Measurement of temperament in pigs

Roger Giles, Richard Lansdowne* and Kerry James

*NSW Agriculture, Elizabeth Macarthur Agricultural Institute, PMB 8, Camden NSW 2570. *Faculty of Veterinary Science, The University of Sydney, PMB 3, Camden NSW 2570*

The concept of active and passive temperament

There is evidence from a number of vertebrate studies that individual animals show consistent differences over time to stressful or challenging situations (reviewed by Koolhaas et al., 1999). These stable differences in behaviour between animals are often referred to as 'temperament', 'personality' or 'coping style'.

The original concept of temperament arose from studies on aggression in house mice selected from two genetically diverse lines of mice; the first line showing strong avoidance behaviour in response to attack while the second line did not react as readily to aggressive behaviour. When male mice from these two different lines were placed in a cage in which a resident was living, the animals displaying a marked avoidance response and spent a lot of time in fleeing behaviour whereas the low responsive animals spent most of their time immobile (Benus et al., 1991). This led these authors to classify the two coping strategies as active and passive respectively.

While the above studies centred on aggression and the reaction of animals to the social stress of dominance and submission, it did not take long for people to think about applying the principle of active and passive social strategies to domestic livestock. This was not done in relation to social dominance but with a view to studying how animals cope with the variety of stressors encountered in modern animal husbandry. For instance, the majority of studies into what we understand to reflect temperament in farm animals has been assessed following some form of restraint (eg a weigh crate), mixing with unfamiliar animals or response to humans in an arena test (Giles and Kilgour, 1999).

Assessment of temperament in pigs

In pigs there have been several studies into behavioural and physiological characteristics associated with active and passive temperament. Most studies have centred on the 'backtest' as a key indicator of temperament (Hessing et al., 1994a, 1994b, 1995; van Erp-van der Kooij et al., 2000; Bolhuis et al., 2000). The backtest, as first described by Hessing et al., (1993) consists of restraining a piglet (prior to weaning) in a supine position for one minute while at the same time recording the number of escape attempts. Piglets making more than two escape attempts were classified as resistant (or active) compared to piglets that made less than two escape attempts which were described as non-resistant (or passive). Importantly, Hessing et al. (1993; 1994a) demonstrated that the back test was a repetitive predictor of either active or passive temperament in pigs suggesting that temperament is a genetically regulated behavioural measurement. Studies by Jensen et al. (1995a) and a recent report by van Erp-van der Kooij et al. (2000) indicate that results from the backtest are not bimodal in distribution but rather distributed continuously in female and castrate male piglets from 0 to 12 escape attempts. Female piglets showed a higher number of escape attempts than castrate males.

Hessing et al., (1993, 1994a) demonstrated that, relative to passive animals, active piglets vocalised more frequently during the back test and were less likely to approach novel objects in an open-field test. Glucocorticoid status was higher in active piglets subjected to the open-field test but basal cortisol concentrations were lower. Similarly, active piglets were observed to have increased heart rates during the back tests and displayed higher heart-rate responses to a novel object. Furthermore, Hessing et al. (1995) demonstrated that differences in backtest scores were associated with differences in immune response between piglets. Pigs with active temperaments were characterised as having higher cellular immunity while humoral immunity was enhanced in passive animals.

There is ample evidence in the literature for an association between dopamine activity in the brain and the response of individual animals to stress situations. Recent studies by Bolhuis et al. (2000) demonstrated that the response of pigs to injections of the dopamine agonist, apomorphine differed between pigs depending on the number of escape attempts displayed during the backtest. Increase in locomotion and abnormal coordination between hind and front legs was more pronounced in passive pigs following injection with apomorphine. These findings suggest that the reactivity of the central dopaminergic system of passive animals is reduced when the axis is subjected to a stressful situation.

Comparative measurements of temperament in pigs

Behavioural studies in rodents and other vertebrate species involve predictable associations between social and non-social tests. The backtest is used in pigs only and is often regarded as a non-social test. However there is some uncertainty about how the pig perceives the backtest. It has been speculated by D'Eath and Burn (2002) that the pig may perceive the handler as a predator and try to escape, or behave as though in conflict with another pig.

Hessing et al. (1993) and Ruis et al. (2000) used a 'social confrontation test' to show that piglets that struggled more in the backtest were more aggressive when housed in a group pen with unfamiliar pigs. However, the backtest has been criticised in the literature (reviewed by D'Eath and Burn, 2002). Most notable are the reports of Jensen et al. (1995a,b), who found no association between the backtest in piglets and conventional measures of behaviour. Forkman et al. (1995) compared the backtest with two social tests. The first test was a 'group dominance test' where priority for access to a single-space feeder was assessed within litter-mates. The second test was a 'resident-intruder' test where individual pigs in their home pen were confronted with individual intruders from a different pen. There was no association with the backtest and either social test. D'Eath and Burn (2002) concluded that struggling behaviour in the backtest and aggressiveness in the resident-intruder test do not represent different expressions of the same temperament trait. Thus selection for increased struggling behaviour using the backtest is unlikely to be associated with an increase in aggressive behaviour.

An alternative measure of temperament was developed at Camden based on the variation in vocalisation between growing pigs when restrained for one minute with a nose snare. First described by Giles and Furley (1999), vocalisation is recorded with a decibel meter at intervals of 2 seconds and stored electronically. Aggregate vocalisation in male pigs was distributed continuously from animals that were quiet (or passive temperament) to pigs that squealed continuously which was deemed to represent active temperament (Black et al., 2001).

In a recent comparison between the backtest and vocalisation, Richard Lansdowne (unpublished) selected 72 male piglets at weaning on a commercial piggery using the backtest. Pig temperament was chosen as either passive (zero escape attempts) or active (more than 6 escape attempts). The 72 pigs were transferred to EMAI, Camden and grown from 16 ± 3.5 kg (mean ± SD) to 80.6 ± 7.2 kg live weight. There was a positive correlation between aggregate vocalisation recorded at the start (38 days of age), middle (58 days of age) and end (97 days of age) of the study. However there was no significant association between passive and active temperament measured with the backtest and vocalisation when restrained for one minute with a nose snare. Similar to the findings of D'Eath and Burn (2002) with the resident-intruder test, we concluded that increase in struggling behaviour during the backtest and elevated vocalisation when restrained with the nose snare do not represent different expressions of the same temperament trait in pigs.

The definition of temperament in pigs remains confused. The number of escape attempts recorded with the backtest appears to be closely associated with different arms of the endocrine-immune system. This association could be reasonably expected to be closely associated with differential gene expression for these endocrine-immune systems. The proponents of social and non-social tests as measures of temperament in pigs (Jensen et al., 1995a,b; Forkman et al., 1995) claim that only three temperament traits exist in pigs: namely aggression, sociability and exploration. The association between these traits and the endocrine-immune system is yet to be explored.

Temperament as an indicator of growth and carcass quality in pigs

There have been few studies of the association between measures of temperament in pigs and production parameters. Hessing et al. (1994b) found that castrate male and female pigs housed in mixed pens containing both active and passive animals grew faster than pigs that were maintained in group pens of either passive or active animals. However, in a recent report from the University of Utrecht, the Netherlands, van Erp-van der Kooij et al. (2000) conducted two studies with castrate male and female pigs and found no association between the number of escape attempts during the backtest and growth. The first experiment consisted of 823 pigs and the second experiment included 566 animals. In both experiments pigs were housed in a commercial environment from nine weeks of age until slaughter at about 110 kg live weight. No information on pen allocation or stocking rate was provided. These authors reported a significant ($P<0.01$) positive relationship in the first study between lean meat percentage at slaughter (calculated using backfat and eye-muscle thickness) and the number of escape attempts measured with the backtest prior to weaning.

In a study described above, Richard Lansdowne (unpublished) conducted backtest measurements on a commercial piggery to choose 72 male piglets at weaning as either passive (zero escape attempts) or active (more than 6 escape attempts). The pigs were transferred to EMAI, Camden and allocated at 16 ± 3.5 kg (mean ± SD) to 3 temperament treatments (passive, active and mixed) and either high (0.75 m^2/pig) or low (1.5 m^2/pig) stocking density. The pigs were housed in groups of 6 animals per pen and the experiment continued until the pigs reached 80.6 ± 7.2 kg live weight. The pen was used as the experimental unit.

Average daily live weight gain was significantly higher in pens containing active pigs compared to passive pens with pigs in the mixed treatment intermediate in growth. There was no significant temperament x stocking density interaction for average daily gain. However, within the low stocking density treatment there was a trend for pens containing active pigs to display increased daily live weight gain compared to pens containing passive animals.

At the conclusion of the study backfat thickness and eye-muscle depth were measured at the P2 position on all pigs using a real-time ultrasound device. There was no significant effect of either stocking density or temperament on P2 backfat thickness. However, there was a significant temperament x stocking density interaction for eye-muscle depth. Increased eye-muscle depth was observed in active pigs maintained at the high stocking rate compared to passive animals. There was no significant effect of temperament on eye-muscle depth at low stocking density.

In another study at EMAI, Camden using RT (Rootin-Tootin) feeders, a strong negative relationship was demonstrated between vocalisation score and feed intake when entire male pigs were housed at low stocking rate (1 m^2/pig) in either individual or group pens (reviewed by Black et al., 2001). Quiet animals consumed about 10% more feed than noisy pigs. However feed consumption in pigs housed in groups was always 12-15% less than pigs housed in individual pens irrespective of vocalisation score.

Contrary to these findings at Camden, vocalisation was recorded in a large quantitative trait loci study conducted at QAF Industries, Corowa during 2001. No association was found between vocalisation score and growth and vocalisation score and feed intake when pigs were housed in individual pens from 16 to 23 weeks of age.

The effect of pig temperament on growth and carcass quality remains equivocal. There is some evidence from pig studies at Camden (R Lansdowne, unpublished) and in the Netherlands (van Erp-van der Kooij et al., 2000) to suggest that increased struggling behaviour during the backtest is associated with increased growth and increased carcass lean content. We are not aware of any investigation of the association between the backtest and meat quality. Additional backtest studies are required under commercial conditions to select piglets of each sex as either passive or active temperament. Pigs need to be allocated to group pens according to live weight and maintained in groups containing either passive, active or mixed temperament. Daily live weight gain, carcass lean content and meat quality can then be analysed using the pen as the statistical unit. If pigs are allocated at random to group pens, the effect of temperament will be confounded by pen and live weight.

Towards a practical measure of temperament in pigs

A practical measure of temperament needs to fulfil a number of criteria before it is likely to be adopted. In the first instance, a practical measure of temperament needs to be quantitatively associated with growth and carcass quality. The second criteria must include speed and simplicity of measurement without a requirement for additional labour inputs. Thirdly and most importantly, adoption of a practical measure of temperament is likely to be rapid if the new measure of temperament can be incorporated into existing husbandry practices.

Existing measures of temperament in pigs including the backtest, vocalisation score and the resident-intruder test do not meet the above criteria. Most measures of temperament in domestic animals include an animal's reaction to some form of restraint, such as a weigh crate. In commercial piggeries animals are likely to be weighed once only prior to market, and the responses of individual pigs to restraint in a weigh crate can vary markedly. However individual pigs can adapt to restraint in a weigh scale when weighed at intervals of one week. Once pigs become familiar with the weighing procedure they will move through a weigh crate unassisted.

Traditional measures of temperament in cattle include a subjective assessment of movement in a crush. Since the subjective assessment is a reflection of the animal's movement, Stookey et al. (1994) constructed a movement device to quantify the animal's movement when restrained in a crush and standing on an electronic weigh scale. The movement device calculated the standard deviation of the analogue signals from the load cells of the weigh scale over a period of one minute.

Using a similar approach, Ian Craven of Ruddweigh International Scale Company at Guyra, NSW modified an existing pig weigh scale monitor to output live weight measurements continuously. The new monitor, called a 'pig movement meter', was coupled to a hand-held computer (Palm) containing a software program to record live weight at intervals of 0.4 sec over a period of one minute. This software provided 150 recordings of live weight when a pig was restrained in a conventional Ruddweigh pig scale. Standard deviation of the 150 weight recordings was calculated as a measure of pig temperament.

Richard Lansdowne and Kerry James (unpublished) found that the association between pig movement and struggling behaviour during the backtest improved with increase in live weight. The number of escape attempts (1.3 ± 1.1, mean ± SD) was recorded in 47 castrate male pigs following arrival at EMAI at 7.2 ± 1.0 kg live weight. Individual pig movement with 33 animals, derived from the original group of 47 animals, was recorded at 30.4 ± 4.4 kg live weight. The association between pig movement and the backtest was completely random. However when individual pig movement was recorded with 17 pigs at 82.8 ± 6.2 kg live weight, derived from the same group of 33 animals, pig movement was found to be positively associated with the number of escape attempts recorded during the backtest.

We speculate that the group of 33 lighter pigs were not restrained sufficiently in a conventional Ruddweigh scale and all animals were able to move about freely irrespective of struggling behaviour in the backtest. The group of 17 heavier pigs were more restrained in the weigh scale and pig movement was associated more closely with the backtest results.

To determine if it was possible to speed up the recording of pig movement to less than one minute, Richard Lansdowne calculated the sequential change in SD from 1 to 150 recordings of live weight for each pig using the group of 17 heavy animals. The results are presented in Figure 1.

The first 25 recordings (over 10 seconds) in Figure 1 appear to be random measurements as the pig settles into the weigh crate. After this initial period of 10 seconds sequential SD declines exponentially over time and is differentiated according to the number of escape attempts in the backtest. The results in Figure 1 suggest that movement measurements should not commence until at least 10 seconds after the pig has entered the weight crate. Movement recordings for a further 10 seconds (25 measurements of live weight at intervals of 0.4 seconds) should be sufficient to differentiate pigs according to struggling behaviour in the backtest.

Further studies are required with the pig movement meter to confirm the association between the backtest at weaning and movement in a weigh crate at market live weights (90 to 100 kg). Although the pig movement meter and Palm software developed by Ian Craven can capture pig movement, the authors consider that presentation of mean live weight and SD directly onto the pig movement meter would assist in adoption of this technology.

Conclusions

Although the backtest has come in for much criticism in the behaviour literature there is now some evidence that increased struggling behaviour in piglets during the backtest is associated with differential responses in the endocrine-immune system, an increase in growth to market weights and an improvement in carcass lean content. Comparison between the backtest and social tests such as the resident-intruder test suggest that selection for an increase in struggling behaviour in piglets is unlikely to be associated with an increase in aggressive behaviour.

Our investigations at Camden have developed a pig movement meter in collaboration with Ruddweigh International Scale Company at Guyra NSW. These studies have provided early evidence that the standard deviation of pig movement in a weigh crate is associated with struggling behaviour during the backtest. The pig movement meter offers a practical alternative to determine temperament in pigs. Further development of this technology should include direct recording of mean live weight and standard deviation within the pig movement meter.

Further studies are now required in commercial environments to measure the association between struggling behaviour in the backtest, growth, carcass lean content and meat quality. These studies should record pig movement as a practical measure of pig temperament.

Acknowledgements

The studies conducted at Elizabeth Macarthur Institute, Camden were supported by Australian Pork Ltd. The authors appreciate the helpful comments of Associate Professor Peter Wynn during preparation of this paper.

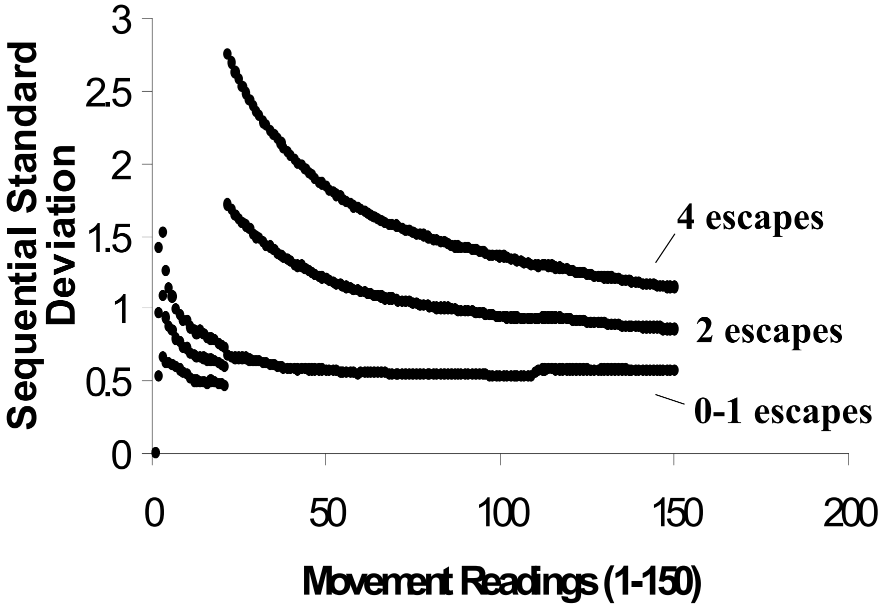

Figure 1 Sequential change in standard deviation (SD) from 1 to 150 measurements of live weight recorded with a pig movement meter over one minute for 17 pigs weighing 70 to 95 kg live weight. Sequential SD is presented according to the number of escape attempts recorded during the backtest.

References

Black, J.L., L.R. Giles, P.C. Wynn, A.G. Knowles, C.A. Kerr, M.R. Jones, A.D. Strom, N.L. Gallagher and G.J. Eamens (2001). "Factors affecting the performance of growing pigs in commercial environments." In, *Manipulating Pig Production* Ed. P.D. Cranwell. Australasian Pig Science Association: Werribee, Victoria.

Benus, R.F., B. Bohus, J.M. Koolhaas, and van G.A. Oortmerssen (1991). "Heritable variation for aggression as a reflection of individual coping strategies." *Experientia* **47:** 1008-1019.

Bolhuis, J.E., W.G.P. Schouten, I.C. de Jong, J.W. Schrama, A.R. Cools and V.M. Wiegant (2000). "Responses to apomorphine of pigs with different coping strategies." *Psychopharmacology* **152:** 24-30.

D'Eath, R.B. and C.C Burn (2002). "Individual differences in behaviour: A test of 'coping style' does not predict resident-intruder aggressiveness in pigs." *Behaviour* **139:** 1175-1194.

Forkman, B., I.L. Furuhang and P. Jensen (1995). "Personality, coping patterns and aggression in piglets." *Applied Animal Behaviour Science* **45:** 31-42.

Giles, L.R. and R.J. Kilgour (1999). "Coping style in farm animals: behavioural trait or production index?" *Recent Advances in Animal Nutrition in Australia* **12:** 187-192.

Giles, L.R. and G.R. Furley (1999). Vocalisation as a measure of temperament in growing pigs. In, *Proceedings of the 26th Conference of the Australasian Society for the Study of Animal Behaviour*. 8-11 April 1999, Armidale, NSW

Hessing, M.J.C., A.M. Hagelso, J.A.M. van Beek, P.R. Wiepkema, W.G.P. Schouten and R. Krukow (1993). "Individual behaviour characteristics in pigs." *Applied Animal Behaviour Science* **37:** 285-295.

Hessing, M.J.C., A.M. Hagelso, W.G.P. Schouten, P.R. Wiepkema, and J.A.M. van Beek, (1994a). "Individual behavioural and physiological strategies in pigs." *Physiology and Behaviour* **55:** 39-46.

Hessing, M.J.C., W.G.P. Schouten, P.R. Wiepkema and M.J.M. Tielen (1994b). "Implications of individual behavioural characteristics on performance in pigs." *Livestock Production Science* **40:** 187-196.

Hessing, M.J.C., G.J. Coenen, M. Vaiman and C. Renard, (1995). "Individual differences in cell-mediated immunity in pigs." *Veterinary Immunology and Immunopathology* **45:** 97-113.

Jensen, P. (1995a). "Individual variation in the behaviour of pigs - noise or functional coping strategies?" *Applied Animal Behaviour Science* **44:** 245-255.

Jensen, P., J. Rushen and B. Forkman (1995b). "Behavioural strategies or just individual variation in behaviour?" A lack of evidence for active and passive piglets." *Applied Animal Behaviour Science* **43:** 135-139.

Koolhass, J.M., S.M. Korte, S.F. de Boer, BJ. van der Vegt, C.G. van Reenen, H. Hopster, I.C. de Jong, M.A.W. Ruis and H.J. Blokhuis (1999). "Coping styles in animals: current status in behaviour and stress-physiology." *Neuroscience and Biobehaviour Reviews* **23:** 925-935.

Ruis, M.A.W., J.M. Koolhaas, H.J. Blokhuis (2000). "The backtest as a possible tool to improve welfare of pigs after mixing. 51st Annual Meeting of the EEAP, The Hague, Netherlands, Wageningen Pers, p 177.

Stookey, J.M., T. Nickel, J. Hanson and S. Vandenbosch (1994). "A movement-measuring-device for objectively measuring temperament in beef cattle and for use in determining factors that influence handling." *Journal of Animal Science* **72:** (Supplement 1): 207.

van Erp-van der Kooij, E., A.H. Kuijpers, J.W. Schrama, E.D. Ekkel and M.J.M. Tielen (2000). "Individual behavioural characteristics in pigs and their impact on production." *Applied Animal Behaviour Science* **66:** 171-185.