, this may be interpreted as these medium weighting pigs were more passive in the behaviour tests. Even if the aim with the hidden door test was to measure the piglets’ cognitive abilities, it is difficult to find a biological reason why medium weight piglets would have a less developed cognitive ability than the larger and smaller piglets. It might be that the influence of piglet birth weight is predisposing for differences in how the piglet behaves in different situations. Thus being more reactive as the larger piglets seem to be, may be beneficial for the survival of the piglets, as piglets screaming more may have a low risk of getting crushed by the sow as the sow more easily will hear them and a more reactive piglet may be more successful in getting a good teat at the udder and gain optimal milk supply. Partly this activity might also be needed for the smallest piglets as they would need to get more access to their mother’s milk.

Compared to previous studies reporting cognitive deficiency in animals that were given reduced levels of n−3 PUFA or having low levels of DHA in the brain (e.g. Catalan et al., 2002), no strong effect of sow diet on piglet behaviour could be recognized in our study. All sow diets were plausibly non-deficient in PUFA and the piglet brains seemed to be provided with enough DHA in all treatments, although the fatty acid composition content of the sow diet was reflected in brain tissue of the piglet. At levels that are above minimal requirements, subtle differences in cognition may exist but our study design may not have been optimal to detect the differences between treatment groups.
5. Conclusion

The study did not show a substantial influence of fat content and composition in sow diet on the behavioural development of piglets. In order to draw any conclusions about possible enhancements of the behavioural development of the piglet, in the same ways as reported in other species, more studies need to be performed. Possibly, the behavioural tests need to be refined in order to reflect a part-purpart effect of diet.

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