Reliability of temperament tests on finishing pigs in group-housing and comparison to social tests

Jennifer A. Brown a,*, Cate Dewey b, Cornelius F.M. Delange a, Ira B. Mandell a, Peter P. Purslow c, J. Andrew Robinson a, E. James Squires a, Tina M. Widowski a

a Department of Animal and Poultry Science, University of Guelph, Guelph, Ont., N1G 2W1 Canada
b Department of Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, Ont., N1G 2W1 Canada
c Department of Food Science, University of Guelph, Guelph, Ont., N1G 2W1 Canada

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ABSTRACT
If variation in behaviour is consistent within individuals and reliably associated with relevant welfare measures, this variation could aid in genetic selection, or development of management schemes designed to improve welfare. In this study, we focused on temperament tests in group-housed finishing pigs, with the objective of validating measures that are readily applicable in commercial settings and potentially related to individual differences in stress response. A total of 118 pigs in two replicate studies were housed in pens of 7–8 pigs per pen. At 24 weeks of age, animals were subjected to three tests of fear in the home pen: the human approach test (HAT), novel object test (NOT) and open door test (ODT). In each test, pigs were scored on their latency to contact the human or object, or to leave the home pen. Tests were repeated on three occasions at intervals of 3–4 days. On each test day the HAT was performed twice to compare results between different handlers. Behaviour in tests of fear was compared with two social tests in a subset of 58 pigs. Lesion scoring was performed after mixing as a measure of aggression, and a feed competition test was used to assess social status. Repeatability within-test was evaluated in a mixed model with pig as a random effect, and agreement between days, handlers and tests was evaluated by partial correlations after controlling for replicate, pen and day effects. Latency to perform all three fear tests decreased significantly over time. Correlations within-test showed significant agreement between all days for HAT and ODT, and between HAT handlers. Between tests, the HAT and ODT were correlated, and ODT and NOT tended to correlate. Comparisons between group fear tests and social tests showed that pigs which readily approach a human tended to have higher lesion scores and fewer feeding bouts in the feed competition trial. While test latencies decrease with repetition, the HAT and ODT show individual consistency over time, which suggests that these tests describe behavioural tendencies and may be useful for predicting fearful responses at slaughter.

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1. Introduction
It is widely recognized that individual animals show large variations in stress response, and that both genetic and environmental factors play a part. In pigs this variation is especially evident around the time of slaughter, when behavioural and physiological responses to stress can have a significant impact on the welfare of animals, and on the quality of meat they produce. Stress contributes to the prevalence of downer pigs, death losses, carcass downgrading and poor meat quality, and these problems also negatively impact public perception of the pork industry. Therefore understanding the stress response and why
some animals respond negatively, while others do not, has important implications from both ethical and economic standpoints.

Variation in stress response patterns was initially proposed by Henry and Stephens (1977), and studies in rodents confirmed the presence of two extremes of coping style (Benus et al., 1991). A coping style is defined as, “a coherent set of behavioural and physiological stress responses which is consistent over time and which is characteristic to a certain group of individuals” (Koolhaas et al., 1999). The two coping styles are known as proactive (active) and reactive (passive), with proactively coping individuals showing physiological changes associated with the fight-flight response originally described by Cannon (1915), and reactively coping individuals displaying a conservation-withdrawal response (Engel and Schmale, 1972).

Through the 1990s and early 2000s, many studies were carried out in pigs in an effort to validate the coping styles hypothesis, with variable success. Some studies found consistency both within and between tests (Hessing et al., 1993; Ruis et al., 2000) while others found weak consistency within tests, or poor agreement between tests (Lawrence et al., 1991; Jensen et al., 1995a; Forkman et al., 1995; Spoolder et al., 1996; D’Eath and Burn, 2002). Variability in the results and conclusions of these studies may be due to differences in methodologies, including differences in breed, age, rearing environment and testing protocols, as well as differing opinions regarding the definition of coping style (Jensen, 1995; Jensen et al., 1995b). Most studies used a test of tonic immobility, also referred to as the back-test, performed at an early age (Hessing et al., 1993), as the main indicator of coping style, and compared back-test results against a range of social and non-social tests, including various rodent-style laboratory tests, tests of fear (Van Erp-van der Kooij et al., 2002; Erhard and Mendl, 1999), and tests of aggression and social status (Forkman et al., 1995; Janczak et al., 2003b; Bolhuis et al., 2005). Another possible explanation for the variability in results is that the coping styles model is uni-dimensional, while coping styles may in fact be a multidimensional phenomenon, related to personality (Koolhaas et al., 1999; Gosling, 2001). This would help to explain why bimodal distributions of coping style are not found in pigs, and why relationships across situations are not consistently found.

Regardless of the validity of the coping styles hypothesis per se, it is widely agreed that if behavioural responses are measurable and predictive of the stress response in subsequent situations, this information could be of great value in improving welfare. This study focuses on the human approach test (HAT), novel object test (NOT) and open door test (ODT), all three of which have been widely used in previous studies. Studies on the relationship between the HAT, NOT and ODT suggest that pigs which rapidly approach a human or novel object, or exit the home pen, demonstrate a proactive coping style, while pigs that are reluctant to approach, or exit the pen show a reactive coping style (Ruis et al., 2000; Van Erp-van der Kooij et al., 2002). The HAT and NOT have been used both in groups (Van Erp-van der Kooij et al., 2002) and in isolation (Hemsworth et al., 1994, 1996; Janczak et al., 2003b; Marchant-Forde et al., 2003; Terlouw and Porcher, 2005; Hayne and Gonyou, 2006), while the ODT is performed on groups of pigs (Lawrence et al., 1991; Erhard and Mendl, 1999; Ruis et al., 2000). We refer to the HAT, NOT and ODT collectively as tests of fear as they all involve some degree of novelty and measure the response to potentially threatening stimuli; however we emphasize that the tests are only indicators of fear, not direct measures of the emotional state (Boissy, 1995). Other motivations are likely involved in test responses, such as activity level, specific fear of humans, curiosity or exploratory drive, and social status.

In this study, we examine reliability of the HAT, NOT and ODT when performed on group-housed pigs at approximately 24 weeks of age. Specific goals include: (i) measurement of repeatability within-test over time, (ii) measurement of repeatability of the HAT when performed by different handlers, (iii) measurement of agreement between tests of fear, and (iv) comparison between tests of fear and tests of aggression and social status. While establishing the relationship between tests of fear and social tests is not essential for validation of these tests as predictors of stress, this relationship is relevant to the study of coping styles and personality, and for placing the work in the context of previous research.

2. Methods

Animal care and all methods used in this study were approved by the University of Guelph Animal Care Committee.

2.1. Animals and housing

The study was conducted between January and July 2006 at the Ponsonby Research Station of the University of Guelph, in Ontario, Canada. A total of 120 grower pigs (69 castrated males and 49 females) were purchased at approximately age 8 weeks of age (25 kg) from four commercial farms. Breeds included purebred Landrace and commercial Yorkshire × Landrace and Yorkshire × Duroc crossbreds. Two replicate studies were done, with 60 pigs sourced from two farms in each replicate. At the time of receipt, individually numbered ear tags were applied (Alltag USA, Ltd.), and pigs were sorted by farm of origin and gender into eight pens with seven to eight pigs per pen. Pigs were reared in spindle-sided pens measuring 3.66 m ×3.66 m. Each pen was furnished with a feed hopper and bite drinker, and water and a commercial pelleted grower ration were provided ad libitum. Pens were cleaned daily and bedded with wood shavings. From the age of 10 weeks to 24 weeks, pigs were weighed on a weekly basis. During the weighing procedure the pen door was opened and pigs were moved into an alleyway. Each pig was then driven into a weigh scale using a handling board and returned to the home pen.

2.2. Behavioural measures in group-housing

When the pigs averaged approximately 90 kg (approximately 23 weeks of age), the HAT, NOT and ODT were
Erp-van der Kooij et al. (2002) used a scoring system based with the main difference being the scoring technique used. This study used latency measures in seconds, whereas Van Erp-van der Kooij et al. (2002) used a scoring system based on 30 s intervals. On each test day, the HAT was performed twice, once by handler ‘a’, and once by handler ‘b’, and the order of HAT 1 (handler ‘a’), HAT 2 (handler ‘b’) and NOT tests were randomized, while the ODT was always performed last due to the apparent arousal it caused in pigs and disturbance of other pigs. The HAT provides a measure of fear and exploratory behaviour directed towards a human. To begin the test, a handler (initially unfamiliar to the pigs and wearing blue coveralls) entered the pen with a tape recorder, clipboard and stopwatch, and walked purposefully to a central location where no pigs were within 0.5 m. The handler stood in place and recorded the latency to first contact of each pig over 3 min on audiotape. To minimize disruption of pigs’ behaviour, microphones were placed on the handler’s shirt collar and observations were made in a low speaking tone. Pigs which did not make contact received the maximum score (180 s), and if all pigs made contact in under 180 s the test was terminated. The NOT provides a measure of fear and exploratory behaviour directed towards a novel object. Novel objects varied on each test day, and included: (1) a white feed bucket, (2) an orange traffic cone, and (3) a partially deflated basketball. To begin the test, an observer dropped the object into the pen at the centre of one side and approximately 1 m inside the pen. Over 3 min, the latency to first contact of individual pigs with the object was recorded on audiotape. Pigs which did not make contact received the maximum score (180 s), and if all pigs made contact in under 180 s the test was terminated. The ODT provides a measure of the pigs’ motivation and fear related to exiting the home pen. The door of the pen was opened, and the observer stood quietly to one side, location where no pigs were within 0.5 m. The handler stood in place and recorded the latency (time at feeder/number of bouts).

2.3. Lesion scoring and feed competition tests

Lesion scoring (LS) and feed competition (FC) tests were performed on a subset of 58 pigs (the second replicate). Lesion scoring was performed once at approximately 8 weeks of age, approximately 24 h after receiving and sorting pigs by gender (and farm) into groups of seven to eight animals per pen. To facilitate scoring, the body was divided into three regions: front (head, neck, shoulders and front legs), middle (flanks and back) and rear (rump and hind legs), following the method of Turner et al. (2006). The number of superficial skin scratches was counted and lesion scores were assigned for each region on a 4-point scale as follows: no scratches (0), less than 5 scratches (1), 5–10 scratches (2), more than 10 scratches (3). Scores for both sides of the body were averaged.

A feed competition test was performed on pigs at approximately 90 kg, or 22 weeks of age. Feeders were removed at 16:00 h and returned at 10:00 h the following morning (±60 min), at which time two feeders were placed in the pen (i.e. four pigs/feeder). Continuous observations were recorded on audiotape by two observers for the 10 min following introduction of the feeders. Ten minutes was selected as the cutoff because active competition at the feeders visibly declined after this time point. Each observer watched one feeder and recorded: (i) the order in which pigs accessed the feeder (rank, with the first pig ranked number (1), (ii) number of feeding bouts for each pig (bouts), (iii) duration of time at the feeder (recorded as percentage of the 10-min period), and (iv) average bout length (time at feeder/number of bouts).

2.4. Statistical analysis

Repeatability of group HAT, NOT and ODT over the three test days was evaluated using a mixed model with repeated measures in SAS (version 9.1.3). For statistical analysis, each pig was considered an experimental unit. The frequency of censored data in the HAT, NOT and ODT was found to be low (<2%), so these results were retained in the data set. Day and sex were modeled as fixed effects, while replicate, farm of origin, pen (by replicate) and pig (by pen and replicate) were random effects. For analysis of the HAT, handler (‘a’ or ‘b’) was added as a random effect. Distribution of residuals was checked for normality, and log transformations were applied to increase normality. Non-significant effects (\(P > 0.10\)) were removed from the model. Results between days were also compared by partial correlation coefficients after controlling for systematic effects of pen, farm of origin and day by GLM. For HAT correlations, daily measures were the average of handler ‘a’ and handler ‘b’, and for NOT and ODT, raw latencies were used.

The effect of handler in the HAT was assessed in two ways; first by inclusion of observer as a random effect in a mixed model analysis (described above), and second by calculation of the partial correlation coefficient of handler ‘a’ versus handler ‘b’, after controlling for systematic effects of pen, farm of origin and day.

Between-test comparisons of HAT, NOT and ODT in group-housing were performed within and across days by calculation of partial correlation coefficients, after controlling for systematic effects of pen, farm of origin and day. Average HAT, NOT and ODT measures and measures of aggression and social status were compared by partial correlation coefficient, after controlling for systematic effects of pen, and farm of origin.

3. Results

3.1. Repeatability and agreement within HAT, NOT and ODT

Variation among pigs in the mixed model was significant in both the HAT and ODT (HAT: \(z = 5.37, P < 0.0001\) and ODT: \(z = 3.46, P = 0.0003\)), accounting for
Table 1

<table>
<thead>
<tr>
<th>Test</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAT</td>
<td>10.4* (8.4–12.8)</td>
<td>8.0b (6.4–9.9)</td>
<td>6.6b (5.3–8.1)</td>
</tr>
<tr>
<td>(handler ‘a’)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOT</td>
<td>6.3 (5.1–7.8)</td>
<td>6.0 (4.9–7.5)</td>
<td>5.9 (4.7–7.3)</td>
</tr>
<tr>
<td>ODT</td>
<td>14.6* (11.6–18.3)</td>
<td>13.1* (10.5–16.5)</td>
<td>9.1* (7.3–11.5)</td>
</tr>
<tr>
<td></td>
<td>10.7a (8.4–13.6)</td>
<td>9.6a (7.6–12.1)</td>
<td>6.1b (4.9–7.7)</td>
</tr>
</tbody>
</table>

*a,bDifferent superscripts within rows indicate significant difference; P < 0.05 (t-statistic).

Values in bold represent significant level at P < 0.005.

<table>
<thead>
<tr>
<th>Day тест</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HAT</td>
<td>NOT</td>
<td>ODT</td>
</tr>
<tr>
<td>1</td>
<td>HAT</td>
<td>0.09*</td>
<td>0.030</td>
</tr>
<tr>
<td>NOT</td>
<td>0.173</td>
<td>-0.016</td>
<td>0.061</td>
</tr>
<tr>
<td>ODT</td>
<td>0.137*</td>
<td>0.054</td>
<td>0.382</td>
</tr>
<tr>
<td>2</td>
<td>HAT</td>
<td>0.006</td>
<td>0.078</td>
</tr>
<tr>
<td>NOT</td>
<td>0.036</td>
<td>-0.035</td>
<td>-0.049</td>
</tr>
<tr>
<td>ODT</td>
<td>0.088</td>
<td>0.095</td>
<td>0.195</td>
</tr>
<tr>
<td>3</td>
<td>HAT</td>
<td>0.0130</td>
<td>0.015</td>
</tr>
<tr>
<td>NOT</td>
<td>0.015</td>
<td>0.015</td>
<td></td>
</tr>
<tr>
<td>ODT</td>
<td>0.004</td>
<td>0.004</td>
<td></td>
</tr>
</tbody>
</table>

Values in bold represent significant level at P < 0.005.

3.2. Reliability between handlers

No significant handler effect was found in the HAT when analyzed in the mixed model with handler as a random effect (z = 0.66, P = 0.254). Correlation of handlers was significant, giving a partial correlation coefficient of 0.3218 (P < 0.0001) after controlling for systematic effects of pen, farm of origin and day.

3.3. Between-test comparisons of HAT, NOT and ODT

Comparisons between tests over the 3 days revealed several significant correlations between HAT and ODT, ODT and NOT and HAT and NOT results, as shown in Table 2. For example, partial correlation coefficients (r) comparing HAT and ODT on days 1 and 2, days 2 and 3, and within day 3 were 0.205 (P < 0.0001), 0.105 (P = 0.026), and 0.195 (P = 0.005), respectively. While these correlation coefficients are low, they are significant. Relationships between ODT and NOT showed similar agreement, while agreement between HAT and NOT was weaker still, with significant correlations (P < 0.05) only within day 1 and between days 1 and 2, and corresponding r values below 0.10.

Comparison between tests based on test averages similarly showed a significant correlation between HAT and ODT (r = 0.293, P < 0.0001), a trend for correlation between ODT and NOT (r = 0.102, P = 0.061), and no correlation between HAT and NOT (r = 0.052, P = 0.334).

3.4. Comparison between group and social tests

Mean results of lesion scoring and feed competition trials are presented in Table 3, and correlations with tests of fear (average HAT, NOT and ODT) are presented in Table 4. Similar relationships were found between HAT, NOT and ODT to those presented for all pigs in Section 3.3: HAT and ODT showed significant correlation (r = 0.286, P = 0.047), while ODT and NOT showed a tendency for
agreement ($r = 0.248, P = 0.085$) and HAT and NOT did not correlate ($r = 0.079, P = 0.590$). Front and hind lesion scores showed significant correlation ($r = 0.405, P = 0.004$). The correlation of front and hind lesion scores with the total lesion scores is spurious, as these measures are part of the total measure. There were also significant correlations between feed competition measures. Rank at the feeder was negatively correlated with the number of feeding bouts ($r = -0.409, P = 0.004$), indicating that pigs which access the feeder sooner have more feeding bouts, and number of bouts and bout length were correlated with time at the feeder ($r = 0.643$ and $0.510$, respectively, for bouts and bout length, $P < 0.001$), showing that pigs which access the feeder more frequently and which have longer bouts spend more time there.

No significant relationships were found between tests of fear (HAT, NOT and ODT), aggression and social status (see Table 4). However average HAT scores did show a tendency for correlation with front and total lesion scores and number of bouts during the feed competition trial. Partial correlation coefficients between average HAT and front and total lesion scores were $-0.275$ and $-0.253$, respectively ($P < 0.10$), indicating that pigs which were faster to contact a human received more lesions during mixing. As stated, the correlation between average HAT and feed competition bouts showed a trend ($r = 0.248$, $P = 0.090$), suggesting that pigs which are quick in the HAT had fewer bouts at the feeder.

### Table 3
Mean lesion scores and feed competition results ($n = 58$).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (±std error)</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lesion scoring</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Front</td>
<td>1.53 (±0.10)</td>
<td>0.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Hind</td>
<td>0.74 (±0.09)</td>
<td>0.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Total</td>
<td>3.47 (±0.24)</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td><strong>Feed competition</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bouts</td>
<td>6.04 (±0.40)</td>
<td>0.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Bout length (s)</td>
<td>19.08 (±1.54)</td>
<td>4.71</td>
<td>69.52</td>
</tr>
<tr>
<td>Time (%)</td>
<td>14.28 (±1.22)</td>
<td>2.13</td>
<td>40.27</td>
</tr>
</tbody>
</table>

### Table 4
Correlations between behavioural tests, lesion scores and feed competition results (partial correlation coefficients; HAT, NOT and ODT latencies were averaged over 3 days and log transformed, $n = 58$).

<table>
<thead>
<tr>
<th>Test</th>
<th>Average scores</th>
<th>Lesion scores (LS)</th>
<th>Feed competition (FC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HAT NOT ODT</td>
<td>Front Hind Total</td>
<td>Rank Bouts Bout length (s) Time (%)</td>
</tr>
<tr>
<td>Average scores</td>
<td>0.079 0.286 0.248</td>
<td>$-0.275^<em>$ $-0.103$ $-0.253^</em>$</td>
<td>$-0.131$ 0.248 $-0.211$ 0.057</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$0.097$ 0.014</td>
</tr>
<tr>
<td>LS</td>
<td>Front</td>
<td>0.405</td>
<td>$0.205$ $-0.181$ $-0.040$ 0.209</td>
</tr>
<tr>
<td></td>
<td>Hind</td>
<td>0.785</td>
<td>$0.091$ $-0.013$ $-0.014$ 0.136</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>$0.157$ $-0.133$ $-0.034$ 0.196</td>
</tr>
<tr>
<td>FC</td>
<td>Rank</td>
<td></td>
<td>$0.040^*$ $-0.077$ $-0.183$</td>
</tr>
<tr>
<td></td>
<td>Bouts</td>
<td></td>
<td>$-0.116$ 0.643 0.510</td>
</tr>
<tr>
<td></td>
<td>Bout length (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time (%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values in bold represent significant level at $P < 0.05$.

* $P < 0.10$.

### 4. Discussion

#### 4.1. Repeatability within-test and habituation

In this study, individual behaviour in the HAT and ODT showed consistency over time, with all days showing significant correlation, while performance in the NOT was inconsistent. Few studies have examined the reliability of tests of fearfulness in pigs, and a lack of standardization and validation in behavioural tests has been recognized as a problem in ethological research (Gosling, 2001; Wai-blinger et al., 2006; Forkman et al., 2007). Studies on the development and validation of fear testing methods in pigs began in the 1980s and early 1990s (reviewed in Hemsworth and Coleman, 1998; Forkman et al. (2007) and Spoolder (2007)). More recent studies involving repeated tests of fear have usually had other primary objectives, such as validation of the back-test as a measure of coping style (Hessing et al., 1994; Spoolder et al., 1996; Ruis et al., 2000), and/or evaluation of effects of regrouping (Van Erp-van der Kooij et al., 2002; Hayne and Gonyou, 2006). The study of Van Erp-van der Kooij et al. (2002) is most relevant to the current work, as they also performed the HAT, NOT and ODT on pigs in group-housing, although at an earlier age (5–7 and 10–12 weeks) and longer test interval. They found significant within-test correlation for the NOT and ODT ($r = 0.26$ and 0.24, respectively, $n = 94$) but not the HAT. Ruis et al. (2000) also carried out a group ‘novel environment test’ (including measures comparable to the ODT and HAT) at 10 and 24 weeks of age, but found no within-test correlation. While consistency over time would demonstrate stable personality traits, it is also possible that changes occur during development, and discrepancy in these results may reflect changes that occurred during the test interval. In our study, tests were repeated three times over an 8-day period, so the effects of development (but not of learning) were minimized.

Studies which examined within-test repeatability of HAT and NOT in isolation (instead of in groups) have generally found significant agreement, including Hessing et al. (1994; NOT at 3 and 8 weeks), Spoolder et al. (1996; HAT and NOT at 17 weeks), and Hayne and Gonyou (2006;
HAT at 4 and 7 weeks). While we predict that similar responses should be observed between group and isolation tests, there are significant differences between these two scenarios that can affect behavioural responses. Fear and anxiety are likely greater in isolation, due to added uncertainty imposed by the novel environment and absence of conspecifics, and pigs may be more motivated to explore the novel environment than to interact with a human or object (Spoolder, 2007). It is also clear that responses are affected by environment and management (Bolhuis et al., 2004; Marchant-Forde et al., 2003), and that different personality types may respond differently. These factors could explain why the observed correlations are low. In this study, the ODT and HAT showed overall consistent performance, while in the NOT only results on days 1 and 3 were in agreement. This may be due to the low stimulus value of the NOT when performed in groups of pigs, and especially as the animals were in a relatively enriched environment (i.e. ample space, daily human interaction and wood shaving substrate). Another confounding factor was that pens were constructed of metal spindles; during performance of the NOT some pigs were more focused on the human observer standing near the pen than on the novel object.

Habituation to tests of fear is well documented in previous studies and was confirmed in this work. Repeated testing of pigs over an 8-day period resulted in a significant decrease in latencies in all three tests. Despite the large variation in sampling intervals in previous work, or whether testing was done in groups or isolation, most studies demonstrate a similar decrease in time to contact (HAT and NOT), or to exit (ODT). This decrease in approach latency has been interpreted as a habituation response (Hemsworth et al., 1986; Hemsworth and Barnett, 1992), and an indicator of reduced fear. These findings prompted interest in using the HAT as a welfare assessment tool; however, as previously discussed, subsequent studies have shown that motivations other than fear can significantly affect responses. Because of these confounding factors, it has been concluded that tests of fear based on latency times are not generally suitable for welfare assessment (Marchant-Forde et al., 2003; De Passilé and Rushen, 2005; Spoolder, 2007). HAT, NOT and ODT latencies in this study are shorter than those found in other studies, with a mean latency of under 30 s for all three tests.

Van Erp-van der Kooij et al. (2002) performed the tests in groups of pigs in a similar way, and found mean latencies over 2 min at 5–7 weeks of age and over 1 min at 12–17 weeks. This difference could be partly age-related as our pigs were older (24 weeks). However, Ruis et al. (2000) recorded mean ODT latencies over 2 min at both 10 and 24 weeks. In addition to our pigs being older, the fact that they received regular human contact (during daily pen-cleaning), and left the pen weekly for weighing are likely to have had a strong habituation effect, and contributed to the short contact latencies in this work.

While tests of fear may be of limited value in welfare assessment, these tests can be a valuable measure of relative response between individuals, or groups of individuals subjected to different treatments. For example, Hayne and Gonyou (2006), examined the effects of regrouping pigs on HAT contact latency and found increased latency following mixing; this was in a subgroup of pigs initially selected for fast latencies. By contrast, groups of pigs selected on the basis of slow latency times showed a consistent, steady decrease over time. Hayne and Gonyou (2006) suggest that the fast (proactive) and slow (reactive) pigs perceive or express fear differently, and thus habituate to the test differently. Thus, tests such as the HAT are useful for identifying subgroups within the population, and studying why and how they vary.

4.2. Consistency between tests of fear

If distinct personalities exist and the HAT, NOT and ODT have similar stimulus value, we expect to find agreement between the tests. Of 27 possible correlations between tests (within and across days, Table 2) 6 were significant at P < 0.005, and 4 at P < 0.05. Van Erp-van der Kooij et al. (2002) found similar levels of consistency, with significant inter-correlations among HAT, NOT and ODT in the first test at 5–7 weeks, and again in the second test at 10–12 weeks. Comparing across times, they found significant agreement between the HAT at 5–7 weeks and ODT at 10–12 weeks. Janczak et al. (2003a) also found significant agreement between the HAT and NOT at 8 weeks; however no agreement was found when pigs were retested at 24 weeks. Results of between-test comparisons are therefore less consistent than within-test, but are similar in showing moderate agreement over a limited time frame. It appears that younger pigs show a more generalized fear response, resulting in higher agreement between tests, whereas responses in older animals are more stimulus-specific (Marks and Nesse, 1994; Janczak et al., 2003a). An example of stimulus-specific responses is described in Hemsworth et al. (1996), where 10-week-old pigs were exposed to either regular handling or novel objects for 4 weeks and then tested in the HAT and NOT in isolation. Pigs which received regular handling showed a generalized reduction in fear and were faster to approach both a human and a novel object, while pigs which were exposed to novel objects showed more selective fear reduction and were faster to approach a novel object, but not a human. Similarly, the consistent correlation between HAT and ODT (Van Erp-van der Kooij et al., 2002 and this work) may reflect a stimulus-specific response to humans. Although handlers in the ODT attempt to not influence behaviour in the test, pigs are aware of their presence in proximity to the pen door.

4.3. Comparisons with social tests

In rodents, coping style is associated with social behaviour, particularly aggression (Benus et al., 1991). Previous works examining coping styles in pigs have typically presented the correlation of behaviour in social and non-social challenges as the critical criterion for validation of the coping styles hypothesis. Unfortunately, and despite numerous studies, a clear answer has not been found. Of 11 studies which addressed this question (dating between 1991 and 2005), five found significant correlations between behaviour in social and non-social situations (Hessing et al., 1993; Thodberg et al., 1999; Ruis et al., 2000; O’Connell et al., 2004; Bolhuis et al., 2005), while six...
found no correlation (Lawrence et al., 1991; Forkman et al., 1995; Jensen et al., 1995a; Spoolder et al., 1996; D’Eath and Burn, 2002; Janczak et al., 2003a), and the correlations which have been found are low. While variation in the tests and criteria used explain some of the differences, we can fairly conclude that, with the possible exception of aggression (see Section 4.4 below) behaviour of pigs between social and non-social situations is inconsistent. Several explanations have been offered as to why responses to different challenges vary in pigs, but not in rodents. An initial suggestion by Jensen et al. (1995b) was that coping styles do not exist in pigs, with differences in selection pressure between the species being a possible explanation.

That is, wild rodents are subject to population cycles which benefit proactive and reactive coping styles at different times, maintaining them as evolutionarily stable strategies (ESS) in the population, while (female) pigs live in stable social groups which would not benefit from these strategies. However, the demonstrated consistency of behaviour within social and non-social contexts clearly indicates that individual pigs do have distinct behavioural phenotypes, or personality. Recent studies have focused on a multidimensional models of personality in animals, such as the five factor model (FFM) used in human psychology (John, 1990; Gosling and John, 1999), to resolve this problem. The FFM consists of traits ‘extraversion’, ‘neuroticism’, ‘openness’, ‘conscientiousness’ and ‘agreeableness’, and it had been further suggested that stress response (and coping style) may integrate aspects of the FFM dimensions ‘extraversion’ and ‘neuroticism’ (Koolhaas et al., 1999; Gosling, 2001).

Aggression is the social trait which has shown the most consistent relationship with non-social behaviour in pigs (Hessing et al., 1993; Ruis et al., 2000; Bolhuis et al., 2005), with proactive pigs showing more aggression than reactive pigs. This finding is also consistent with rodent research on ‘short attack latency’ (SAL) and ‘long attack latency’ (LAL) rats (De Kloet et al., 1996). In this study, a tendency for negative correlation between HAT latency and lesion score was found, suggesting that pigs which approach a human more quickly are more aggressive at mixing. Lesion scoring is a rapid, simple technique for estimating aggression in pigs. Turner et al. (2006) performed a validation of the method, which showed that the critical factors influencing lesion score are body weight, reciprocal aggression and being bullied. They also found that lesions on the front of the animal correlate with time spent in reciprocal aggression, while lesions on the rear of body are correlated with time spent being bullied. In our study, we evaluated front, hind and total lesion scores, and found trends associating HAT latency with front and total lesions, and no association with hind lesions, giving further indication that this was due to aggressive behaviour, not being bullied.

Results of the feed competition study showed no clear relationship between rank, number of bouts, bout length or time spent accessing feed and tests of fear. However, a positive trend was found between the number of bouts at the feeder and HAT latency, indicating that pigs which were fast to approach a human tended to access the feeder less frequently, suggesting that proactive animals are not necessarily more dominant. Other studies which have examined coping styles and social status in pigs have generally found no relationship, i.e. proactive and reactive animals show similar levels of dominance (Forkman et al., 1995; Ruis et al., 2002; Bolhuis et al., 2005). In the study reported here, the feed competition trial was performed once per group of animals, while most other studies which have used the feed competition test have performed the test multiple times (Ruis et al., 2000; Terlouw and Rybarczyk, 2008). Had the test been repeated in this study it would likely have provided a more reliable estimate of social rank.

4.4. General discussion

Group tests were evaluated in this study because of their ease of use and applicability to commercial settings. The HAT, NOT and ODT as performed in this study are suitable for use in small groups, but could not be readily applied to large groups where access to the human, object or pen door are restricted by competition or poor visibility. Pigs in this study were housed under conditions which were enriched in comparison to most commercial conditions in North America, and it is difficult to estimate the behavioural effects of a more restrictive environment. Commercially reared animals may be expected to show greater fear responses and slower approach times due to their lack of experience. However, experience does not always result in reduced latency, for example Marchant-Forde et al. (2003) found that in human approach tests in isolation, sows with more human exposure were slower to make contact. Therefore, lack of experience in commercially reared pigs may in fact result in greater motivation to approach a human or novel object, especially in the home pen.

Results of this study showed significant, albeit low, correlations within and between HAT and ODT tests over time. The fact that these correlations are in general agreement with previous work and were present despite potentially confounding factors confirms the presence of behavioural phenotypes related to fearfulness in pigs and indicates a degree of robustness in the tests. Potential confounds included the pigs’ previous experience with handling and leaving the home pen, variation in genetics and early experience, and the hormonal status of gilts. Pigs in this study were part of a larger investigation of sources of variation in meat quality, which is why the animals were sourced from four commercial farms. However, no farm of origin or replicate effects were found, and no gender effects were found even though pubertal gilts were used. The low correlations found are problematic, as we would expect that the short latency between tests in this study would result in higher r values. The problem may lie in the tests, which may not provide a reliable measure of underlying traits, or in the nature of personality and behaviour. Behaviour (especially in a group setting) is highly variable, and each test may measure more than one trait.

5. Conclusion

The objective of this study was to assess the reliability of behavioural tests of fear which can be used on-farm before pigs are sent to slaughter. The HAT and ODT showed moderate consistency over time, in keeping with previous studies and despite the presence of potentially confound-
ing factors, suggesting that the tests are fairly robust. In contrast, results of the NOT were inconsistent. Different handlers performing the HAT showed significant agreement, and results of the HAT and ODT were correlated. Comparison to tests of fear with social tests showed that pigs which were faster to approach a human tended to be more aggressive. We conclude that the HAT and ODT measure behavioural traits, and may be useful in predicting fearfulness and stress response at slaughter.

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