# Coping style in farm animals: behavioural trait or production index?

L.R. Giles[1] and R.J. Kilgour[2]

[1]NSW Agriculture, Elizabeth Macarthur Agricultural Institute, PMB 8, Camden NSW 2570
[2]NSW Agriculture, Trangie Agricultural Research Centre, Trangie NSW 2823

## Summary

Evidence is emerging to suggest that individual animals vary in their ability to cope with the social consequences of living in a group. This characteristic referred to as 'coping style' is manifested as individual differences in physiological, endocrine–immune and behavioural mechanisms which may be genetic in origin.

Measurements of vocalisation in pigs have shown that coping style is continuously distributed between the extremes of either 'passive' (quiet and unresponsive to social stress) or 'active' (vocal and responsive to social stress). Recent experiments in Australia with pigs, sheep and cattle have shown that animals with behavioural traits which reflect a passive coping style are associated with improvements in food intake (and hence growth) and reproductive characteristics such as lamb–rearing success. If further studies can establish that coping style is heritable, then there could be selection for this trait in animal breeding programmes.

An alternative approach is to manipulate (or shift) the normal distribution of coping styles within a population (or group) of animals towards those with associated benefits in production. An example of this approach is yard weaning of calves prior to entering a feedlot. Other examples of manipulating coping style may include intense handling and positive human–animal interaction.

Although low vocalisation in pigs was associated with a 10% improvement in food intake, grouping of low vocalisation animals does not raise food intake to the level observed for pigs in single pens. Opportunities exist to examine new penning arrangements and feeder designs in group environments which may alter dominance and submissive behaviour and hence allow animals to cope better with group environments.

## Introduction

The performance of farm animals maintained in commercial environments is well below their potential, and the performances achieved under experimental conditions. For example, pigs housed in single pens in research or boar–test environments grow 15–25% faster than animals of similar genotype when offered the same diet under commercial conditions (Black and Carr 1993). The reduced growth of animals maintained in commercial environments appears to be due primarily to a reduction in food intake although there is some evidence of an increase in fatness as nutrients are re–directed away from growth (Chapple 1993). This phenomenon has been referred to as the 'Growth Gap' within the pig industry. However an understanding of the causes, and ameliorating the effects of the Growth Gap are likely to have benefits which are common to most farm animal species.

There are many reasons for the reduction in food intake and changes in nutrient utilisation in commercial environments, including the social consequences of being housed in a group, changes in the thermal environment, deterioration in air quality, and the association between social factors and the incidence of disease, particularly respiratory diseases. Commercial strategies exist to improve the thermal, aerial and disease environments, but group housing remains as a constant factor that contributes to reduced animal performance in commercial situations.

Is it possible that some animals are better adapted to group environments, and hence have improved productivity and welfare characteristics? There is evidence emerging in the literature to suggest that individual animals vary in their ability to cope with the social consequences of living in a group. This characteristic referred to as 'coping style' is manifested as individual differences in physiological, endocrine–immune and behavioural mechanisms which may be genetic in origin. At Camden and Trangie we have been interested in assessing coping style in pigs, sheep and cattle and measuring the association between coping style and animal performance. Other studies in Australia have investigated management strategies to alter coping style in farm animals and hence improve livestock performance. This paper reviews the concept of coping

style and describes some recent Australian studies on its assessment and manipulation in farm animals, and the effects on animal performance.

## The concept of coping style

The notion of coping style in animals arose out of work by von Holst *et al.* (1983) who, in experiments on tree shrews, described two distinct groups of submissive male shrews living in the cage of a resident male. One of these groups actively avoided the resident male whereas the other group barely responded to threats and attacks by the resident.

In later studies on aggression in house mice, van Oortmerssen and Busser (1988) showed that there was a bimodal distribution of readiness to attack an intruder. These authors set up two genetically diverse lines of mice, the first line for high–readiness to attack and the second line for low–readiness to attack. When male mice from these two different lines were placed in a cage in which a resident was living, the high–readiness animals spent much time in fleeing behaviour whereas the low–readiness 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 or classical behavioural traits 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 of what we believe to reflect coping style in farm animals have been assessed following some form of restraint (e.g. a weigh crush in cattle) or the response of sheep to humans in an arena test.

## Assessment of coping style in farm animals

In an attempt to assess coping style in piglets, studies in the Netherlands (Hessing *et al.* 1993) demonstrated it was possible to differentiate active from passive coping styles when each piglet was restrained on their back for one minute (referred to as the 'back test'). In this test, piglets aged between one and three weeks were placed on their backs and restrained by an operator holding one hand loosely over the piglet's head. Piglets making more than two escape attempts were classified as resistant (or active), less than two escape attempts as non–resistant (or passive), and two escape attempts as intermediate. The test was repeated five times and the final classification of resistant, non–resistant and doubtful was based on all five tests. Importantly, Hessing *et al.* (1993; 1994) demonstrated that the back test was a repeatable predictor of either resistant or non–resistant coping strategies which suggested that coping style is genetic in origin.

Hessing's group however, made a fundamental error in assessment of coping style in piglets. They assumed that the bimodal distribution seen in coping with aggression in mice and shrews existed in the reaction of piglets to the back test. This was quickly challenged with evidence being presented to show that the reaction of piglets to the back test was continuously distributed (Jensen *et al.* 1995).

The only error from the work conducted by Hessing and co–workers was their assumption of the underlying distribution in coping style. They conducted some important work on physiological differences between resistant (active) and non–resistant (or passive) piglets (Hessing *et al.* 1993; 1994). For instance, they showed that, relative to the non–resistant piglets, those resistant had a higher number of vocalisations during the back test, were less likely to approach novel objects in an open–field test, had higher cortisol levels during the open–field test, had lower basal cortisol, had higher heart rates during the back tests, and had higher heart–rate responses to the novel object. Furthermore, Hessing *et al.* (1995) demonstrated differences in immune response between different coping styles. Pigs with resistant coping style had increased cellular immunity compared to enhanced humoral immunity in non–resistant animals.

### Pigs

At Camden we have recorded vocalisation as a measure of coping style in growing pigs. Hessing *et al.* (1993) had shown that the back–test was related to vocalisation, and since the back–test was subjective and restricted to piglets, we decided to use a test with wider application to growing pigs. Vocalisation was recorded with a decibel meter in growing pigs which were restrained with a nose snare (Giles and Furley 1999). Aggregate vocalisation was measured in decibels at intervals of two seconds and summed over one minute. In several groups of male pigs we have ranked aggregate vocalisation and observed a linear range from completely quiet (1800 dB) to extremely noisy animals (3300 dB). These findings support the assertion of Jensen *et al.* (1995) that coping style is neither active nor passive but exists as a continuous distribution.

### Ruminants

The assessment of coping style in sheep and cattle has focussed on animal response to the presence of a human within a closed yard, often referred to as an 'arena test'. Examples of the arena test with sheep include Australian studies conducted by Fell and Shutt (1989). They showed that after the acute surgical operation of mulesing, sheep coped with the presence of a humans by actively avoiding them.

In cattle, there is recent work on coping style assessment in France where the arena test has been

used to develop a measurement of docility in beef animals with a view to assessing their handling ability and productivity. This test measures individual differences in docility and detects real differences in behaviour which can discriminate between animals reared traditionally (with much interaction with humans) or extensively (Boivin *et al.* 1994). This group also estimated heritability of the docility test at 0.2 (Le Neindre *et al.* 1995).

Other measurements of coping style in cattle have been based on the animal's response to restraint. One measurement records the time taken for an animal to cover 1.7 m as it emerges from a race or weigh crush, often referred to as the animal's 'flight speed' (Burrow and Dillon 1997). Other measures of coping style include subjective description of an animal's reaction to restraint in a weigh crush (Fordyce *et al.* 1982; Kilgour *et al.* 1998). The measures of coping style in cattle following restraint appear to be associated with breed, with Brahman cross cattle actively resisting restraint to a greater extent than British animals (Fordyce *et al.* 1988).

## The association between coping style and animal performance

Phenotypic studies over several generations with sheep at Trangie have produced selected and unselected lines of ewes for lamb–rearing success. These two groups of ewes provided an opportunity for Kilgour and colleagues to measure the association between behaviour and lamb–rearing ability. Because lambing and the formation of a bond with the lamb is an individual–ewe characteristic, the research approach involved assessment of an individual behavioural trait in the ewe, which did not include the lamb, and if possible one which could be measured in rams.

Whereas Fell and Shutt (1989) measured aversive behaviour in groups of four sheep in an arena, Kilgour and Szantar–Coddington (1995) adapted the arena test to measure behaviour of ewes in isolation. They found that ewes from a flock selected for lamb–rearing success bleated less and moved around the arena less than ewes from an unselected flock (see Table 1). These authors showed also that arena behaviour of ewes was under significant genetic control and that it could be measured in ewes and rams at least as early as six months of age (Kilgour 1998).

Although the study conducted by Kilgour and Szantar–Coddington (1995) was designed to assess behaviour in ewes, it is now recognised as one of the first investigations of the association between coping style in sheep and animal performance.

Recent studies at Camden have investigated the association between vocalisation in growing pigs and voluntary food intake (Giles, unpublished). Aggregate vocalisation was assessed in 138 male pigs (mean live weight 30 kg) and experimental animals chosen were those with the 32 lowest and 32 highest scores for vocalisation. These animals were housed in single pens or in groups of either low or high vocalisation animals (6 per pen) to assess voluntary food intake from 57 to 87 kg live weight. Animals with low vocalisation score consumed 10% more food (2630 versus 2376 g/day) and hence grew faster (1057 versus 990 g/day) when housed in groups (see Table 2). However placing pigs in groups

**Table 1** Mean (± SEM) distance travelled and number of bleats in a ten–minute arena test of adult ewes from a flock selected for lamb-rearing success and ewes from an unselected flock. Ewes were not pregnant and had been separated from their lambs four months earlier.

| Flock | Selected for lamb–rearing success | Unselected |
|---|---|---|
| Distance travelled (m) | 54.4 ± 3.9[a] | 88.5 ± 4.3[b] |
| Number of bleats | 31.2 ± 2.8[a] | 48.1 ± 3.6[b] |

[ab]Means within a row with different superscripts are significantly different (P<0.05) (from Kilgour and Szantar–Coddington 1995).

**Table 2** Mean (± SEM) live performance for growing pigs (57–87 kg live weight) chosen with low and high aggregate vocalisation[1] and housed in either single pens or in groups of six pigs per pen.

| | Single pens | | Groups | |
|---|---|---|---|---|
| Vocalisation | Low | High | Low | High |
| Daily food intake (g) | 2959 ± 103.7 | 2869 ± 80.7 | 2630 ± 15.6 | 2376 ± 86.3 |
| Daily gain (g) | 1196 ± 59.2 | 1137 ± 38.1 | 1057 ± 43.1 | 990 ± 37.4 |
| Feed:gain | 2.5 ± 0.14 | 2.5 ± 0.14 | 2.5 ± 0.23 | 2.4 ± 0.02 |

[1]Aggregate vocalisation assessed with a decibel meter at intervals of 2 seconds and summed over one minute when each pig was restrained with a nose snare (Giles, unpublished).

of quiet pigs did not raise food intake to the consumption of quiet animals in single pens (2959 g/day).

Although coping style in pigs assessed as aggregate vocalisation had a substantial effect on food intake, experiments conducted at Camden suggest that physical factors in addition to coping style are responsible for the reduction in food consumption when pigs are housed in groups. These physical factors include feeder access and penning arrangements that allow individual animals to feed at their preferred time. A feeding behaviour study conducted recently at Camden (Giles *et al.* 1999) with a group of six pigs provided with one feeder space suggested that pigs with high vocalisation levels were dominant animals who consumed less feed but spent more time per day occupying (or blocking) the trough. This suggests that it may be possible to increase food intake of animals housed in groups to the level achieved in single pens by altering penning arrangements to provide alternative feeding spaces, and hence reduce the influence of dominant animals on feeding behaviour of the group.

There have been few cattle studies in Australia linking innate coping behaviour and animal production. In Queensland, Burrow and Dillon (1997) recorded flight speed and growth in a feedlot of *Bos indicus* crossbreds which had received either intense human interaction for four months prior to entering the feedlot or handling at weaning only. Compared to animals handled at weaning only, the intensively–handled group had fewer animals with fast flight speed (12 vs. 51%), and had a faster growth rate. The study suggested that intense handling of cattle prior to entering the feedlot resulted in improved temperament (or passive coping style) and improved weight gains.

## Manipulation of coping style

An assessment of coping style suggests that it is possible to differentiate individual animals into poor and superior performance. Hence the assessment approach proposes different production strategies for different coping styles. An alternative strategy is to accept a normal distribution of coping style within a population (or group) of animals and attempt to change the mean distribution of coping style (and productivity) of the whole group rather than assess coping strategies of individual animals.

A recent example of manipulating the behaviour and performance of feedlot cattle was described by Fell *et al.* (1998). They utilised a weaning technique with calves known as 'yard weaning'. Traditional weaning generally involves bringing cows and calves into the yards, separating them by drafting and letting the calves go into one paddock and the cows into another. This procedure results in the calves wandering around the perimeter of their paddock calling for their mothers.

Yard weaning involves separation of the cows and calves, but the calves remain in the yards for ten days following weaning with feed and water supplied. The sides of the yards are enclosed so that the calves have to focus on each other rather than be concerned about finding their mothers. Yard weaning has been shown to be beneficial to recently–weaned cattle entering feedlots. Compared to their traditionally–weaned herdmates, yard–weaned cattle adapt more readily to the feedlot ration, spend more time eating, grow faster and are less prone to illness (Table 3).

It is thought that yard weaning forces calves to go through a period of intense socialisation which moves the mean distribution of innate coping style towards a passive strategy, and hence improved group performance. It is reasonable to suggest that the performance benefits derived from the many studies of positive human–animal interaction with pigs and cattle (reviewed by Hemsworth and Coleman 1998) may in fact be associated with movement of the mean distribution of coping style towards a passive strategy. Further studies are required to test this hypothesis.

## Delivering the benefits of coping style to the livestock industries

Evidence is beginning to accumulate which suggests that: a) coping style in farm animals exists as a continuous distribution, which in the case of the restraint test with pigs ranges from passive to active strategies; b) some of the traits which we believe reflect coping style may be genetically determined; and c) there are possible production benefits from animals which possess an appropriate coping strategy. Examples of a

**Table 3** Mean (± SEM) daily live weight gain and morbidity for *Bos taurus* steers that had been either yard or paddock weaned six months prior to feedlot entry.

| Weaning method | Yard weaned | Paddock weaned |
|---|---|---|
| Daily gain (g) after 36 days on feed | 1.54 ± 0.06[a] | 1.22 ± 0.06[b] |
| Daily gain (g) after 84 days on feed | 1.45 ± 0.03[a] | 1.20 ± 0.03[b] |
| Morbidity[1] (%) | 5.9[a] | 22.2[b] |

[1] The percentage of animals in each group removed to the hospital pen.
[ab] Means within a row with different superscripts are significantly different (P<0.05) (from Fell *et al.* 1998).

genetic basis for some of the characteristics which reflect coping style include breed differences in the responses of cattle to restraint in a crush (Fordyce *et al.* 1988), heritability estimates of 0.2 for docility in cattle (Le Neindre *et al.* 1995) and differences in arena behaviour between sheep flocks which differ genetically in their lamb–rearing behaviour (Kilgour and Szantar–Coddington 1995). Animals with behavioural traits which reflect the passive extreme of the distribution in coping style appear to eat more (and hence grow faster) and have improved reproductive characteristics. There is also the possibility that these animals may have other desirable attributes, such as improved meat quality. If further studies confirm the heritability of coping style in farm animals and the benefits of particular coping strategies, then there could be selection for the trait in animal breeding programmes.

There is however a need to hasten slowly towards selection for passive coping style. It appears that natural selection within populations of animals has maintained a wide distribution of coping strategies and the extremes of these strategies offers benefits and costs to individual animals. For example there appear to be differences in endocrine–immune characteristics between animals with passive and active coping styles (Hessing *et al.* 1995). Hence if selection programmes were to shift the mean and reduce the variation within the population distribution towards animals with passive coping style it could increase the incidence of animals which respond to diseases protected by humoral immunity, and conversely predispose more animals to diseases requiring protection from cell–mediated immunity.

An alternative approach is to accept the normal distribution range of coping style within an animal population but manipulate the mean distribution towards those strategies with associated benefits in production; yard weaning in cattle is one example. Our work with vocalisation in pigs as an assessment of coping style suggests there is scope to improve the performance of group–housed animals across the normal distribution towards the performance of animals in single pens as the 'gold standard'.

In order to move productivity of animals maintained in group pens and lot–fed environments towards the performance of animals housed in single pens, we need to re–assess the theory of coping style which had its origins in studies centred on aggressive behaviour and animal reaction to the consequences of dominance and submission. Opportunities exist to examine new penning arrangements and feeder designs in group environments which may alter dominance and submissive behaviour. These management strategies may allow animals to cope better with group environments and improve animal performance towards the gold standard.

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