Relationships between individual behavioural traits and post-weaning growth in segregated early-weaned piglets

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Abstract

Piglets’ individual behavioural traits have been studied in the last decade but no report has linked these traits with growth. This experiment was conducted to determine if behavioural traits of segregated early-weaned piglets could be good predictors of their post-weaning growth and, thus, help to predict their adaptation to early weaning. Following segregated early weaning at 17±1 days old, 252 piglets were submitted to three tests between 20 and 25 days of age: open-field, reaction to humans and rank order based on competition for a restricted-access feeder. The body weight of each piglet was measured the day before weaning and once a week for the next 4 weeks. A principal component analysis yielded five factors with an Eigenvalue higher than 0.90 that accounted for 81% of the total variation between individuals: reaction to humans (25%), active response to stress (21%), passive response to stress (14%), feeding behaviour (10%) and rank order (9%). Passive reaction to stress was associated with better weight gain during the first week post-weaning ($r=0.18; P<0.01$), and a positive correlation was found between social status and weight gain during the 4 weeks following weaning ($-0.15 \leq r \leq -0.10; P<0.10$). No relation was found between reaction to humans and growth. These results confirm the relationship between rank order and growth in pigs and may suggest that reacting passively to stress could facilitate adaptation to weaning. Crown Copyright © 2000 Published by Elsevier Science B.V. All rights reserved.

Keywords: Pig; Ontogeny; Weaning; Social behaviour; Segregated early weaning; Temperament test

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1. Introduction

Individual differences among behavioural traits of animals are of increasing interest in the behavioural sciences. There could be enormous benefits for swine industry and pigs’ welfare if behavioural traits could be good predictors of adaptation to weaning and other challenges (Spoolder et al., 1996). This could be particularly interesting in segregated early weaning (SEW) herds where weaning is associated with sudden, important changes to which some very young animals are unable to adapt (Robert et al., 1999). In the early weaning context, a high level of exploration of the surroundings could accelerate discovery of the surroundings and, thus, reduce the delay in feeding (Gonyou et al., 1998) and favour growth. As many SEW producers feed their piglets up to six times per day during the first days after weaning, a favourable reaction to humans would also insure against behavioural and physiological reactions to fear (Hemsworth and Barnett, 1987).

Some authors have attempted to identify pigs’ individual characteristics. Hessing et al. (1993a) reported evidence for an active/passive coping strategy differentiating aggressive and non-aggressive piglets. They characterised the two types of piglets in function of their behavioural responses, cortisol levels and heart rates in open-field test (Hessing et al., 1993b). However, this classification was criticised by other authors (Forkman et al., 1995; Jensen et al., 1995a) who instead suggested three personality traits (aggression, sociability and exploration) that explained 60% of the total variation among piglets.

The objective of the present study was to identify the behavioural characteristics of a large group of early-weaned piglets and to determine if these traits could be good predictors of their post-weaning growth and, thus, help to predict their adaptation to early weaning.

2. Materials and methods

2.1. Animals and husbandry

The study involved two replications of 16 crossbred litters born from purebred (Yorkshire) and F1 (Yorkshire×Landrace) sows and boars of Duroc breed. The animals were housed on a commercial farm in Que., Canada. On the day of birth, all piglets were identified by placing a numbered tag on their right ear. They received 2 ml of iron, the tails of the female piglets were cut and the eye–teeth of all piglets were clipped. By Day 3 of the experiment, the male piglets were castrated and their tails were cut. Within each replication, only litters born <4 days apart were used. Litter size was adjusted to 10±1 by fostering piglets <48 h after birth among litters born <48 h apart. Piglets with birth weight lower than 650 g were removed from the litter because survival rate is generally low for such animals. These piglets were fostered to another sow which was not included in the experiment.

Before being moved to the post-weaning building, piglets were weighed and 8 out of the 10±1 piglets of each litter were kept in the study. The remaining piglets were then divided in eight post-weaning pens, each containing four piglets from four different litters. On their arrival at the post-weaning building, each group of 16 piglets was housed in a pen of 3 m×2 m and all piglets were numbered on the back with a non-toxic black marker. The
piglets were fed commercial post-weaning diets specially formulated for early-weaned piglets. The photoperiod was 12 h light/12 h darkness.

The care of the animals was based on the Guide to the care and use of experimental animals of the Canadian Council on Animal Care (1993).

2.2. Experimental treatments

Piglets were weighed between 13 and 17 days of age, that is, 1 day before weaning. After their arrival at the post-weaning building at 18±1 days of age, they were weighed once a week for the next 4 weeks.

When piglets were between 20 and 25 days old, behavioural tests were performed. An open-field test (Jensen et al., 1995b) was performed on each piglet. The piglet was put in an empty unfamiliar pen and its behaviour was noted by scan sampling every 20 s for a total of 4 min. The following behavioural categories were recorded: (1) exploring; (2) walking or running with the head up; (3) standing still; (4) feeding or drinking; (5) urinating or defecating; and (6) vocalising. The first four categories were mutually exclusive. At the end of the open-field test, a ‘human reaction test’ similar to that developed by Hemsworth et al. (1981) was done. An unknown person entered the pen and stood in the middle of one of the longest walls. The approach behaviour of the piglet was then recorded for 3 min by measuring the latency to enter an area of 50 cm radius around the feet of the person, the time spent in this area and the number of contacts with the person.

At 23±1 days old, the rank order of each piglet within its group was determined by a competition test (Forkman et al., 1995) conducted in the home pen. Piglets were food-deprived for 8 h before the test. During the test, the access to the feeder was reduced in order to allow only one piglet to feed at the time. Observation of piglets’ behaviour started when food was poured in the feeder. When the first piglet had fed for 30 s, he was removed from the pen and was given top rank position; the next piglet eating for 30 s was designated second position rank and removed from the pen, and so on until a rank had been attributed to all piglets. A low score in hierarchy test, thus, indicated a high dominance rank. According to Forkman et al. (1995), ranking obtained by this method correlates well (r=0.68) with the results from paired encounters.

2.3. Statistical analysis

All the variables recorded in the three behavioural tests were entered into a principal component analysis (PCA) and the factors were rotated using a varimax rotation. PCA is used for identifying relationships among multiple variables. It separates individuals in a sample in terms of a few components. This analysis helps interpreting relationships in the data through grouping (Frey and Pimentel, 1978). The correlation between components determined by PCA and weight gain data was analysed with a Spearman correlation test because data did not meet the normality assumption of parametric statistics.

Data from 252 piglets out of the 256 studied animals were analysed because four piglets of the second group died during transport between farrowing and post-weaning buildings.

Weekly piglets’ growth was calculated by dividing the mean weight gain over the period by the mean weight at the beginning of the period. These data were analysed with paired
Student *T*-test to measure if weekly growth was different from zero. Paired Student *T*-tests were also used to verify if there were differences in piglets’ growth between the periods.

3. Results

Results from the tests of open-field and reaction to humans varied among animals and most of the measured variables showed a non-parametric distribution (Table 1). The PCA used to derive a number of possible behavioural traits created five factors with an Eigenvalue higher than 0.90 (Table 2). These five factors accounted for 81% of the variation among individuals. The proportion of total variance explained by each factor was 27, 21, 14, 10 and 9% for Factors 1 to 5, respectively.

The variables with the highest loading (degree with which the parameter influences the factor) for Factor 1 were those related to a favourable reaction to the presence of an unknown human (a long time spent in the area around the person and a high number of contacts with him); the lowest loading for this factor was a long latency before entering the area around the person. Factor 2 was composed of the variables related to an active response to the open-field test, i.e. walking or running and a high number of vocalisations. The lowest loading on this factor was exploration of the surroundings. Factor 3 was composed of the variables related to a passive response to the open-field test, i.e. standing, urinating and defecating. The lowest loading on this factor was exploration of the surroundings. Factor 4 had high values for feeding and drinking; the lowest loading was for the number of vocalisations. Factor 5 had high values for rank order. No variables had a high negative loading for this factor (Table 2). The five principal components were tentatively labelled: reaction to humans (Factor 1), active response to stress (Factor 2), passive response to stress (Factor 3), feeding behaviour (Factor 4) and social rank (Factor 5).

Table 1
Mean±S.D. and median for the variables measured during the tests of open-field and reaction to humans (*n*=252)

<table>
<thead>
<tr>
<th>Reaction to humans</th>
<th>Mean±S.D.</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latency to enter the area (s)</td>
<td>62±65</td>
<td>33</td>
</tr>
<tr>
<td>Time spent in area (s)</td>
<td>32±30</td>
<td>26</td>
</tr>
<tr>
<td>No. of contacts</td>
<td>4.35±3.72</td>
<td>4</td>
</tr>
<tr>
<td><strong>Open-field</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exploring</td>
<td>5.44±2.20</td>
<td>5</td>
</tr>
<tr>
<td>Walking or running</td>
<td>5.62±2.15</td>
<td>6</td>
</tr>
<tr>
<td>Standing</td>
<td>1.41±1.44</td>
<td>1</td>
</tr>
<tr>
<td>Feeding or drinking</td>
<td>0.52±0.87</td>
<td>0</td>
</tr>
<tr>
<td>Urinating or defecating</td>
<td>1.35±1.19</td>
<td>1</td>
</tr>
<tr>
<td>Vocalising</td>
<td>7.61±3.32</td>
<td>9</td>
</tr>
</tbody>
</table>

*a* Total duration of the test was 180 s.

*b* No. of scan-sampling observations over a total of 13 (exclusive categories, except for vocalising and urinating/defecating).
Piglets’ body weight increased during every week of the study ($P \leq 0.01$). The percentages of increase were 15% in the week following weaning (Days 17–24), 25% in the second week, 35% in the third week and 34% in the last week of the experiment (Fig. 1). There were differences ($P < 0.01$) in piglets’ growth among all weeks, except between weeks 3 and 4 ($P \geq 0.13$) (Fig. 1).

Spearman tests showed significant correlations between weight gain and two out of the five factors (Table 3). The correlation between Factor 5 and weight gain was significant for 3 out of the 4 weeks ($P \leq 0.03$) and approached significance during the other week ($P = 0.10$), thus indicating that a low score (or a high dominance rank) in the rank order was associated with a higher weight gain ($-0.15 \leq r \leq -0.10$). A significant positive

Table 2
PCA factor loadings rotated with varimax rotation of each variable used in the behavioural tests ($n=252$)

<table>
<thead>
<tr>
<th>Test</th>
<th>Variable</th>
<th>Factors 1</th>
<th>Factors 2</th>
<th>Factors 3</th>
<th>Factors 4</th>
<th>Factors 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reaction to humans</td>
<td>Time spent in area</td>
<td>0.91</td>
<td>-0.02</td>
<td>0.03</td>
<td>-0.05</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>Latency to enter the area</td>
<td>-0.78</td>
<td>-0.11</td>
<td>0.12</td>
<td>0.04</td>
<td>0.08</td>
</tr>
<tr>
<td>Open-field</td>
<td>No. of contacts</td>
<td>0.94</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.12</td>
<td>-0.03</td>
</tr>
<tr>
<td>Exploring</td>
<td>Walking or running</td>
<td>0.08</td>
<td>-0.89</td>
<td>-0.38</td>
<td>-0.11</td>
<td>-0.04</td>
</tr>
<tr>
<td>Standing</td>
<td>Feeding or drinking</td>
<td>-0.21</td>
<td>0.03</td>
<td>0.87</td>
<td>-0.02</td>
<td>0.07</td>
</tr>
<tr>
<td>Urinating or defecating</td>
<td>0.06</td>
<td>0.06</td>
<td>0.81</td>
<td>-0.04</td>
<td>-0.09</td>
<td></td>
</tr>
<tr>
<td>Vocalising</td>
<td>Hierarchy Rank</td>
<td>-0.06</td>
<td>0.04</td>
<td>-0.03</td>
<td>-0.03</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Fig. 1. Piglet’s weekly weight gain (mean±S.D.) over the experiment ($n=252$). The first point illustrates the mean weight 1 day before weaning.
relationship was also found ($r=0.18; P=0.01$) between Factor 3 and weight gain during the first week after weaning, thus indicating that a passive reaction to stress (standing, urinating, defecating, with low exploration of surroundings) was associated with a higher weight gain during this period.

4. Discussion

Our results provide evidence for the existence of at least five factors accounting for 81% of the variation seen among early-weaned piglets in the experimental situations. These behavioural characteristics were labelled as reaction to humans, active response to stress, passive response to stress, feeding behaviour and social status. These results support the findings of Forkman et al. (1995) that factors other than active and passive coping influence the behaviour of piglets, but they also show that early-weaned piglets had a bimodal distribution of reaction patterns to novelty and isolation (open-field test) similar to the coping strategies reported by Hessing et al. (1993a, b).

The social rank of early-weaned piglets accounted for 9% of the variation among individuals and was correlated with post-weaning weight gain. The finding that ranking is accounting for variation among individual piglets has previously been reported by Forkman et al. (1995) who identified aggressiveness as one of the personality traits of pigs and found a positive correlation between rank and aggressive behaviour, a relationship already reported by Blanchard et al. (1988). Altogether, these results confirm previous reports of Algers et al. (1990) and Pluske and Williams (1996) showing that after weaning, piglets gaining more weight than their pen mates are more aggressive, while those gaining less weight are more submissive. These data contrast with the statement that growth is independent of social status in weaned piglets (Blackshaw et al., 1994, 1997).

The positive correlation between weight gain and a passive response to the stress of isolation and novelty measured during the first week after weaning could indicate that piglets reacting in a calmer manner to the stress of weaning (spending more time standing still, low level of exploration and squealing less) would dissipate less energy than piglets reacting actively to stress, thereby gaining more weight. The active response to stress, also
called the ‘wandering-squealing’ syndrome, has already been observed in fostered piglets (Horrell, 1982; Robert and Martineau, unpublished data) and was associated with decreased growth. It is interesting to note that the growth of piglets was slower during the first week after weaning than in the following weeks, thereby suggesting that the first week post-weaning is the most critical for early-weaned piglets.

No correlation was found between growth and a favourable reaction to humans, invalidating our hypothesis of a better adaptation to weaning in piglets showing less fear of humans. Low levels of exploratory behaviour were associated both with active and passive reactions to stress, but none of the five factors explaining 81% of variation among piglets included high levels of exploration of the surroundings. This behaviour could therefore not be used as predictor of growth or adaptation to weaning.

In conclusion, five factors, labelled as reaction to humans, active response to stress, passive response to stress, feeding behaviour and social rank, could explain 81% of the variation between early-weaned piglets in their response to different behavioural tests. Among these factors, two were related with post-weaning growth of piglets. First, a passive response to stress was positively correlated with weight gain in the first week post-weaning. Also, a high rank order was related to a better weight gain during the 4 weeks following weaning. These results confirm the relationship between social status and growth in pigs and may suggest that reacting passively to stress could facilitate adaptation to weaning.

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