Behavioural uniformity or diversity? Effects on behaviour and performance following regrouping in pigs

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Abstract

Behavioural differences among pigs can be reliably determined using the human approach test. This study investigated the theory of ‘pre-forming’ a stable hierarchy based on behavioural composition. While in the nursery with littermates, 222 pigs were individually tested in two human approach tests and classified as either being slow, medium, or fast to approach a novel person. Pigs were then regrouped at eight weeks of age. Groups of 12 pigs, consisting of either all slow (uniform slow), all fast (uniform fast), or slow, medium, and fast (diverse) were formed. Intact litters were used as a control treatment. Subsequent aggression, average daily gain, and approach times were assessed. Regrouped pigs took longer to approach than pigs in intact litters (28.6 versus 9.25 ± 3.03 s; \( P = 0.02 \)) during the final human approach test. There was less fighting per pig in the intact litters (0.45) compared with regrouped pigs (greater than 3.61 ± 0.45 s; \( P < 0.01 \)). Pigs in the intact litters tended to grow faster than pigs in the uniform fast treatment (863 versus 805 ± 21.6 g/day; \( P = 0.09 \)). The slow pigs in the intact litters, diverse and uniform-slow treatments all became faster to approach over time (\( P < 0.05 \)), and did not differ in average daily gain. Whereas, fast pigs in the intact litters became slower to approach than fast pigs in the diverse treatment (49.4 ± 8.61 versus 13.4 ± 7.04 s; \( P = 0.02 \)) and tended to take longer than the uniform-fast pigs (49.4 ± 8.61 versus 26.7 ± 7.04 s; \( P = 0.09 \)). There were no differences in average daily gain among fast pigs in any of the treatments (\( P > 0.1 \)). The human approach test is useful for distinguishing among individuals. Regrouping affects the ability to habituate over time. Furthermore, the type of regrouping strategy influences the ease of habituation. Pigs that are initially classified as slow, medium, or fast may habituate differently.
to the test. The pigs also have different growth patterns depending on whether they have experienced regrouping. Behavioural uniformity tended to result in more aggression and less weight gain, when compared to intact litters.

Keywords: Pigs; Behavioural assessment; Human approach; Regrouping; Habituation; Stress

1. Introduction

Regrouping of unfamiliar pigs is a common management practice, which usually occurs at several stages of the pig’s life. Every time pigs are regrouped, a new social structure must be formed (Meece and Ewbank, 1973). This results in aggression in which pigs will fight intensely for approximately 2 h. Less intense fighting will continue to occur over the next couple of days, until a relatively stable structure or organization is formed.

The aggression that results is a serious animal welfare concern. This concern has prompted many studies to investigate methods of reducing the regrouping aggression. Some examples that have not been very successful include masking odours, using sedatives (Luescher et al., 1990), providing hide areas (McGlone and Curtis, 1985; Luescher et al., 1990) and environmental enrichment (Schaefer et al., 1990; Arey and Franklin, 1995).

Pre-exposure of unfamiliar pigs prior to regrouping has yielded variable results, being somewhat successful (Fraser, 1974; Jensen and Yngvesson, 1998) or unsuccessful (Rushen, 1988; Stookey, 1991) at reducing aggression in different studies. The use of individual reactions to non-social challenges (such as response to restraint) and age as predictive tools to determine which pigs would fight with unfamiliar pigs did not prove to be successful (Jensen, 1994). However, individual aggression in response to a social challenge (resident-intruder test) did prove to be successful for predicting levels of regrouping aggression (Erhard et al., 1997).

There has been evidence suggesting that regrouping pigs into behaviourally diverse groups results in less aggression and better performance (Hessing et al., 1994). van Erp-van der Kooij et al. (2003) have suggested that when pigs are regrouped into behaviourally uniform groups, some of the pigs will change their behaviour. The authors have suggested that the change in behaviour by some pigs could either be intentional (to increase behavioural diversity, which ultimately increases social stability) or it could be unintentional (due to a change in the hypothalamic–pituitary–adrenal axis because of the social stress). Both studies suggest that regrouping into either behaviourally uniform or diverse groups based on a backtest score (number of escape attempts by the pig while restrained on its back) affects subsequent behaviour. In a previous study, it was determined that a human approach test was also a useful method for behaviourally distinguishing among pigs based on their willingness to approach a novel person (Hayne and Gonyou, 2003). Pigs either remained in intact litters or were regrouped at random. Interestingly, responses during the human approach test differed between the intact litters and regrouped pigs following regrouping. The pigs were tested individually in an arena away from their home pen. Pigs in the regrouped treatment did not show habituation with repeated testing, but the pigs that were not regrouped did. This suggests that the change in social
environment that resulted because of regrouping caused those pigs to maintain some fear and uncertainty about the result of an environmental change (which the pigs experienced during the testing procedure). Consistency in the social environment, on the other hand, appeared to result in reduced fear in response to environmental change, and led to eventual habituation. Willingness to approach novelty has been interpreted as an indicator of fearfulness (Hemsworth et al., 1986). A decrease in time to approach over repeated tests has been interpreted as a decrease in fear and habituation to the test. However, just as there are variations in responses to restraint and aggression (Hessing et al., 1994; van Erp-van der Kooij et al., 2003; Bolhuis et al., 2005) there are variations in fear responses (Boissy, 1995). Fear responses can be as divergent as active attack and active avoidance. Using a different method (the human approach test) for behaviourally distinguishing among pigs based on their fear response, an attempt was made to further test Hessing et al.’s (1994) and van Erp-van der Kooij et al.’s (2003) theory, that the behavioural composition at regrouping (uniform versus diverse) has an affect on subsequent behaviour and performance. The hypotheses of the current study are that ‘pre-forming’ a stable dominance hierarchy based on behavioural characteristics is possible and that behavioural diversity will result in greater social stability than behavioural uniformity. If greater social stability results from a particular regrouping treatment, then there should be less regrouping aggression, better performance and habituation to the human approach test. The first objective was to determine the effects of regrouping pigs into either behaviourally uniform or diverse groups, based on their response in a human approach test, on subsequent aggression, willingness to approach a person and average daily gain. The second objective was to evaluate the effects of regrouping on the subsequent approach behaviour of initially slow and fast approaching pigs (previous research has tended to focus on the average time to approach).

2. Methods

2.1. Facilities and animals

Two blocks, based on starting week, of this study were conducted. A total of 222 pigs obtained from 23 litters were weaned into the nursery for initial assessment (Pig Improvement Company hybrids, Airdrie, Alberta). A total of 184 pigs were studied during the grow-finish phase (92 pigs per block). All pigs were cared for according to standard procedures, following the Canadian Code of Practice (Agriculture and Agri-Food Canada, 1993) for space allowance and temperature requirements. Pelleted diets were formulated to meet the nutritional requirements of the pigs (National Research Council, 1998). All piglets were ear notched for individual identification. Male piglets were castrated at 3 days of age and all pigs were weaned and individually weighed at 3 weeks of age. While in the farrowing facility, pigs were housed in farrowing crates equipped with heat lamps. While in the nursery facility, pigs were housed as intact litters in raised weaner decks with plastic coated expanded metal flooring. At the end of the nursery phase, pigs had an average body weight of 21.7 kg and a space allowance of 0.27 m² per pig. The pen walls were metal spindles. The pigs were housed under thermoneutral conditions and had access to feed and water ad libitum.
At 8 weeks of age each pig was ear-tagged, weighed and moved into the grow-finish facility. The pigs were housed in floor pens with fully slatted concrete floors. At the end of this experiment, the pigs had an average body weight of 75 kg and their space allowance was 0.62 m² per pig. Thermoneutral conditions were maintained and the pigs continued to have access to feed and water ad libitum. This research protocol was approved by the University of Saskatchewan’s Animal Care Committee (#2000004-Renewed), which is regulated by the Canadian Council on Animal Care.

2.2. Formation of treatment groups and data collection

In a previous study, Hayne and Gonyou (2003) found that the pig’s willingness to approach a novel person during a human approach test (according to a similar procedure by Hemsworth et al., 1986) was a reliable method for distinguishing among pigs based on their behaviour. Therefore, this test was used in the current study to assess the pre-treatment behaviour and classification of each pig during the nursery phase at four (nursery test 1) and seven (nursery test 2) weeks of age, and the post-treatment responses during the grow-finish phase at 12 (grow-finish test 3) and 17 (grow-finish test 4) weeks of age. The test was conducted in an arena, which had six sides, each at a height of 1.2 m (Fig. 1). An attempt was made to ensure the pigs always had 0.5 m to avoid the person (in addition to the 0.5 m approach area marked around the person). During the tests conducted in the nursery phase,
the diameter of the arena was 2.0 m. During the first test in the grow-finish phase, the diameter was maintained at 2.0 m (the pigs were bigger, but less space was used by the person who sat during the nursery and stood during the grow-finish tests). During the last test in grow-finish, the diameter was increased to 2.5 m to accommodate the bigger pigs and ensure the avoidance area of 0.5 m was maintained. Each pig was given 2 min to acclimate to the new environment. A novel person (someone who was unfamiliar to the pigs) entered the arena after the acclimation period. Each time the test was conducted, a different person was used. In order to increase and ensure the novelty, the person entered the arena and sat stationary at the entrance during the nursery phase and wore blue coveralls, but stood upright and wore red coveralls during the tests in the grow-finish phase. The following information was recorded for 3 min each time the test was conducted:

1. Time taken to approach within 0.5 m of the human.
2. Total time pig spends within 0.5 m of the human.
3. Time taken to interact with (contact) the human.
4. The number of interactions with the human and any biting, nosing, or jumping.

The pigs were classified based on their pre-treatment willingness to approach. Pigs that did not approach the person during the 3 min test were given a time score of 180 s. The time to approach during the two human approach tests conducted in the nursery were averaged, and based on this time pigs were classified either as slow (83–180 s; slowest 33%), medium (32–79 s; middle 33%) or fast (0–27 s; fastest 33%) to approach. The regrouping treatments were determined based on these classifications. Pigs were regrouped to form either behaviourally uniform or diverse groups, or remained as intact litters. Essentially, the intact litters were naturally diverse (containing slow, medium and fast approaching pigs; only one litter contained just slow and medium approaching pigs). The uniform groups were comprised entirely of pigs that were of the same behavioural classification: either all slow or all fast. To form the diverse groups, four slow, four medium and four fast pigs were combined. The uniformity of weight distribution was not considered in the regrouping procedure. It was not possible for all the pigs within each pen to be unfamiliar. However, the degree of familiarity was kept to a minimum, such that the goal was to ensure that the proportion of familiar dyads did not exceed 10% within each regrouped pen (i.e., less than 6 of the 66 social dyads within each pen). In summary for both blocks (four pens per treatment):

- Litters remained intact, each with 10 pigs: intact.
- All slow to approach, 12 pigs per pen: uniform slow.
- All fast to approach, 12 pigs per pen: uniform fast.
- Four slow, four medium, and four fast pigs (12 pigs per pen): diverse.

The pigs were weighed and regrouped upon their move into the grow-finish room at 8 weeks of age. Final pig weights were determined at 17 weeks of age, such that overall average daily gain could be calculated.

Immediately following regrouping, the number of fights was recorded for each pen for 1 h during the 2 h following regrouping. Four people observed the eight pens. Each observer recorded the number of fights occurring in a pen for 5 min and then rotated to the
next pen for 5 min (each observer was separated from the next observer by an unobserved pen). Therefore, each pen was observed for three 5-min periods by each of four people, resulting in a total of 60 min per pen. A fight was defined as the interaction between two or more pigs that lasted at least 10 s, in which all the pigs involved were continuously biting and pushing each other. The results are presented as the number of fights per pig per hour (number of fights per pen multiplied by the number of pigs involved in the fight, and divided by the number of pigs in the pen).

During the grow-finish phase, all pigs were re-tested individually in the human approach test at 12 and 17 weeks of age. The testing procedure was similar to the procedure used during the nursery phase, except that the person stood upright at the entrance of the arena.

2.3. Statistical analysis

The distributions of the data were checked for normality and transformed if necessary. Principal factor analysis with varimax rotation was used to determine if the variable loadings in this data set would be similar to those found in a previous study (Hayne and Gonyou, 2003). The data collected until the end of the nursery phase and the data collected during the grow-finish phase were subjected to separate factor analyses, in order to determine if regrouping caused a change in factor structure.

The time to approach variable was analyzed using an analysis of variance with a general linear model procedure (SAS Institute Inc., 1990) to ensure that there were no pre-treatment differences between those litters that remained intact (which were naturally diverse) and those that were subsequently regrouped into the diverse treatment. A general linear model was used to determine if there were any differences among the four regrouping treatments (intact litters, diverse, uniform slow, uniform fast) for the time to approach, number of fights per pig and average daily gain variables. A planned comparison analysis using a contrast statement in SAS was used to determine if there was an overall difference between the diverse and uniform treatments, regardless of approach classification. The effect of regrouping into uniform or diverse groups or remaining as intact litters on the time to approach and average daily gain variables was tested within approach classification (fast/slow) in separate analyses. As different approach classifications existed within each pen of the intact and diverse treatments, a split plot model was used to analyze the interaction of treatment and approach classification for the time to approach and average daily gain variables. In this model, treatment (d.f. 1) was tested against the error term of replicate × treatment (d.f. 3), and approach classification and the treatment × approach classification interaction were tested against the residual error (d.f. 11). Block and block (replicate) were accounted for in the model. Paired comparisons using Proc Means in SAS were used to determine if time to approach differed between subsequent tests within each treatment.

In summary, the following statistical analyses were conducted:

1. Time to approach for each of the four tests:
   (a) Intact versus diverse.
   (b) The four treatments (intact, diverse, uniform slow, uniform fast).
   (c) Diverse versus overall uniform (uniform slow and uniform fast).
   (d) Fast pigs within three treatments (intact, diverse, uniform fast).
(e) Slow pigs within three treatments (intact, diverse, uniform slow).
(f) Interaction between treatment and approach classification.
(g) Between tests within treatments.

(2) Number of fights
(a) The four treatments (intact, diverse, uniform slow, uniform fast).
(b) Diverse versus overall uniform (uniform slow and uniform fast).

(3) Average daily gain
(a) The four treatments (intact, diverse, uniform slow, uniform fast).
(b) Diverse versus overall uniform (uniform slow and uniform fast).
(c) Fast pigs within three treatments (intact, diverse, uniform fast).
(d) Slow pigs within three treatments (intact, diverse, uniform slow).
(e) Interaction between treatment and average daily gain.

3. Results

3.1. Factor extraction

Table 1 shows the results of the factor analysis of the variables collected during the human approach test. All the variables from both tests loaded onto a single factor in both the nursery and grow-finish phase. The interpretation of the relationship among the variable loadings indicates the following pattern of responses towards the novel person: the longer it took pigs to approach, the less time they spent within 0.5 m, the longer it took them to interact and the fewer interactions they had with the novel person. Therefore, this factor was named ‘willingness to approach’.

3.2. Effect on time to approach

3.2.1. Intact litters versus diverse treatment

Although the factor scores represent all the data collected during the human approach test, they are not useful when attempting to illustrate the responses over time. The results

<table>
<thead>
<tr>
<th>Factors</th>
<th>Variable</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time to approach within 0.5 m of human (test 1/2)</td>
<td>0.79/0.77</td>
</tr>
<tr>
<td></td>
<td>Time to interact with human (test 1/2)</td>
<td>0.85/0.84</td>
</tr>
<tr>
<td></td>
<td>Time spent within 0.5 m of human (test 1/2)</td>
<td>−0.85/−0.76</td>
</tr>
<tr>
<td></td>
<td>Number of interactions with human (test 1/2)</td>
<td>−0.84/−0.77</td>
</tr>
<tr>
<td>Nursery factor</td>
<td>Time to approach within 0.5 m of human (test 3/4)</td>
<td>0.71/0.75</td>
</tr>
<tr>
<td></td>
<td>Time to interact with human (test 3/4)</td>
<td>0.77/0.78</td>
</tr>
<tr>
<td></td>
<td>Time spent within 0.5 m of human (test 3/4)</td>
<td>−0.71/−0.60</td>
</tr>
<tr>
<td></td>
<td>Number of interactions with human (test 3/4)</td>
<td>−0.75/−0.57</td>
</tr>
</tbody>
</table>

from a previous study indicated that the habituation response to repeated human approach tests is disrupted following regrouping, as indicated by a difference in the time to approach variable (Hayne and Gonyou, 2003). The factor structure in the current study, as in the previous study, indicated that the length of time the pig took to approach the novel person was very descriptive of the primary factor. Therefore, the focus continued to be on the effects of regrouping on time to approach, and this variable was used to illustrate the pattern of responses over time (Fig. 2). During the nursery phase, there were no significant differences in time to approach during the human approach test for those litters that would remain intact and those that were subsequently regrouped into the diverse treatment (test 1: $P > 0.1$; test 2: $P > 0.1$; Fig. 2).

There was a marginally significant difference in time to approach during the third test, conducted in the grow-finish phase, and a significant difference during the fourth test. The regrouped pigs (in the diverse treatment) took longer to approach within 0.5 m of the novel person than those litters that remained intact, during the fourth test ($P = 0.02$).

3.2.2. The four treatments (intact, diverse, uniform slow, uniform fast)

A comparison of the time to approach among the four treatments from this study is illustrated in Fig. 3. The consistency in responses can be observed during the first two tests in the nursery period when no regrouping occurred. The uniform slow treatment had a significant decrease in time to approach from tests 2 to 3 ($P < 0.001$); whereas, uniform fast showed an increase ($P < 0.01$). However, a significant difference between uniform slow and uniform fast was maintained in test 3 ($P < 0.01$). In test 4, the uniform slow and uniform fast treatments were similar in time to approach ($P > 0.1$). The only significant difference among the four treatments in test 4 was between diverse and uniform fast ($P = 0.04$). Overall, regardless of the uniform regrouping strategy, there were no differences in time to approach for pigs in the diverse or uniform treatments ($P > 0.1$).
3.2.3. The fast pigs (in the intact litters, diverse, and uniform fast treatments)

A comparison of the responses of the fast pigs within the different social environments is illustrated in Fig. 4. The intact fast, diverse fast and uniform fast did not differ during the nursery period (pre-regrouping) and were consistent from tests 1 to 2 (Fig. 4). The comparison of the fast pigs among the treatments during test 3 indicates that intact fast took longer to approach than diverse fast ($P = 0.02$) and tended to take longer than uniform fast ($P = 0.09$). There was no difference between diverse fast and uniform fast ($P > 0.1$). By the fourth test, there were no differences among the treatments for fast pigs ($P > 0.1$). The intact-fast pigs significantly increased their time to approach from tests 2 to 3 ($P = 0.05$; Fig. 4), and then significantly decreased from tests 3 to 4 ($P = 0.02$). A similar pattern was followed for the uniform fast pigs, with an increase in time to approach from tests 2 to 3.
(P < 0.01) and a decrease from tests 3 to 4 (P < 0.01). There were no changes in time to approach by diverse-fast pigs (P > 0.1).

3.2.4. The slow pigs (in the intact litters, diverse, and uniform slow treatments)

Similar to the fast pigs, the intact slow, diverse slow and uniform slow pigs did not differ and were consistent from tests 1 to 2 during the nursery period (Fig. 5). There were no differences in time to approach for slow pigs among the treatments during the third test (P > 0.1). There was a marginally significant difference during the fourth test between intact slow and diverse slow, with intact slow being faster to approach than diverse slow (P = 0.06; Fig. 5). There was a decrease in time to approach from tests 2 to 3 by all slow pigs whether they were in the intact, diverse or uniform treatments (P = 0.02, P = 0.05 and P < 0.01, respectively; Fig. 5). Pigs in the intact slow and uniform slow also decreased their time to approach from tests 3 to 4 (P < 0.01).

3.2.5. The interaction between treatment (intact versus diverse) and approach classification (slow, medium, fast)

There were no significant interactions found for test 3 (P > 0.1) or test 4 (P > 0.1) (Fig. 6). Also, there were no significant differences in approach classification (slow, medium or fast; P > 0.1), regardless of whether the pigs came from the intact or diverse treatments (Fig. 7).

3.3. Effect on aggression

Less fighting occurred among pigs that remained with their littermates compared with the three regrouping treatments (fights per pig per hour: intact litters = 0.45 ± 0.45 versus diverse = 3.61 ± 0.45; uniform slow = 4.38 ± 0.45; uniform fast = 4.52 ± 0.45; P < 0.01; Table 2). Overall, regardless of the uniform regrouping strategy, pigs in the diverse treatment tended to fight less than pigs in the uniform treatments (P = 0.08).
3.4. Effect on average daily gain

3.4.1. The four treatments (intact, diverse, uniform slow and uniform fast)

Pigs that remained as intact litters tended to grow faster than those that were regrouped into the uniform fast treatment (863 and 805 ± 22 g/day, respectively; \( P = 0.09 \); Table 3). Overall, regardless of the uniform regrouping strategy, there were no differences in average gain.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>I</th>
<th>D</th>
<th>US</th>
<th>UF</th>
<th>S.E.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of fights per pig</td>
<td>0.45\textsuperscript{a}</td>
<td>3.61\textsuperscript{b}</td>
<td>4.38\textsuperscript{b}</td>
<td>4.52\textsuperscript{b}</td>
<td>0.45</td>
</tr>
<tr>
<td>Average daily gain (g/day)</td>
<td>862.5\textsuperscript{a}</td>
<td>839.6\textsuperscript{y}</td>
<td>816.0\textsuperscript{y}</td>
<td>804.6\textsuperscript{y}</td>
<td>21.6</td>
</tr>
</tbody>
</table>

Treatments: I (intact), D (diverse), US (uniform slow), UF (uniform fast).

\textsuperscript{a,b}Means within the same row not sharing a letter are different at \( P < 0.01 \).

\textsuperscript{x,y}Means within the same row not sharing a letter are different at \( P < 0.10 \).
daily gain for pigs in the diverse treatment compared with pigs in the uniform treatments ($P > 0.1$).

3.4.2. The fast pigs (in the intact litters, diverse, and uniform fast treatments)/the slow pigs (in the intact litters, diverse, and uniform slow treatments)

There were no significant differences in average daily gain among the fast pigs in the intact, diverse or uniform treatments ($P > 0.1$; Table 3). Similar to the fast pigs, there were also no significant differences in average daily gain found among the slow pigs in the intact, diverse or uniform treatments ($P > 0.1$; Table 3).

3.4.3. The interaction between treatment (intact versus diverse) and approach classification (slow, medium, fast)

There were no significant interactions between treatment and approach classification for average daily gain ($P > 0.1$). However, the analysis of approach classification indicates that slow pigs grew significantly faster than fast pigs, regardless of whether they came from the intact or diverse treatment ($P = 0.04$) (Table 4).

4. Discussion

Pigs that were regrouped fought more than pigs in the intact litters. There was a tendency for pigs in the uniform fast treatment to gain less weight than pigs in the intact litters, suggesting they may have experienced more regrouping stress.

Table 3
Effect of regrouping strategy on the average daily gain of fast and slow pigs within the intact, diverse and uniform treatments during the grow-finish phase (mean (S.E.M.))

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Intact</th>
<th>Diverse</th>
<th>Uniform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average daily gain (g/day)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fast</td>
<td>823.0 (19.5)</td>
<td>840.1 (15.9)</td>
<td>804.6 (15.9)</td>
</tr>
<tr>
<td>Slow</td>
<td>889.6 (31.5)</td>
<td>873.0 (31.5)</td>
<td>816.0 (31.5)</td>
</tr>
</tbody>
</table>

Table 4
Average daily gain (g/day) of slow, medium and fast pigs within the intact and diverse treatments during the grow-finish phase (mean (S.E.M.))

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Intact</th>
<th>Diverse</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach classification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slow</td>
<td>889.6 (17.5)$^a$</td>
<td>873.0 (17.5)$^a$</td>
<td>881.3 (13.8)$^a$</td>
</tr>
<tr>
<td>Medium</td>
<td>875.2 (17.5)$^{ab}$</td>
<td>805.0 (17.5)$^b$</td>
<td>840.1 (12.4)$^{ab}$</td>
</tr>
<tr>
<td>Fast</td>
<td>823.0 (21.5)$^b$</td>
<td>840.1 (17.5)$^{ab}$</td>
<td>832.0 (12.4)$^b$</td>
</tr>
<tr>
<td>Average</td>
<td>862.6 (21.6)</td>
<td>839.4 (21.6)</td>
<td>851.1</td>
</tr>
</tbody>
</table>

$^a,b$Means within the same column not sharing a letter are different at $P < 0.05$. 
The factor analysis of the data collected during the human approach tests from this study resulted in the same willingness to approach factor being extracted as in a previous study (Hayne and Gonyou, 2003). Based on the similarity in factor structures extracted in both studies, the results indicate an underlying personality factor. This ‘willingness to approach’ factor was found to represent a continuum of responses and the relationship among the other variables measured during the human approach test can be determined from the time to approach variable. At one extreme of the continuum, pigs are slower to approach, slower to interact, have fewer interactions and spend less time within 0.5 m of the person, which could be interpreted as the adoption of a passive response. Hessing et al. (1994) and Ruis et al. (2000) labeled pigs that were slower to approach a novel object, enter a novel environment, less resistant to a restraint test, and less likely to engage in aggressive behaviour as adopting a passive response. Whereas, at the other end of the continuum, pigs are faster to approach, faster to interact, have more interactions and spend more time within 0.5 m of the person, and could be interpreted as the adoption of an active response. Hessing et al. (1994) and Ruis et al. (2001) found that pigs that adopted an active response to a challenge, were faster to approach a novel object, but lost interest more quickly. Bolhuis et al. (2004) found that housing environment had a different effect on the behavioural responses of different ‘types’ of pigs. Pigs were either classified as low-resisting or high-resisting in response to restraint, and were either raised in barren or enriched environments. During a T-maze test, low-resisting pigs from an enriched environment made more mistakes, vocalized more, took longer to enter the part of the maze where a novel object was located, and took longer to reach a food reward than low-resisting pigs from a barren environment. Therefore, it appears that certain coping characteristics can be modified by housing environment.

When the time to approach variable for the intact litters and diverse treatments was compared, a similar pattern was observed as in a previous study (Hayne and Gonyou, 2003). As expected, there were no differences between the intact litters and subsequently regrouped pigs during the nursery period, indicating that the populations were similar. By the fourth test in the grow-finish period, the patterns in studies one and two were the same, where intact pigs habituated to the test, but regrouped pigs maintained a consistent time to approach from tests 3 to 4, showing a lack of habituation. This provides further support that the stress experienced from regrouping or social instability may be generalized and long lasting. Although the overt fighting decreases over the first 24 h post-regrouping, other research has suggested that less obvious threats and subordination persist once a dominance hierarchy has been formed, which can lead to continuous social stress (Jensen, 1982; Stookey and Gonyou, 1994).

It appears that the type of social environment had different effects on the reactions of fast pigs to the human approach test, but not on the reactions of the slow pigs. Ruis et al. (2001) also found that the behavioural and physiological reactions of passive pigs were less variable during social isolation and novelty tests than the reactions of active pigs. They suggest that this could indicate that in response to challenges, passive pigs adapt better. Similarly, Bolhuis et al. (2005) suggest that passive pigs learn their place in the hierarchy more quickly than active pigs. As a consequence, passive pigs adapt better to disruptions in the social environment. In the current study, the fast pigs in the intact litters and uniform fast treatments increased their time to approach after regrouping. Both the intact and uniform fast decreased from tests 3 to 4, but the diverse maintained a consistent time to
approach across all four tests. Whereas, the slow pigs all showed the ‘typical’ habituation response, with gradual decreases in time to approach over the four tests. This typical response has been reported by Hemsworth et al. (1986) and appears to be entirely due to the slow approaching pigs within the population. The authors did not initially differentiate between slow and fast approaching pigs and interpreted this overall response as an indication of the degree of fear experienced by the pigs throughout the repeated tests. The time to approach was shown to decrease over time, which was interpreted as a decrease in fear over time. However, because the results from the current study indicate that the human approach test is a useful test for distinguishing among individuals, it would be expected that different pigs also respond and adapt differently to the test. As a result, the fast and slow pigs within the population could express their fear of novelty differently, and therefore habituate differently to the human approach test. On the surface, an initially fast approaching pig would likely be considered less fearful, and an initially slow approaching pig would likely be considered more fearful. However, perhaps fear responses are distributed on a continuum along with other behavioural responses such as response to restraint and aggression (Bolhuis et al., 2005). Therefore, an increase or decrease in time to approach should be interpreted differently depending on whether the pig is initially a fast (active) or slow (passive) responder. The increase in time to approach by fast pigs in the intact treatment (no regrouping stress experienced) during the third test could be an indication of decreased agitation/emotional arousal/fear and an increase in calmness. This could indicate that habituation is occurring for the fast pigs. Likewise, there was an increase in time to approach by fast pigs in the uniform treatment, but no significant increase by fast pigs in the diverse treatment. This could indicate that the initial regrouping aggression and/or long-term social environment was more stressful for fast pigs in the diverse treatment than for fast pigs in the uniform treatment, as the fast pigs in the diverse treatment maintained a relatively consistent time to approach. By the fourth test, the fast pigs in the intact and uniform treatments showed dramatic decreases in time to approach. This could be an indication that following a period of calmness in association with the human approach test, the fast pigs then show what would be considered the typical habituation response with a decrease in time to approach. However, the slow pigs in the intact litters, diverse and uniform slow treatments all followed the same pattern of gradual habituation to the test. This again suggests that the slow pigs (presumably adopting a passive response) experienced less stress and emotional arousal, regardless of the social environment; therefore their habituation to the test was not disrupted.

Ruis et al. (2001) also suggested that the greater emotional arousal experienced by socially isolated gilts may have disrupted the habituation process to a novel object by maintaining fear of the challenging situation. Fear and/or exploratory motivation are known to occur in novel situations (Boissy and Bouissou, 1995). Excitability in a novel environment has been characterized by increased locomotory activities and adrenocortical responses, which may represent fear (von Borell and Ladewig, 1992). The unpredictability and lack of control in the situation may contribute to the fear and anxiety experienced (Ruis et al., 2002). Emotionally aroused individuals may become excitable due to fear and/or exploratory motivation. Hessing et al. (1994) and Ruis et al. (2002) found that active responders had shorter approach latencies to novel objects. Animals adopting an active response tend to be more restless as they actively attempt to remove the stressor or themselves from the stressful situation (Benus et al., 1991; Koolhaas et al., 1999).
Therefore, in the current study, the initial approach speed among fast pigs may actually represent the degree of excitability. Faster approach speeds may represent higher levels of excitability and greater emotional arousal (such as fear and/or exploratory motivation). Although, according to Hemsworth et al.’s (1986) work, decreasing approach speed has been suggested to represent habituation, which indicates decreasing fearfulness. However, their data has been explained on the basis of overall means, not differences within approach speed categories. Furthermore, in the current study, the fast pigs start out fast and maintain a fast approach time, which may mean that this active response represents a maintenance of a heightened emotional arousal and excitability throughout all the tests (perhaps they are also more agitated), which results in a state of chronic stress. Whereas, the slow pigs (adopting a passive response) initially start out cautious and wary in a stressful situation, but are calmer and less emotionally reactive. Bolhuis et al. (2005) also suggest that passive pigs have behavioural flexibility and learn from their mistakes and past experiences, whereas active pigs are behaviourally inflexible and do not learn from their mistakes.

In summary, the results from this study indicate that there are different ways pigs could adapt to this test, which are dependent on how they are initially classified and the type of social environment to which they are exposed. Regrouping aggression/social stress is thought to have less of an effect on passive individuals, and therefore they calmly adapt and adjust to the human approach test. In the case of passive individuals, their decrease in time to approach probably represents decreased fear. Passive individuals have greater behavioural flexibility, adapt faster to change and therefore are more successful in variable environments compared to active individuals (Mendl and Deag, 1995; Bolhuis et al., 2005). Ruis et al. (2001) found that pigs that were classified as low resistant to restraint (adopting a passive response) recovered from social isolation faster than those pigs that were classified as high resistant to restraint (adopting an active response). The lower parasympathetic response experienced by low resistant pigs in a novel situation suggests that they were less stressed. The high resistant pigs were more restless at the beginning of isolation. Greater restlessness by active animals in stressful situations has been interpreted as the animal’s attempt to remove the stressor or themselves from the stressful situation (Benus et al., 1991; Koolhaas et al., 1999). If pigs initially show an excitable response to fear, the opposite response (calmness) should result when fear is reduced (if an initial fast approach represents fear, then a change to a slow approach could represent decreased fear/increased calmness). The fact that our control treatment (intact litters) did not experience any stress and showed an increase in time to approach after regrouping could be an indication of a differential habituation response, where increased time to approach represents decreased fear (for pigs initially classified as fast to approach).

In the current study, the type of social environment did not have an effect on overall average daily gain. There were no differences among the fast pigs in the intact, diverse or uniform treatments. Likewise, the overall average daily gain was similar for the slow pigs in the intact, diverse, and uniform treatments. The final human approach test and final weights were determined during the same week. The responses to the final human approach test indicate that all pigs, regardless of social environment, eventually habituated to the test. Perhaps the overall average daily gain is a reflection of a point when stability within the social structure has been reached in all the social environments. Therefore, individuals...
have found their place in the hierarchy, the stress has subsided and no differences were observed in their average daily gain.

5. Conclusions

Regrouping disrupts habituation to the human approach test, which suggests that initially slow, medium and fast approaching pigs respond differently to regrouping. Slow approaching pigs seem to adapt better to different social environments than fast approaching pigs. No evidence was found that would suggest that there are long-term benefits for regrouping into behaviourally diverse or uniform groups.

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