Proceedings of the 29th International Congress of the International Society for Applied Ethology

3-5 August 1995, Exeter, UK

Edited by S.M.Rutter, J.Rushen,
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Cognition and Applied Ethology

Applied ethologists have proved to be excellent field (or controlled-environment house) biologists, taking accurate observations of animal behaviour, and investigating the effect of treatments such as stocking density, pen size, temperature or social structure. Other experiments have established the basic learning skills, motivational strengths and preferences of domestic animals. However, in order to get to the root of some of the more intractable husbandry problems it may be helpful to take a more cognitive approach. As a hypothetical example we could consider why a minority of hens lay on the floor rather than in the nest boxes provided. There are many potential reasons, each requiring a different solution. Some highly speculative possibilities are (i) floor-layers perceive nest-features differently from other hens, (ii) floor-layers may have difficulty locating a given nest box within a bank of blocked tiers, and may choose to lay on a floor area that they can re-locate on subsequent days, (iii) floor-layers follow a flexible frequency-dependent strategy and lay in areas not used by the majority of the flock. In order to distinguish even these possibilities it would be useful to know more about hens' abilities to combine and classify simple and compound stimulus features, to navigate through horizontal and vertical space, to assess group size and density, and to attend to the behaviour of conspecifics.

What is Cognition?

Comparative cognition seeks to understand the structures and processes of the mind that intervene between experience and behaviour. The rules by which information is re-organised and utilised cannot be directly studied but can be deduced by careful experimentation. Cognitive scientists model the ways in which information is stored, transformed and accessed. The test of a good cognitive model is that it provides a better prediction of ultimate behaviour than an analysis in terms of a response to unmodified internal or external stimuli. It is a mistake to divide behaviour into cognitive and non-cognitive components, or to assume that cognitive skills are those that cannot be explained by reflex-based or reinforcement-based links. In fact, reflexes, and the reinforcement-based strengthening of links between stimuli and responses typical of associative learning, provide two different examples of how animals can respond to their environment. Models that attempt to elucidate how animals learn temporal correlations among stimuli provide a cognitive analysis of classical conditioning (Gallistel, 1990), and neural net models of imprinting in young chicks provide a cognitive analysis of a memory system (Bateson and Horn, 1994). However, cognitive analyses are more usually applied to seemingly complex behaviours, often with the assumption that "simpler" processes such as associative learning could not explain the behaviour observed. There are many pitfalls associated with the cognitive analysis of complex behaviour, and even more so with the analysis of mental states. The application of cognitive analysis to farm animal behaviour is still in its early stages, and a prudent first step must be to consider the basic assumptions and tenets of cognitive theory.

Representations

A central concept in comparative cognition is that of the representation, defined by Roitblat (1987) as a correspondence between some aspect of the environment and a brain process. The capacity of the brain to represent some aspect of the environment is put to use when animals respond selectively to stimuli, navigate through space, or organise their behaviour in time. Complex representations may involve re-organisation of acquired spatial information to form cognitive maps, or representations of sequences of events. In some texts, use of the term representation is used as a synonym for a visual or other mental image of a goal, or expected outcome. However, the concept of representation is arguably of more value when it is *not* equated with mental image. The existence of representations has to be inferred from psychological paradigms, e.g. mental chronometry - the time taken to perform a task such as matching one image to another, or from neurophysiological methods. This has been something of a stumbling block for some ethologists who prefer to deal with what they can observe. However, 'motivation' is a similar non-observable construct that has proved immensely valuable to ethologists attempting to model and understand behaviour.

Representations and Attention

To form a representation of an event, an animal must be able to sense the event with its sensory apparatus, then transduce these sensory features into neural information for the brain to process into the representations that guide its later behaviour. In many cases a number of stimuli are equally available and valid, but the animal responds to some of these stimuli and not to others. A number of factors are important in determining whether an animal will attend to a stimulus, including its past validity as a predictor of reinforcement and its salience or noticeability. I have become increasingly interested in the phenomenon of selective attention after early social learning results suggested that hens were more likely to acquire an operant keypeck response after watching a dominant demonstrator than a subordinate demonstrator (Nicol and Pope, 1994). Recently, we have tried to partition the effects of foraging success, and the familiarity and status of the demonstrator. This allows a distinction to be made between actual differences in keypecking performance by dominant and subordinate demonstrators, and differences contingent on observers' knowledge and perception of the succcess or 'quality' of a familiar bird. In these experiments, observer hens did not perform significantly above baseline levels after watching trained cockerels or trained subordinate hens, even those that were known to be successful foragers in their home flock. Once again, dominant birds provided the best models, even when they were unfamiliar to the observer hens. Observers made significantly more pecks to an operant key after watching a dominant bird than any other category of demonstrator. This suggests that dominant birds may perform the task in a different way to other demonstrators, but we have been unable to ascertain what this might be. We have found no differences in pecking accuracy, pecking rate, or pecking position relative to the key, although we have still to measure pecking force. Thus, although observers are exposed to seemingly identical performances by demonstrators of different status, they appear to process the incoming information in very different ways, paying more attention to the behaviour of dominant birds.

Representations and Concept Formation

One way of efficiently re-organising information is to treat similar stimuli as members of a class, or category. Work on categorisation is highly relevant for applied ethologists who may want to know whether broilers perceive robotic harvesters as predators, or whether horses perceive familiar humans as conspecifics. Kendrick (1994) using single-cell recordings from neurones in the temporal cortex, has shown that sheep have populations of cells that code for faces, with subpopulations that code for functional categories such as familiar conspecifics, or predators. Pioneering work on slide classification in pigeons showed, at a behavioural level, that this species has remarkable abilities to relate disparate stimuli into functional categories, such as trees, people, or water (Herrnstein et al., 1976). However, despite the fact that a wide variety of exemplars of each category were presented, with little apparent feature overlap (e.g. trees could be exemplified by slides of leaves or overhead views of forests), it was not possible entirely to rule out the possibility that pigeons were making their classifications, not by utilising natural concepts, but by stimulus generalisation, i.e. that the pictures of trees were more similar to each other in some aspect of patterning, colour or outline, than the non-tree pictures that were presented. Some of the neural data on sheep could be explained in a similar way. Lea (1984) has argued that true concept formation must involve more than classification based on similarity in physical features.

The use of entirely arbitrary stimuli may help to resolve some of these difficulties, although studying animals in artificial situations may underestimate their abilities. In discrimination learning, one stimulus is more predictive of reward than others and it benefits the animal to respond selectively. However, in cases where a similar reward is associated with more than one stimulus, animals may cease to discriminate between these stimuli. If the stimuli are purely arbitrary then the animal can be said to have formed a concept i.e. the ability to respond to some members of a set of stimuli without regard to similarity or direct reinforcement. A concept is in this sense a complex representation which allows the appearance of emergent, untrained relations. Wasserman et al (1992) have provided some evidence that pigeons can form concepts of this kind. They trained pigeons to associate dissimilar stimuli such as chairs and cars with a common response. Then a new response was learned to just one class e.g. cars. The subjects were shown to have a strong tendency to make the new response to the second class of stimuli, the chairs, for which they had received no explicit training. In this case the pigeons treated all stimuli as functionally equivalent. However, Sidman et al (1989) have argued that functional equivalence does not explain all equivalence relations. Humans can also be shown to treat stimuli as equivalent even if they do not react in the same way to each stimulus, and it remains a researchable area to investigate whether other species also have this conceptual capacity.

Representation of Goals

An extremely important question for applied ethologists is whether animals are able to represent goals, particularly for resources that may be absent in their living environment. Thus, ethologists have wondered whether hens kept on wire floors, may nonetheless possess or use a representation of a dustbath to guide their behaviour. Petherick et al (1990) deprived hens of litter for three or four days and then tested them in a Y-maze for their ability to associate a coloured cue with gaining access to peat. Five out of sixteen subjects showed some ability to associate the abstract cue with peat. The authors concluded from these results that hens may be capable of forming and retaining a 'representation' of a dustbath. This may be true but the nature of the representation is not clear. Only a simple representation of the stimulus and the appropriate response at that choice point is actually required. Complete sequences of behaviour can be established by chaining without the animal requiring a representation of the ultimate goal at any point, and there is certainly no necessity for the conditioned stimulus to conjure up an image (visual or otherwise) of the unconditioned peat stimulus. Stronger evidence that the animal represents the ultimate goal in a sequence of behaviour comes from studies that manipulate the relative value of the goal, before the animal starts the operant task. Rats that have become averse to particular food items will not run a maze to obtain those items. This provides some evidence that rats can represent an end-goal at an early stage in a sequence of behaviour.

In order to address the more difficult issue of whether 'out of sight is out of mind' it is necessary to devise experiments that present no external cues, conditioned or unconditioned, to the subject (Rushen, 1993). The issue is whether a deprived animal is able to generate any internal mechanism that leads it to seek a missing resource and, in this sense, intrinsic motivation and intrinsic goal representation have many points in common. If we were better physiologists we might be able to define both the neural and motor changes that occured in the deprived animal, but even a black box approach can lead to testable predictions. Nicol and Guilford (1991) for example, predicted that hens deprived of food would spend more time in exploratory activity in a featureless tunnel than non-deprived hens if they had some intrinsic motivation to seek food. Not only was this prediction confirmed but it was also shown to hold true for litter deprived hens. Recently Cooper and Appleby (1995) used a similar procedure and found that hens that have never previously experienced a nest site showed similar amounts of searching behaviour as experienced hens. This suggests that animals can be deprived of resources that they have never experienced. It remains to be seen whether the detailed characteristics of searching behaviour are contingent on the nature of the resource.

It also remains to be seen whether there is any necessity for the goal representation to include a mental image of that goal. If so, one would expect as a minimum that the animal should possess some concept of object permanence, the realisation that an object has a physically distinct identity fixed in time and space. As in the protocols outlined above, the variable measured in tests of object permanence is searching behaviour. Initial tasks involve visual displacements of a desired object that is then hidden. More sophisticated tasks require the subject to infer the position of the object following invisible displacements e.g. the object is concealed in a box prior to transfer from one hiding place to another. Cats and dogs have been shown to perform well on these tests, and Regolin et al (1995) have shown that chicks are able to represent the permanence of an imprinted object. It would be worth examining the abilities of adult domestic fowl to represent the permanence of resources such as nest sites and litter.

Representations and Neurobiology

It is tempting to speculate that one day it may be possible to observe the formation of representations in the animal brain. In humans, brain mapping by positron emission tomography (PET) or magnetic resonance imaging (MRI) can be used to map active brain regions. A central assumption with brain mapping studies of this kind is that an increase in cerebral blood flow (CBF) is associated with a higher contribution of that brain area to the task. This generally governs the interpretation of PET findings, but it is also the case that the more practised the subject, the less activation is recorded. Thus, the contribution of CBF increase and extent of involvement of this region to the function is not linear. Many other interpretational flaws have accompanied early work in this field (Sergent, 1994), and it has been stated that such techniques can be useful only in telling us where, rather than how, brain function might be represented. However, improving experimental designs show this may be an overly pessimistic view. Parsons et al (1995) recently described a technique in which human volunteers were asked to discriminate between pictures of left and right hands, presented in various rotations. By presenting pictures on either the left or right side of the screen they were able to exploit known differences in visual brain lateralisation. Each subject initially estimated whether the picture was of a right or a left hand, but this was rapidly followed by a confirmatory activation of the *motor* area of the brain associated with that hand, although no actual hand movements were recorded. Parsons et al (1995) suggest that, rather than mentally rotating the picture (a strategy commonly invoked when attempting to match abstract rotated pictures to samples), the subjects rotated a motor representation of their own hand, thus activating motor rather than visual areas of the brain.

Cognitive Ethology and Animal Consciousness

The completely separate tradition of cognitive ethology is concerned with studies of subjective experiences in animals. The major proponent of this field has been Griffin (1981) who attempts to address some of the most exciting questions concerning the nature of other species - are they conscious or self-aware, do they plan ahead or intend to deceive? These questions are also of ultimate relevance to animal welfare. The demonstration of preference or aversion is meaningless unless it is accompanied by feelings of pleasure or suffering. I therefore agree entirely with Duncan and Petherick (1991) that animal welfare depends solely on what the animal 'feels'. However, I part company when it comes to the possibility of experimentally demonstrating the existence of feelings with our current protocols. In fact my sympathies lie with Yoerg and Kamil (1991) who argue that in overemphasizing conscious events and largely ignoring the efforts of cognitive scientists who use the concept of representation as a tool to investigate brain processing, cognitive ethology is in danger of extinguishing a small flame before the fire has really begun to burn. The ethologist's contribution must be to recognise the evolutionary history that has shaped cognitive abilities and to investigate these with an open mind. Ethologists should also be in a position to contribute to the philosophical debate about the functional significance of consciousness. However, once consciousness is (temporarily) removed from our scientific endeavours there is no necessity to assume that an animal with cognitive skills in a given area is more likely to suffer than one lacking those skills.

There has been a recent tendency to assume that rigorous science is also uncaring. Yet it must be possible to be sceptical in the interpretation of scientific data, not with the aim of denying that animals may have complex subjective experiences, but with the aim of advancing understanding by producing data that others can agree on, replicate and extend. Heye's (1994) insightful critique of experiments on mental state attribution in primates can be seen in this light. It is still possible in taking such an approach to be humble in the face of what we don't yet know, and to extend the benefit of the doubt to our fellow animals.

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Comparison of the demand for dustbathing substrates by layer hens

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Introduction

Behavioural demand functions have been shown to be a useful way to quantify the value that animals place on different behaviours or features of their environment (Matthews *et al.*, 1993; Matthews and Ladewig, 1994). In a study with pigs, Matthews and Ladewig (1994) showed that the demand for food was highly inelastic (demand function slope close to 0.0) while the demand for brief periods of social contact or other simple stimulus changes in the environment were more elastic (slopes around -0.5). Thus, it was concluded that food (or eating) was more highly valued than the other two stimuli.

Matthews et al (1993) utilised the demand function paradigm to assess the value of litter (peat) to caged layer hens. The demand for peat was relatively inelastic (slope of -0.34). This study aimed to replicate this finding and to compare the demand for peat with that for other types of litter (woodshavings and sand) and for food. Studies by van Liere (1991) using preference testing procedures have shown that peat and sand are preferred to woodshavings as a dustbathing substrate.

Materials and Methods

Six non-beak trimmed layer hens (Shaver breed), 2 years old at the start of the study, were used and housed singly in standard wire cages (300 x 450mm). All birds had been reared with access to a litter substrate.

Each hen was given the opportunity to work for access to each of three different litter substrates (peat, washed river sand and woodshavings), a wire floored cage and food. When working for food the animals remained in their home cage and the food delivery apparatus was operational for 12 hr each day (9am to 9pm). All birds had *ad libitum* access to water in the home cage. In addition, all hens had access to food *ad libitum* in the home cage when they were not on the conditions requiring work to gain food. When working for access to litter or the wire cage the hens were placed singly in an experimental chamber (see Matthews et al, 1993) for 1 hr every other day (3 birds being tested each day). Each hen had access to one commodity only at a time. Access to litter, the wire cage and food was available by working on fixed ratio (FR) schedules of reinforcement (5, 10, 20, 30 etc in steps of 10 up to 200). The numbers of responses made and reinforcers obtained during each test session were recorded by computer. The behaviour of the birds during all tests were recorded on video. For each reinforcer delivery, the occurrence of pecking, scratching and dustbathing was recorded.

Results

The demand functions for each commodity were calculated by fitting linear regression lines to plots of the total numbers (logarithmic) of reinforcers obtained (for litter types) or weight of food consumed (for food) versus the FR value (logarithmic).

The means and standard errors of the slopes of the regression lines for each commodity are shown in Table 1. The slopes for the three litter substrates were relatively shallow and not significantly different from each other. All litter substrate slopes were significantly less steep than the slope of the food demand function ($p<0.01$). As the hens worked for access to the wire floored cage at low FR values only, meaningful demand curves could not be calculated for this commodity.

Separate demand functions were determined for the two main activities (dust bathing, pecking/scratching) occurring during reinforcer delivery (Table 1) by plotting the numbers of reinforcers during which each activity occurred as a function of FR value. The slopes of the functions were shallow and similar across litter substrates for pecking/scratching activity ($p>0.05$). The slope for dustbathing in sand was significantly less than that for dustbathing in woodshavings.

The hens engaged in pecking and scratching activities during most reinforcer deliveries with all three litter substrates. Dustbathing occurred significantly more often ($p<0.05$) during access to peat (mean 75% of reinforcers) than during access to wood shavings (mean 37%). For sand, the mean proportion of journeys with dustbathing was 50%, which was not different from that with either of the other two substrates.

Table 1. The means (s.e.) of the slopes of the demand functions for each commodity. Three separate functions were calculated for each commodity: using the total numbers of reinforcers obtained, those involving dustbathing only, and those involving pecking/scratching only.

	Peat	Woodshavings	Sand	Wire	Food
Total reinf.	-0.36(0.05)	-0.39(0.04)	-0.47(0.03)	+	-0.88(0.07)
Dustbathing	-0.24(0.03)	-0.27(0.11)	-0.09(0.06)	N.A.	N.A.
Peck/Scratch	-0.32(0.05)	-0.38(0.04)	-0.38(0.04)	N.A.	N.A.

+ insufficient reinforcers were obtained to calculate demand functions.

Conclusions

The relatively inelastic and similar functions for each of the three types of litter substrate and the failure to work consistently for access to a wire floored cage indicates that there was a high demand for access to litter. As reported by van Liere (1991), the value of the various substrates appeared to vary with the type of activity performed.Woodshavings were less valued for dustbathing as shown by the higher elasticity of demand, the reduced frequency of use and the cessation of dustbathing at the higher FR values with this material in comparison to peat and sand.

All three substrates were similarly (and highly) valued for pecking and scratching as indicated by the slopes of the demand functions and consistent use of the substrates up to the highest FR values tested (FR 200).

Compared with other animals (e.g. pigs; Matthews and Ladewig, 1994) the slope of the demand curve for food shown by hens was relatively steep. Logically, feeding is a very high valued activity. Thus, the other commodities that had less elastic demand functions than food would also seem to be important for the welfare of hens.

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Comparison of demand for environmental resources in hens using a computer-controlled push-door

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Introduction

Consumer demand theory can be used to assess the environmental requirements of captive animals (Dawkins, 1990). If the cost of an activity or resource is increased, then animals will persevere acquiring psychologically important resources, but cease to work for unimportant resources. It is, however, necessary to consider equipotentiallity and constraints on learning when designing operant tasks and experimental protocols to measure the demand for different resources, in order to make realistic comparisons.

Laying hens (*Gallus gallus domesticus*) in conventional wire cages have little opportunity to perform nest seeking or nest building activities during prelay. The importance of a discrete littered nest site, which allows the expression of these activities (Cooper and Appleby, 1995) can be assessed by comparing the demand for the nest with demand for food. Food should provide a sound baseline for the comparison of priorities as it is important for the survival of the hen, and likely to vary in importance in a predictable manner with time.

Method and Materials

Twelve medium hybrid laying hens were individually housed in a test arena. This consisted of a nest pen (1mx1m) containing a single wooden nest-box and a home pen (2mx2m) containing food, water and a perch. These were connected by a short corridor (1m long) in which a computer-controlled push door (Petherick and Rutter, 1990) could be placed. This was held shut by an electro-magnet, whilst a load cell recorded the force exerted on the door. This was added to give a cumulative total by the computer, which would release the door, once this total exceeded some pre-determined threshold. Average work rate could then be calculated as the cumulative total divided by the time spent pushing.

Hens were first trained to overcome the unloaded door and a fixed cost (10Ns) for food and nest rewards. Each hen was then tested with the 10Ns cost at 80, 60, 40 or 20 minutes prior to oviposition for the nest reward and were confined for 1, 2, 3 or 4 hours, before overcoming the same workload to return to the home pen. Finally, the workload was varied (10, 20, 30 and 40Ns) and hens again allowed to work to enter the nest pen at 80, 60, 40 and 20 minutes to lay, but only to return to the food pen after 4 hours' confinement. For each test the hens work rate was calculated and its behaviour was recorded by scan sampling once every minute.

Results

With the fixed workload, work rate increased as oviposition approached (Table 1a) and with confinement time (Table 1b). Average work rate after 4 hours' confinement was similar to that at 40 minutes to lay and less than 20 minutes to lay. Time to enter the nest declined with approaching oviposition from 170 secs at 80 minutes to lay to 19 secs at 20 minutes to lay ($F=13.2$). There was no difference in latency to approach food ($F=1.22$) or initial rate of pecking ($F=0.10$), with length of food deprivation but proportion of time feeding did rise from 37% of time after 1 hours deprivation to 58% of time after four hours.

Increasing workload reduced work rate in all tests ($F>2.77$, $P<0.05$), except 20 minutes prior to oviposition ($F=0.76$) (Figure 2). Maximum force varied significantly between hens

(F=4.41, p<0.01), but not between tests. There was positive relationship in individual hens' work rate across tests (F>10, p<0.01).

Discussion and Conclusion

Both the tests with fixed and varied work loads indicate that demand for the nest rises with the approach of oviposition. They also show that although the demand for food rises with length of food deprivation, the demand for the nest at 20 minutes to oviposition was considerably higher in all hens than demand for food after 4 hours' deprivation. Direct observation of behaviour following passing the door shows indicates that the hens were working for the nest and food in the relevant tests, but that directly observed measures of motivation are not as sensitive a measure of demand as work rates. We propose that work rate on the push-door allows a realistic comparison of demand for these two resources, so long as individuals are used as their own controls.

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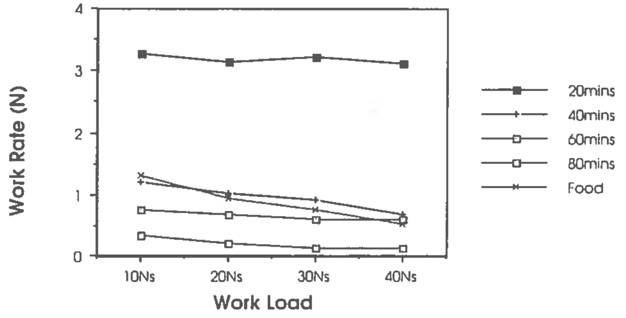
Table 1. Work rate of hens working a) to gain access to nestbox prior to oviposition and b) to return to home pen following a period of food deprivation. F-ratio from repeated measure analysis of variance with 3 degrees of freedom. Probability; *P<0.05, ***P<0.001.

a) Nest	Minutes to oviposition					
	80	60	40	20	F	P
Rate (N)	0.27±0.13	0.73±0.38	1.19±0.62	3.09±1.12	14.9	***
b) Food	Hours of Food Deprivation					
	1	2	3	4	F	P
Rate (N)	0.09±0.03	0.18±0.05	0.65±0.37	1.25±0.44	3.32	*

Figure 1. Work rate by twelve hens for nest at 20, 40, 60 and 80 minutes prior to oviposition and for food following four hours of food deprivation.



Operant control of the thermal environment: the effect of operandum design on learning time in piglets.

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Introduction

The Farm Animal Welfare Council (1993), recognising that exposure to contingent stimulation can have beneficial consequences (e.g. Mineka *et al.*, 1986), has recommended that high priority status be given to the development of systems which allow animals more control over their environment.

Pigs can learn to push panels (Baldwin & Ingram, 1967) or intercept photoelectric beams (Baldwin & Lipton, 1973) in order to control the delivery of infra-red heat. Individuals were reported to learn these operant responses quickly, under experimental conditions that comprised spatial restriction, physical restraint and extreme low temperature. Morrison *et al.* (1987) investigated learning time for pigs to master control of the thermal environment under conditions that could occur commercially. Latency to learn the response then ranged from 1 to 22 hours and 2 groups of the 32 tested failed to reach the learning criterion within 24 hours.

Slow response acquisition exposes the animal to prolonged periods at sub-optimal temperature. The design of operanda can affect the level of operant responding (Young *et al.* 1994) and could consequently influence the rate at which the response is learnt. The current study therefore identified which of four types of operandum [*Panel push* (P); ***Panel push & apple scent*** (PA); *Photo-electric beam break* (B) and ***Photo-electric beam break & apple scent*** (BA)] facilitated the fastest acquisition of an operant thermoregulatory response.

Materials and Methods

Twenty-four Large White x Landrace piglets, 4 - 10 weeks old with a mean initial weight of 8.5 ± 0.5 kg, were assigned individually (n = 6 per operanda type) to pens 120 x 120 cm. These were located within an environmental chamber which was continuously lit and maintained at a dry bulb temperature of 16 °C (SE ± 2). A conventional starter diet and water were provided *ad libitum* All operanda were of similar design: a 30 x 20 x 6 cm wooden construction with a 9 x 9 cm hole on the front aspect. Either a photo-electric beam (B & BA) or a perspex panel connected to a micro-switch (P & PA) was positioned within the hole and 5 ml of a 10 % solution of apple scent (TS915 Master Taste, Dursley, U.K.) was sprayed onto BA and PA.

The operanda were interfaced to a 250-W infrared lamp and connected to a BBC micro-computer running SPIDER real time programming (Paul Fray Ltd., Cambridge, U.K.).The infrared lamp was timed for a 4 minute operating period for each rewarded activation. Response rate data were recorded for 72 hours and summarised each hour. Individuals not consistently activating the heater within 24 hours were classified as "non learners" and were removed from the experimental pen. Food and water were renewed at 24 hour intervals and the quantity of food consumed for each of these periods was recorded. Latency to respond consistently was taken as the measure of learning and was calculated as the first hour of a three hour block during which response rate (activations. hour $^{-1}$) exceeded 75% of the mean response rate recorded in the second 24 hours. Twenty-four hours post learning, response rate was recorded for a 24 hour period to investigate the effect operandum design had on response level.

Results

Addition of the olfactory attractant had no effect on learning (P cf. PA and B cf. BA, p >0.1 Mann-Whitney U test), therefore P plus PA (panel) and B plus BA (beam) data were pooled. The latency to first activation (beam = 3.1 ± 2.0 h cf. panel = 9.7 ± 2.9 h) and latency to master the response (beam = 11.8 ± 2.4 h cf. panel = 19.7 ± 2.1 h) occurred sooner (p <0.02

Mann-Whitney U test) with the beam operanda [Table 1]. Ten piglets failed to respond consistently within 24 hours. These piglets ate significantly more food in the first 24 hours [0.09 ± 0.01 Kg. Kg body weight $^{-1}$, $p < 0.001$ Mann-Whitney U test] than piglets that had responded consistently within this time [0.065 ± 0.004 Kg. Kg body weight $^{-1}$]. The difference in response rate in the period 24 hours post learning was not significant between panel (114 ± 26.5 day $^{-1}$) and beam (139 ± 23.4 day $^{-1}$) operanda.

Table 1. Latency for individual pigs to respond consistently (hours)

Pig	B	BA	P	PA
1	3	24	24	24
2	8	24	24	24
3	4	3	3	24
4	18	9	13	24
5	22	8	24	18
6	5	13	10	24
Mean ± s.e	10.0 ± 3.3	13.5 ± 3.6	16.3 ± 3.7	19.7 ± 3.3

Conclusions

The results demonstrate that the design of operanda can affect learning time and that a high percentage of pigs were unable to learn operant control of the thermal environment within 24 hours. Learning depends on activation which in itself relies upon investigatory behaviour. The differences in latency to first activation indicated that the photo-electric beam operanda promoted investigation better than the panel operanda. This could explain why the photo-electric beam design facilitated rapid response acquisition. The non-significant difference in post learning response rate between the panel and beam design suggested that the poorer performance of the panel operanda was not an artifact of an increased time or effort required for activation.

Individual testing could account for the unexpectedly high proportion of pigs that did not reach the learning criterion. Inactivity and cold defensive posturing would limit investigatory behaviour and inhibit the discovery of the operandum. There is marked variation in individual response rate within a group of pigs (Morrison *et al.*, 1987). The ability of such groups to learn a response readily could, therefore, depend upon a small percentage of individuals learning the response and other group members learning from these individuals through observational learning. If tested in isolation, as in the current experiment, a higher proportion of individuals may have been slower to learn the response.

Alternatively, the greater consumption of food in non-learners could account for the phenomenon as increased nutritional plane can decrease thermal requirements. However, it is more likely that the increased food intake was an effect of not learning operant control rather than the cause.

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Can cattle think?

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Introduction

It is becoming increasingly accepted that non human animals possess cognitive abilities Nadel (1982) defines cognition as the parts of mental life relating to knowledge. Cognitive Ethology is the study of cognition in animals and is defined by Yeorg (1991) as the study of mental experiences and processes, which include learning and problem solving abilities (Pearce, 1987, p17) It has been argued that understanding the cognitive ability of animals can make a significant contribution to improving animal welfare (Kiley-Worthington, 1993)

In the last two decades a number of studies have demonstrated cognitive ability in cattle (Kilgour *et al.*, 1991) In this paper, problem solving is used in order to examine the cognitive ability of cattle as part of a larger study into the existence of bovine individual differences and personality

Materials and Methods

Subjects (60) from 3 age groups (4.3yrs, 23.4mo., 11.5mo.) and 4 rearing conditions (natural, adopted, single- and multi-suckled) were presented with a simple, ethologically appropriate, problem solving task The subjects were required to access food concealed in a lidded 'cognition' box (see Figure 1) The experiment lasted over three consecutive days (two training days, to establish familiarity with the box, and a test day) and took place in a familiar environment (see Figure 2) On day one the box containing 1kg of hay, 1kg of oats and 75ml of molasses was introduced to individual subjects in the field, without the lid Each ate out of it for at least five minutes On day two the subjects were caught in the collecting pen adjacent to the testing pen. The box, again without its lid and containing food, was staked down securely at the rear of the test pen (see Fig 2) Each subject were driven separately into the pen and kept in there until he/she had eaten out of the box for at least five minutes On day three, the test day, the same procedure was followed as for day 2, except that the box had a lid on Subjects were required to open the lid by pushing it downwards with their noses in order to access the food The maximum time allowed to solve the problem was 10 minutes. Table 1 shows the measures derived from the instantaneously recorded behaviours

Table 1 Behaviours observed

Measure	Definition
Solving time (secs)	Time taken to access the food. Failures scored 600s
Attention span (%)	Time spent interested in box. Successes scored 100%
Number of attempts	Number of times subjects nudge or push box.
Number of interests	Number of times subjects touch, smell or lick box
Number of displacements	Number of activities directed at pen, other subjects or observer

Figure 1. The 'Cognition' box

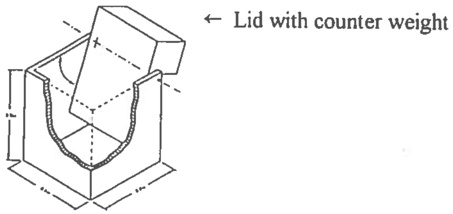
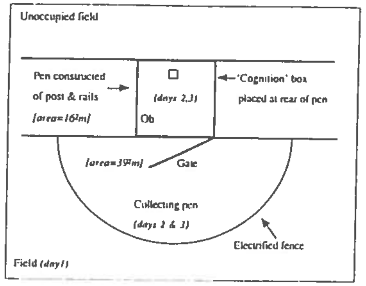


Figure 2. The testing environment



Results

The overall success rate was 30%. Only solving time was influenced by rearing condition ($F_{3,14}$=6.44,**); naturals solved the task more quickly than multi-suckled individuals (q=4.74,*). Age influenced the number of interests ($F_{2,57}$=3.56,*) and the number of displacement activities ($F_{2,57}$=10.4,**). The youngest subjects performed more interest behaviours than adults (q=4.59,**) and more displacement activities than 23.4 mo. subjects (q=5.74,***) and adults (q=4.58,**). Of the 'non solvers' the youngest subjects exhibited greater attention spans than adults ($F_{2,39}$=3.34,*; q=4.07,*). Principal components revealed were 'determination' and 'distractibility'. Regression analysis indicated all measures had an intervening role in the determination of solving time.

Conclusion

The problem solving task measured cognitive ability since the three main characteristics of human problem solving tasks outlined by Mazur (1990, p258) were satisfied: the task was goal directed (to obtain food), could be divided into subgoals (make contact with box, manipulate lid, put head into box) and operations had to be selected to achieve each subgoal (e.g. manipulate lid to gain access to food rather than kick it or tip it upside down). Furthermore, individuals differed in their determination and distractibility when solving the task. It was also clear that individuals employed different strategies to solve the task.

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The ability of dairy cows to distinguish between people

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Introduction

Farmers often believe that cows can distinguish between different people. Dairy calves can distinguish between friendly and unfriendly people, however, some calves do not avoid the aversive handlers when retested outside the treatment place (Ladewig *et al.*, 1994, de Passillé *et al.*, in press). Nothing is known as to which cues the calves use to make this discrimination.

We studied the ability of cows to distinguish between handlers based on the treatment received, the cues used to make this discrimination, and whether they generalise their discrimination to other locations.

Material and Methods

Dairy cows (n=12) were repeatedly moved by persons wearing blue overalls to an isolated treatment stall, where each cow alternately received an aversive or a gentle treatment. Between all treatments the cows were tethered in their home stall. Each cow was treated by two different female handlers, who had not previously handled the animals. The handlers wore red or yellow overalls and were assigned to be the aversive or the gentle handler for an equal number of cows.

The handler treating the animals stood in front of the cow, approximately 0.5m in front of the tie bar. During the gentle treatment, the handler offered hay, fresh grass or concentrate, and if the cow accepted, gently stroked the cow while speaking in a friendly voice. For the aversive treatment, the handler raised the hand high and stuck the cow with the open palm on the front of the head or the muzzle area. This was repeated every 15s, and if the cow approached. Each treatment lasted 2min.

During tests, the handler stood still with hands in pockets for 60s in front of the cow, the distance the cow kept to the person was scored by an observer wearing blue overalls. All cows were tested prior to treatments both at home and in the treatment stall (test 1), after 12 gentle and 12 aversive treatments (test 2) in the treatment stall, and after 15 gentle and 15 aversive treatments both at home and in the treatment stall (test 4). Furthermore, the distance to unknown persons in red and yellow overalls were tested after 13 gentle and 13 aversive treatments (test 3), and the distance to the two handlers, but in blue overalls, after 16 gentle and 16 aversive treatments (test 5).

Results and Discussion

The cows readily learned to discriminate between the gentle and the aversive handler in the treatment stall (table 1). After 12 gentle and 12 aversive treatments they kept a greater distance to the aversive handler and approached the gentle handler (test 2). The results are in agreement with the studies on calves (Ladewig *et al.*, 1994, de Passillé *et al.*, in press). Furthermore, the cows were able to differentiate between the gentle and the aversive handlers in their home stall, suggesting that cows generalise their experience with handlers from one location to another.

Table 1. Distance to the gentle and the aversive handlers in the home and in the treatment stall.

	Treatment stall				Home stall			
Test no.	Gentle	Aversive	P	SEM	Gentle	Aversive	P	SEM
1	4.0	3.9	NS	0.23	3.4	3.4	NS	0.23
2	3.0	4.3	**	0.25				
4	2.5	3.9	***	0.21	2.2	3.1	**	0.21

In order to increase the cows ability to discriminate between the two handlers in the present experiment, the handlers wore different coloured overalls. However, when two unfamiliar people wore red or yellow overalls (test 3), the cows did not distinguish between them in terms of the distance kept ($P = 0.27$). This suggest, that recognition is not based solely on the colour of the clothes worn, and that the cows had not generalised their aversion to other people wearing the same coloured clothes. However, when the handlers wore blue overalls (test 5), the cows no longer discriminated between them in terms of the distance kept ($P = 0.23$). The cows may not be able to discriminate between the handlers without all the cues that were present at the time of treatment. Alternatively, since the staff who took care of the cows always wore blue overalls, the cows may have generalised from their previous experience, that people in blue overalls were not harmful.

Conclusion

In conclusion, cows can distinguish between handlers based on how they are treated, also in other locations than where the handling occurred. Their recognition is not based solely on the colour of the clothes worn.

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Can vocalisations be used to assess piglets' perception of pain?

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Introduction

Vocalisation in response to pain is described in many species (Morton and Griffiths, 1985) and the Canadian Council on Animal Care (CCAC) cites vocalisation as one of the key signs of pain and distress in pigs (CCAC, 1993). They note, however, that pigs "...normally squeal and attempt to escape when being handled..." and therefore the purpose of the following two experiments was to determine if the vocal response of male piglets could be used to distinguish between the pain of castration without anaesthetic and the stress of restraint.

Materials and Methods

In Experiment 1, male piglets (n=26) were obtained from 13 litters (2 pigs/litter) and taken in pairs to a visually- and acoustically-isolated room. Treatments consisted of castration (C) and sham-castration (S-C) and the order in which these were conducted was alternated between litters. The C procedure in use at our research facility involved placing the piglet on a bench in dorsal recumbency securing a front and hind leg in each hand. The castration was divided into 6 stages: "Restraint", "Alcohol application", "Scrotal Incision 1", "Incision 2", "Cut spermatic cord" and "Application of Disinfectant". The S-C treatment also had 6 stages but during the incisions the scalpel was inverted and the dull edge of the blade traced gently down the scrotum. During the cord cutting stage the S-C piglets were simply restrained for an equivalent amount of time.

In Experiment 2, another common restraint used for piglet castration was investigated. Piglets were held upsidedown by the proximal part of the hind legs with their backs toward the handler and bellies toward the castrator. Male piglets (n=40) were obtained from 10 litters (4 pigs/litter) and were taken individually to a visually- and acoustically-isolated room and were subjected to either a bench castration (B-C) or bench sham (B-S) procedure (as described in experiment 1) or the upsidedown castration (U-S) or upsidedown sham (U-S) procedure. In both castration procedures, the surgical steps were identical to those described in Experiment 1, however, no attempt was made to assess the stages separately.

Video recordings were made with a Panasonic Time-lapse VHS recorder (AG-6720) in Experiment 1 and a Sony video Hi8 Handycam (CCD-TR101) in Experiment 2. Audio recordings were made using a Beyerdynamic microphone (MCE 86 N(C)) placed approximately 100 cm from the piglet in Experiment 1 and 50 cm in Experiment 2. Vocalisations were recorded onto a digital audio tape (DAT) with a Sony DAT recorder (WM-D6C) and Symmetrix preamplifier (SX202). Using "Signal" software and a microcomputer we measured call number, duration (ms), loudness (dB), pitch (Hz) and vocalisation rate (call/s).

Results

In Experiment 1, no significant differences were found between the 2 groups during the first 3 stages of the treatments. Rate of vocalisation (calls/s) was significantly greater in C vs S-C piglets during "Incision 2" (0.9±0.2 vs 0.5±0.1), "Cut cords" (1.1±0.1 vs 0.7±0.2) and "Disinfectant" (0.5±0.1 vs 0.3±0.07). During the "Cut cords" stage C piglets produced calls of significantly higher frequency (4483±209 vs 3482±412 Hz), longer duration (650±53 vs 446±65 ms) and larger amplitude (-55±3 vs -63±3 dB) than S-C piglets. There was a significant Trt*Order effect such that S-C piglets treated after C piglets produced significantly more calls/s that S-C piglets treated before C piglets.

In experiment 2, C piglets produced more calls than S-C pigs (5.4±0.4 vs 3.8±0.4) and bench-restrained piglets produced more calls than upsidedown-restrained piglets (5.2±0.3 vs 4.0±0.6). Castrated piglets produced more calls which were greater than 1000 Hz than S-C piglets (4.8±0.4 vs 3.1±0.5), however, there was no difference between the castration treatments in the number of calls less than 1000 Hz. In contrast, not only did the bench-restrined piglets produce more calls greater than 1000 Hz than the upsidedown-restrained pigs (4.5±0.3 vs 3.4±0.5) they also produced significantly more calls less than 1000 Hz (2.4±0.2 vs 1.5±0.3). There was no difference in loudness between C and S-C piglets, however, bench-restrained piglets were significantly louder than upsidedown-restrained piglets (-53±1.7 vs -61±2.0 dB). There was no difference in the pitch of calls produced by C or S-C piglets, however, bench-restrained piglets produced calls that were significantly higher in frequency during the first half of the call than upsidedown-restrained piglets (2600±200 vs 1995±237 Hz).

Discussion

From experiment 1, we concluded that while being tightly restrained on a bench during castration was stressful to piglets, the actual castration procedure and particularly the cutting of the spermatic cords was significantly more distressing. Because the cutting of the cords was an invasive procedure which involved profound damage to nervous tissue we concluded that the changes in the vocalisations of castrated piglets over sham-castrated piglets were a valid measure of pain perception.

From experiment 2, we concluded, with reservations, that a restraint method which put little or no pressure on the body (hanging upsidedown) was less distressing to piglets than being held tightly on a bench as they produced fewer and quieter calls. Although, another explanation for these results may be that piglets find it more difficult to vocalise while hanging upsidedown. However, even though a potentially less distressing handling method was used, castrated piglets still produced more and higher pitched calls than sham-castrated piglets whether they were tightly-held on a bench or loosely-suspended upsidedown.

The increase in vocalisation rate and call pitch during castration is not just related to handling or pressure on the body but rather to the invasive procedure of castration and particularly the severing of the spermatic cords. We believe these vocalisations are reliable indicators the piglet's perception of its state. Outside of confinement housing the benefits of producing a distress or pain call could include startling an “attacker” and attracting the attention of the sow and bringing her to the piglet’s aid. The disadvantages of producing a false distress or pain call might include increased risk of predation and energetic costs. These costs should result in “honest signalling” or trustworthy evidence of a piglet's perception of its state.

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Interaction between feeding and pre-laying behaviour of hens: implications for motivation

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Introduction

Pre-laying behaviour of hens is not triggered by an egg in the shell gland, ready to be laid, but by oestrogen and progesterone released from the follicle either around the time of ovulation, about 24 h earlier, or subsequently (Wood-Gush & Gilbert, 1973). However, it is not known how the behaviour is actually initiated: for example, whether this process involves changing concentrations of these hormones. Furthermore, nothing is known about changes in motivation in the period before oviposition and little about interactions with other behaviour. There is some indication that feeding is normally suppressed during the pre-laying period (Wood-Gush & Horne, 1970) yet providing food-deprived birds with food before oviposition can delay or even suppress pre-laying behaviour (Rasmussen & Appleby, unpubl.). Experiments were carried out to clarify the interaction between these behaviour patterns.

Expt 1: Effect of absence of food during the pre-laying period

Twenty ISA Brown hens were kept in individual cages with nest boxes. Pre-laying behaviour was recorded by video and divided into the searching phase, up to the first nest entry, and the sitting phase thereafter. For experimental days, food was removed either the night before or in the morning and replaced early in the afternoon after eggs were laid.

Pre-laying behaviour was longer on experimental days than control days, with no difference between the experimental treatments (Table 1). The searching phase was longer, but the sitting phase was unchanged, which suggests that pre-laying behaviour started earlier rather than oviposition being delayed.

This suggests that motivation for pre-laying behaviour is increasing around the time that it is initiated and that it competes with feeding behaviour for expression when food is available.

Table 1. Effect of food removal on pre-laying behaviour (mins), tested by ANOVA (df 2,22)

	None	Morning	Overnight	P
Pre-laying behaviour	73	98	101	***
Searching phase	9	32	29	***
Sitting phase	63	63	74	N.S.

Expt 2: Effect of feeding during pre-laying behaviour

Seventeen ISA Brown hens were kept in individual cages, without nest boxes so that they would see food being provided. The sitting phase was defined as starting when a bird first sat in the place where it later laid; this was much shorter (13 mins) than in the nest boxes of expt

1. An initial trial confirmed previous evidence (Rasmussen & Appleby, unpubl.) that feeding birds during pre-laying behaviour always interrupted it, and established that topping up food in the food trough had just as much effect as replacing food which had been removed 1.5 h earlier. The treatment of topping up food was then applied at various times during pre-laying behaviour. It was expected that motivation for pre-laying behaviour would continue to rise so that later interruptions would have less effect than early ones.

After food was topped up, all birds fed, but contrary to expectation later interruptions had more effect. If the interruption was during the searching phase there was no effect on overall duration of pre-laying behaviour. However, if the sitting phase was interrupted, all birds carried out additional searching behaviour after feeding and before resuming sitting. Pre-laying behaviour was therefore extended and oviposition delayed (Figure 1). The delay was described by a logistic ('S-shaped') Gompertz curve, with inflection 16 mins before expected oviposition, asymptote before this of -0.1 mins delay and after this of 23 mins delay.

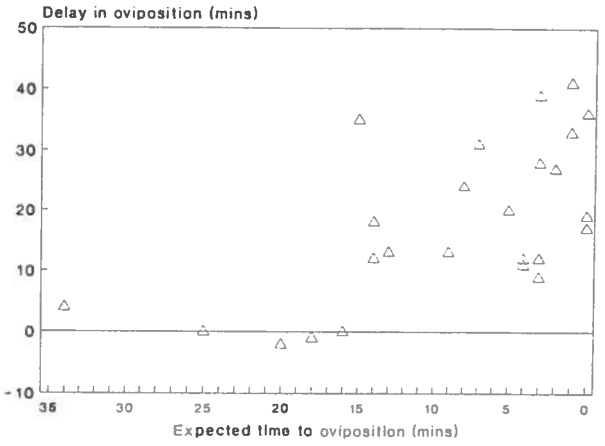

Figure 1. Effect of interrupting pre-laying behaviour at different times before oviposition

Discussion

Expt 1 suggested that motivation for pre-laying behaviour increases gradually rather than suddenly, at least around the time of its initiation. It would be interesting to investigate how this change is related to hormone concentrations. Expt 2 made it clear, however, that there is no simple dependence of phase of pre-laying behaviour on rising motivation, with searching starting at one threshold and sitting at a higher threshold. Motivational control of pre-laying behaviour is complex and may involve separate mechanisms for searching and sitting phases.

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Light-choice by broilers

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Introduction

Normally in practice broilers are kept under continuous lighting regimen. Recently a dark-period was requested but the duration of this period is not defined. In the present experiment broilers were given the choice to use a dark compartment and a light compartment. The time spent in each compartment, differences at various age levels and the use of perches in the both compartments during the fattening period was investigated.

Materials and methods

Two identical compartments were used that were connected and climatized. The size of each compartment was 3.1 x 2.9 m or 9.0 square metre. Stocking density was 12.1 birds per square metre if animals were all in one pen. In the experiment 109 female and male Ross broilers were involved. Water and a standard broiler diet were provided ad libitum. Chopped straw was used as litter. The temperature was 31 °C at the first day and then reduced to 21 °C. The light intensity was 20 lx in one compartment (light) and 0.05 lx in the other compartment (dark). Light intensity was switched between both compartments daily at 10 a.m. in order to prevent the animals getting used to a single compartment.

In both compartments perches were fixed at a height of 20 and 40 centimetres stepwise. Behavioural parameters were registered by video recorders for 24 hours throughout the 6 weeks. Activities observed were the number of animals found in each pen and the use of perches.

The broilers were weighed weekly. For each room daily feed intake and mortality was also recorded. Ambient temperature and relative humidity were recorded separately for both compartments. The experiments were analysed using time sampling in 5 minute intervals. Comparison were made between both compartments using the paired comparison t test.

Results and discussion

The average body weight at 42 days of age was 2130 g and corresponded to commercial weight at this age (Ross Broiler Management Program). During the experiment 6 animals died.

Figure 1 shows the percentage of broilers found in each compartment at weekly intervals. Clearly, animals spent more time in the dark compartment as age increased. During the first four weeks of age only some animals were observed in the dark compartment (0.08 % to 0.65 % of the 109 animals) but at 5 and 6 weeks of age the percentage of broilers found in the dark increased significantly from 12.7 % to 32.6 % respectively (t test, $p<0.01$). The maximum was reached at the end of the experiment at 6 weeks of age. At this time, about one third of the animals were recorded in the dark compartment. Food consumption rised in parallel and amounted to 31.2 % in the dark when compared to the total food consumption. The results can be related to previous observations (Blokhuis and Van der Haar, 1989; Reiter and Bessei, 1994) where walking was reduced and resting behaviour increased with increasing age.

Perches were used after 1 week of age until the end of the experiment. Figure 2 shows that perches with a height of 20 centimetres were mainly used in the light compartment. After 5 weeks of age perches were used to a lesser degree. No animals were observed on the top perch in the dark compartment.

Conclusions

The results suggest that broilers given the choice frequented a dark room increasingly with rising age and body weight. The results do not yet yield conclusive data on the duration of a dark-period necessary.

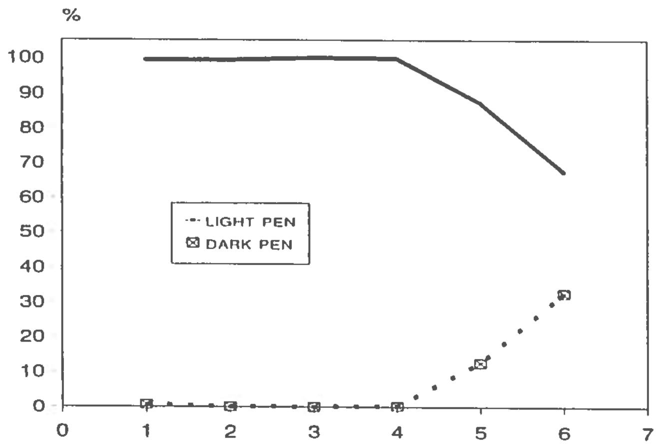

Fig.1. Percentage of animals in light and dark compartment (n=109).

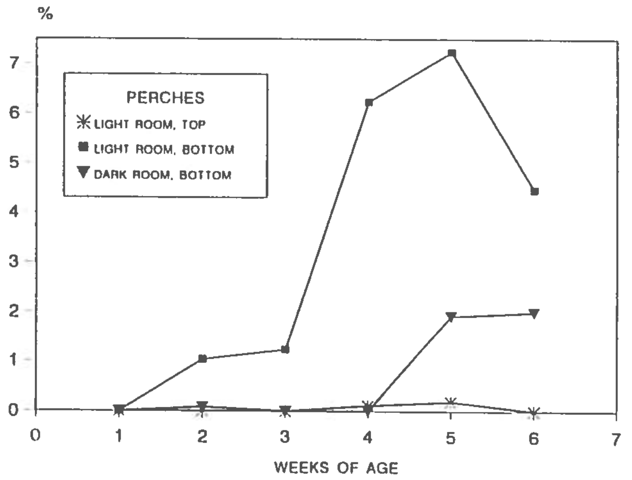

Fig.2. Use of bottom and top perches in light and dark compartment (n=109).

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Ross Broiler Management Program

The Personality of piglets.

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Introduction

In the current litterature on personalities in animals and humans there are two approaches that have been used more than the others, one is the classification of animals into active and passive copers, also called SAL and LAL animals (Benus et al. 1991), and the other is the possibility of finding personaity traits by doing a number of different tests and then try to explain as much of the variance as possible with just a few new, constructed factors (this is often done with principal component analysis; Goldsmith et al. 1987).

Our main concern was with the first of these approaches. To search for a pattern of behaviour similar to the one found for active and passive coping strategies in rodents we tested piglets in a series of tests, including a restraint test previously used by Hessing et al. (1993).

Material and methods

In the restraint test the piglet was turned on its back and held there for one minute while the number of escape attempts was counted. This first test was done on 65 piglets (males and females, two weeks of age). The back-test was then repeated several times on another group of piglets (all female, N: 45; once a week from one to five weeks of age). In addition to the backtest a number of other tests were done. These other tests were designed to measure parameters that previous studies have shown to be correlated to the coping strategies of the animals. The test were rank order, extinction test, social dependence, novel object, and owner/intruder test.

In the rank order test the piglets were given a chance to feed from a feeding apparatus which would only allow one piglet to feed at the time. When the first piglet had fed for 30 s it was removed and marked as number 1, the second pig was allowed to feed for 30 s, and so on. In the extinction test the variables measured were: a) latency to approach the feeding trough that was used b) time spent performing a task without reinforcement. In the social dependence test the piglets were kept alone in their home pen, but with their litter mates close by, the variables measured were: a) number of vocalisations b) approach tendency to the other piglets. In the novel object test the variables measured were: a) latency to make contact with the object b) time spent manipulating the object once they had made contact with it. In the owner/intruder test each piglet was tested in its home pen with a unique opponent (male and of approximately the same weight and age) that it had never met before. The variables measured were: a) number of nose contacts made by the resident before the fight broke out b) the attack latency c) the number of bites of the resident during the fight.

Results and discussion

In our study the result of the back-test was unimodal, not bimodal as suggested by Hessing et al. (1993, Fig 1), furthermore we found no consistency over time.

In none of the other experiments did we find the bimodal distribution predicted by the coping litterature. While some of the distributions e.g. attack latency, are similar to the ones found previously for rats and mice, they can only be thought of as being bimodal if theanimals that did not attack during the session are grouped together at the far end of the x-axis (Fig 2).

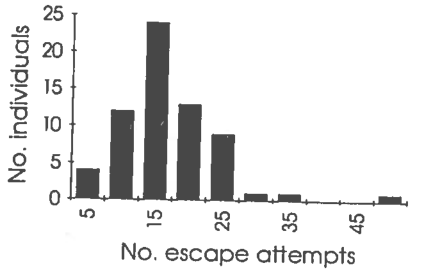

Figure 1. Escape attempts in the first back-test

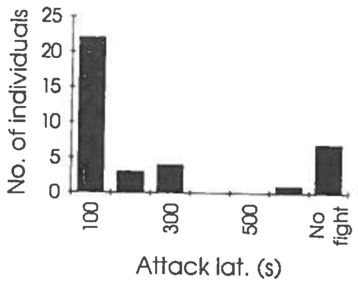

Figure 2. Attack latency of owner in owner/intruder test.

We did not find any significant correlation between the latency to attack and the parameters measured and thus found no evidence for the existence of active/passive copers in domestic pigs.

A rotated principal component analysis (that explained 60% of the total variation) suggested three personality traits: aggression (25%), sociability (20%), exploration (15%). The principal component analysis was done post hoc and the results should therefore be treated with caution. This being said there is a good correspondens between the components found in this study and components found in other studies (see e.g. Goldsmith et al. 1981).

The most heavily loaded variables for the "aggression factor" was number of bites, attack latency, rank and latency in the extinction test (we have no good explanation for why this last variable loaded so high on aggression). For the "sociability factor" the corresponding variables were number of vocalisations, approach to litter mates and number of nose contacts before fight. For the "exploration factor" finally the variables were latency to approach the novel object, time spent manipulating the novel object, and the number of nose contacts before the fight.

In conclusion then, we found no evidence for the bimodal distribution of character traits that is predicted by the theory of coping strategies, neither did we find any of those correlations that are predicted by that theory (Benus et al. 1991). A post hoc PCA of the data from the tests did however indicate that a large proportion of it can be explained by three factors that might be thought of as personality traits.

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Operant Responses of Pigs to Atmospheric Ammonia

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Intensive farming systems generate large amounts of gaseous and particulate contaminants, e.g. dust (including bacterial and fungal spores) and ammonia. Although levels fluctuate, these impurities are essentially always present in the atmosphere of any confinement house. They pose a serious health risk for they have been implicated in the aetiology of respiratory diseases that include: atrophic rhinitis, enzootic pneumonia, pleuropneumonia and swine influenza. Moreover, apart from being detrimental to the health of the farmed animal there may also be economic costs in terms of lost production and reduced performance (Robertson, 1992).

A level of 50 parts per million (ppm) of ammonia gas in piggery air can increase the effective virulence of bacteria in the respiratory tract and thus the incidence of respiratory diseases (e.g. Drummond *et al.*, 1981), while more recent work has indicated that a 20 ppm concentration may augment atrophic rhinitis in pigs (Robertson, *et al.*, 1990).

A complementary approach to establishing what the exposure limits should be for any farmed animal is to measure the behavioural responses of an animal to a pollutant. Yet only a few studies have investigated the preference that pigs have for noxious environments (e.g. Morrison, *et al.*, 1993) and no direct assessment has been made of the motivation of pigs to avoid a polluted atmosphere.

In two separate experiments, 6 Duroc x Landrace pigs, weighing between 30 and 100 kg and feed restricted to 80% maintenance level, were trained to manipulate two operant rooting paddles (e.g. Young, *et al.*, 1993) to gain access to a reinforcer consisting of approximately 8 g of pelleted feed delivered to a common feed trough. Both paddles were continuously ventilated with fresh air at a rate of approximately 3.4 m^3s^{-1} and an outlet, ventilated at approximately 3.6 $^{3}m^{1}s$, serviced the room. This achieved a room air change rate of approximately 7 changes $hour^{-1}$, thereby ensuring a rapid ventilation flow at pig level close to each paddle. During each experimental session, rooting on one paddle 'penalized' the pig by triggering the release of a puff of ammonia gas into the stream of fresh air. This ammonia was delivered at snout level for approximately 2 seconds following each root (non-additive time) through the associated paddle, reaching the pig within 0.125 seconds and peaking at a concentration of approximately 100 ppm. The forced ventilation removed all detectable levels of ammonia within 10 seconds. During each training and experimental session, the pigs were penned individually.

Experiment 1

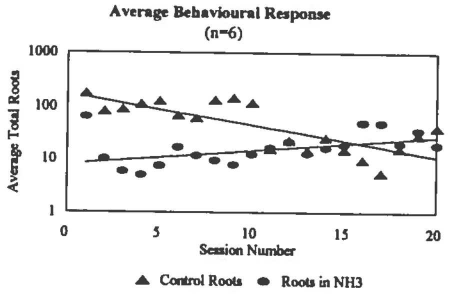
The operation of the paddles was set by operating factors: mode type (either fixed, variable or extinction) and schedule type (either interval or activity based) combined through a randomized block design. These paddles functioned independently with a change over delay of 2 seconds. Each pig was exposed six times, in daily sessions lasting 90 minutes, to any one combination of the experimental factors (3 modes x 2 schedules x 6 days = 36 sessions in total). The ammoniated paddle was allocated at random each day.

Irrespective of the mode and schedule type, significantly fewer roots were made on the paddle emitting ammonia gas than on the control paddle ($\bar{x}$ = 223 vs 359, s.e.d.=28.6, ANOVA, Log_{10} transformation $F_{(1,349)}$ = 12.73, p<0.001). Interval schedules (centred on a delay of 30 seconds before the food reinforcer was available) produced better matching of 'work effort' to the amount of food (reinforcement number) than activity schedules (based on 12 roots per reinforcer). There was no significant influence over whether the required delay or rooting effort was fixed, variable or led to extinction ($\bar{x}$ = 301 vs 310 vs 263, s.e.d.= 35, ANOVA, Log_{10} transformation $F_{(2,349)}$ = 0.6, p>0.05) on how behaviour was apportioned. Yet variable interval schedules are perhaps superior as they do not allow a pig to anticipate reinforcement.

Experiment 2

In this second experiment, evidence of adaptation to the ammonia treatment was sought. Adaptation was tested with an independent fixed interval schedule (of 30 seconds) with a 2 second change over delay. Each pig experienced 20 daily experimental sessions, each of 90 minutes. The position of the ammoniated paddle was maintained for either 5 or 10 days depending on the individual pig.

Again significantly more roots were made on a paddle when ammonia was absent ($\bar{x}$ = 37 vs 116, s.e.d.=12.96, ANOVA, Log_{10} transformation $F_{(1,118)}$ = 13.9, p<0.001). However the pigs did begin to anticipate food reinforcement, lowering their work rate on the control paddle (linear covariance over time, Log_{10} (Roots+1) = 2.24 - (0.06 x session number), p<0.001) and they did adapt to the ammonia (linear covariance over time, Log_{10} (Roots+1) = 0.95 + (0.02 x session number), p=0.009). This is indicated by the linear regression lines on the accompanying graph.



In both experiments there was much individual variation in the behavioural response of the pigs towards the ammonia. That is, some pigs completely avoided exposure to ammonia gas while other pigs consistently preferred a particular paddle, although they worked this paddle less (modified their behaviour) in the presence of ammonia. In some of these pigs the desire to continue to use a particular paddle but to avoid ammonia was so great that they adopted, intermittently, coping behaviour to minimize direct exposure, e.g. foot operation of the paddle.

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A behavioural and physiological study of the responses of inexperienced gilts to electric fencing

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Introduction

The expansion in use of outdoor pig production systems in the UK and Europe has led to increasing exposure of pigs to electric fencing. Little is known of the responses of pigs to these fences, and as a major factor of the animal's environment they may have significant impact on welfare and productivity. The study described here was conducted in order to investigate the behavioural and heart rate responses of gilts encountering electric fencing for the first time.

Materials and Methods

12 group-housed Large White x Landrace gilts, having no prior experience of electric fencing or outdoor pig housing systems, were used in this study. On day one, pigs were paired at random, fitted with Polar Sports Tester heart rate monitors (Polar Electro, Kempele, Finland), and each pair placed in turn in an 85 m x 35 m paddock. This paddock was enclosed by a three wire electric fence, bearing a voltage of approx. 7.5 kV with respect to ground. Behaviour and heart rates of each of the six pairs were recorded for one hour, after which they were removed to a holding area. On the second day of the study, all 12 gilts were placed together in the paddock and behaviour recorded over four one hour sessions distributed throughout the day.

Results

Most fence strikes occurred in the first ten minutes of observation on day one (Table 1).

Table 1. Total number of fence strikes per observation period on day 1 (Friedman's test).

	Period of observation (minutes)					
	00-10	10-20	20-30	30-40	40-50	50-60
No. of Fence strikes	24^a	5^b	3^b	3^b	4^b	2^b

Values with different superscripts differ at P<0.01.

Both gilts exhibited a heart rate response when a fence strike occurred, which was greater for the animal receiving the shock than for the other member of the pair (the pair-mate) (Table 2).

Table 2. Heart rate responses to fence strikes (S.E. in brackets) (Wilcoxon signed-rank test).

Heart rate measure	Shock receiver	Pair-mate	Z	Significance
Mean peak (beats per minute)	168.9 (7.0)	142.7 (5.3)	-2.7	P<0.01
Mean increase (beats per minute)	+58.1 (5.9)	+32.9 (4.6)	-2.7	P<0.01

Neither the shock receiver nor the pair mate exhibited any reduction in heart rate response over successive strikes. The magnitude of the response (both peak and increase) was positively correlated with stage of gestation (Table 3).

Table 3. Correlation of heart rate responses with stage of gestation.

Gilt	Heart rate measure	r	Significance
Shock receiver	Mean peak	0.70	P=0.02
	Mean increase	0.71	P=0.02
Pair-mate	Mean peak	0.69	P=0.03
	Mean increase	0.67	P=0.03

On day 2, gilts spent more time moving in the morning than in the afternoon (P<0.01), and more time rooting and grazing in the afternoon than in the morning (P<0.05, Table 4).

Table 4. Total number of moves and roots and grazes a.m. vs. p.m. on day 2 (Mann-Whitney U test).

	A.M.	P.M.	U	Significance
Total Moves	46	17	5.5	P<0.01
Total Roots and Grazes	63	86	23.5	P<0.05

Discussion

The behavioural data indicate that gilts initially direct explorative behaviour towards the electric fence, but after receiving a few shocks begin to avoid it. It is interesting to note that gilts do still touch the fence after receiving these initial shocks, as this is contradictory to beliefs expressed by many farmers. However, after the first hour of exposure to the fence, the gilts tend to avoid contact with it, although they can be observed grazing and rooting very close to it. Behaviour on the second day, when gilts were exposed to the fence and paddock as a group, is indicative of an initial period of exploration, followed in the later part of the day by less exploratory and more ingestive types of behaviour. The novelty of the outdoor environment, compared with their previous straw yard housing, is likely to have over-ridden any previous diurnal pattern of foraging behaviour. Indeed, prior to moving to the outdoor unit, these pigs were fed in the mornings, thus one would expect them to forage more in the morning if there were a residual diurnal effect, rather than their foraging more in the afternoon as observed. Heart rate responses do not decrease over subsequent fence contacts, although the behavioural responses reduce the incidence of such contacts. The magnitude of heart rate responses on fence contact, increasing with stage of gestation, suggest that exposure to electric fences may be a contributory factor to reproductive upset, particularly in animals experiencing them for the first time in late gestation.

Cognitive aspects of animal-human interaction and the implications for welfare and training

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Physical restraint is the traditional approach to handling many farm, zoo and wild animals. It is also widely used for companion and sport animals. This paper examines whether traditional practices in handling and training of various animals are the most appropriate and if they can be improved to reduce problems for both humans and animals. Illustrations are used from intensive to extensive animal management systems, including sheep, cattle, llamas, zoo animals, wild elephants, horses and dogs.

Species generalisation in response and species specific differences are both important areas. The importance of the behaviour of the human in handling and teaching large mammals has been demonstrated by our recent research. Areas requiring improvement include a greater understanding of the visual cues being given by the human (and how to control or change them); a structured use of language; greater understanding of species similarities and differences in both attention and motivation; methods of motivation and finally an assessment of the effect of associative learning and cognitive behaviour on handling and teaching strategies. These have implications for improved welfare.

Strategy of vocalization by common isolation of chicks

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Introduction

Objective interpretation of behavioural response to the environment by animals is still a major problem. Numerical analysis of vocalization may be a useful tool to this end (Marx, 1993). Our laboratory has previously demonstrated the change of specific parameters of distress calls of chicks exposed individually to an open field. The aim of the present investigation is to assess, by use of our ethometrical method, the internal state of the animal relative to fear or emotion and evaluate the association between call features and environment influences. The distress calls of chicks were used to investigate their dependence on social influences.

Materials and Methods

In one experiment male and female chicks (White Leghorn) were reared in different-size groups for 2 weeks. The chicks were tested in a Step-Isolation-Test (Leppelt *et al.*, unpublished) on day 6 and 7. For the Step-Isolation-Test a variable number of animals was moved from their home unit to a sound attenuated chamber. In the test chamber the chicks were acoustically and visually isolated from the rest of the housing group. Over a 4 minute period all calls were recorded, thereafter the group was successively reduced in size removing one chick at a time. The procedure of 4 minute call recording and subsequent removing of animals was repeated until a single chick remained. This procedure allowed to determine the variation of vocalization of the distress calls with the number of animals in the Step-Isolation-Test and with the size of the original housing group. Social interactions with mother and social companions are an important characteristic in many precocial birds (Wood-Gush, 1971), therefore we postulate that lack of animals social interactions is an important variable influencing the chick's behaviour and vocalization. A considerable social stress was placed at the begin of the test in the way that the size of the isolated group was reduced by approximately 50 % in number of animals. Chicks were housed in groups of either 7, 10 or 15 animals. The sizes of the corresponding isolation groups were: housing group of 7 animals - isolation group of 4 animals / housing group of 10 animals - isolation group of 5 animals / housing group of 15 animals - isolation group of 7 animals. The Step-Isolation-Test was carried out 4 times for each size of isolation groups. Throughout testing vocalization was recorded with a tape recorder. Call samples were given from the tape into a spectrograph, which carried out a spectral analysis of the acoustic signals and set up visual spectrograms (sonagrams). For the first two minutes of the isolation period the total number of calls of each call type given by each subgroup of chicks was counted by visual inspection of sonagrams. Distress calls and short peeps were also evaluated by numerical analysis.

Results and Discussion

In all there were 8583 calls counted on spectrograph. A sample of 540 distress calls was also assessed by numerical analysis. Chicks tested individually in an open field responded with distress calls in rapid succession (Jones and Merry, 1988). Chicks socially isolated in the Step-Isolation-Test emitted distress calls either short peeps or twitter or pleasure notes or transitional calls. The results of the Step-Isolation-Test demonstrate a typical distribution of the four call types (distress calls, short peeps, twitter, pleasure notes) with reference to the number of animals in the test chamber. Figure 1 presents results of the call distributions for the Step-Isolation-Test of 5 animals on day 6 of life.

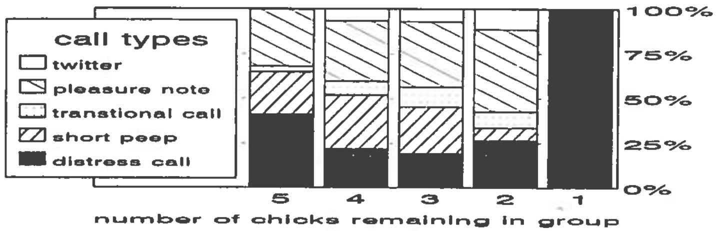

Figure 1. Comparison of distribution of call types within the Step-Isolation-Test

Both distress calls and short peeps are emitted by distress of the animal (Wood-Gush, 1971), however it is likely that short peeps are a response to lower stress situations, because they are short calls with lower energy values. Twitter and pleasure notes are interpreted as calls of contentment of birds (Wood-Gush, 1971). In an isolation group of 5 chicks distress vocalization (distress calls and short peeps summarised) reached beyond of 65 per cent of the total vocalization at the begin of the test. The percentage was decreased by removal of one companion. However, further reduction of the number of companions in the isolation group lead to an increase in the number of distress calls. Calls of contentment are uttered in the opposite direction. The results indicate that, except at the begin of the test, the number of distress calls emitted by remaining chicks increased progressively with a decline in number of social companions, thus illustrating the stressful properties of social separation. The reliability of the trend was confirmed by χ^2 test ($p<0.05$). The large number of distress calls at the begin of the Step-Isolation-Test indicates the likely presence of additional environmental influences such as handling by the experimenter, exposure to a novel environment or loss of social companions. The decrease of the number of distress calls after reduction of the isolation group from 5 to 4 chicks is interpreted as adaptive response of chicks to novel environment and handling. Such orderly relationship between the number of animals in the Step-Isolation-Test and number of distress calls occurs in all group sizes of isolation. Results from the numerical analysis of the distress calls indicate that the systematic removal of companions from established group also induced degrees in specific parameters of the distress calls (Leppelt *et al.*, unpublished).

It appears that not only single isolation but social separation procedures were perceived as distress too, which is reflected in the vocalization of chicks. The internal state of the chicks is reflected in the total number of distress and contentment calls, but also in specific parameters of the distress calls.

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The effects of familiarity on group preferences in laying hens

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Introduction

Preference tests suggest that hens prefer to enter a group of familiar cage mates to unfamiliar ones or an empty space, possibly as a result of being fearful (Dawkins 1982). However, some previous work has confounded familiarity of flock mates with familiarity of the testing environment and procedure. It also appears that familiarity with flock members has some influence on spacing behaviour (Lindberg & Nicol 1994). This experiment used T-maze preference tests to study the effects of the social familiarity of companion hens on group preferences and behaviour of test hens. We did not test space preferences but instead provided a choice between two large or two small groups differing only in familiarity.

Methods and Materials

One hundred and eighteen 19 week old Warren hens were randomly divided into groups of 66 (the Home Flock) and 52 (the Unfamiliar Flock), and placed in two identical rooms of 3 x 7.2 m. The hens had been reared on deep litter in a flock of 500. Each room was equipped with 4 *ad libitum* mash feeders, 2 automatic drinkers, 20 tiered nest boxes, 7 m perch space and wood shavings deep litter. The hens were left in these flocks for 3 weeks before the experiment commenced. The test room was divided into two 3 x 3 m spaces connected by a T-maze with Perspex top and doors, which were operated by levers from the adjacent home room.

Hens were selected randomly for the following familiarity categories, marking test birds and all groups of 4 with coloured legbands: *Home Flock* = 10 test hens + 4 'familiar' companion hens + 4 'semi-familiar' training hens + 4 'semi-familiar' companion hens + 44 'semi-familiar' companion hens and *Unfamiliar Flock* = 4 'unfamiliar' training hens + 4 'unfamiliar' companion hens + 44 'unfamiliar' companion hens. The 10 test hens were familiarised with the 4 'familiar' companion hens by leaving these 14 hens together in a spare room for 3 x 4 hr 'familiarisation sessions' prior to testing and during the experiment when not tested. The test hens spent the remaining time in the home room with all the 66 hens together and were assumed to be 'semi-familiar' with the rest of the Home Flock. The hens in the Unfamiliar Flock remained in their home room outside of testing and were assumed to be unfamiliar to the test hens. 'Training' hens were used during training sessions to maintain lower levels of familiarity prior to testing. The following combinations of companion hen groups were tested, making a total of 12 trials:

Table 1. Testing schedule. Days 5-8 as below but reversing right and left options.

Day	Left side	Right side
1+9	4 semi-familiar	4 unfamiliar
2+10	44 semi-familiar	44 unfamiliar
3+11	4 familiar	4 unfamiliar
4+12	4 semi-familiar	4 familiar

Training: Test hens were trained prior to testing to give them experience of the T-maze and the group options. This was done by gently pushing a test hen through the T-maze into the companion hen group and confining it for 10 min. Each daily testing session was also preceded by a 'daily pre-test training', when the test hen was pushed through the T-maze and confined for 1 min in each of the two companion hen groups.

Testing: Testing occurred immediately after the daily pre-test training, by placing the test hen in the T-maze, opening both exits and allowing her 5 min to make a choice, recording the latency to emerge. The test hen was then confined in her chosen group for 10 min.

Behavioural observations: Each test hen was observed for 5 min when entering her chosen group, and the incidence of the following behaviour patterns was recorded: pecks (aggressive or non-aggressive); threats; fights; pacing; escape movements; drinking; preening.

Results

All hens took < 5 min to leave the T-maze (mean 7.0 ± 0.3 s) and there was no difference in latency to enter the different group options. No significant preferences were found for the different familiarity levels, with approximately half of the test hens choosing each option. However, we found significant differences in agonistic behaviour, which was expressed more frequently in small groups. Aggressive pecks were more common in semi- and unfamiliar groups, whereas threats occurred more frequently in familiar groups (Table 2).

Table 2. Mean number (±SE) of aggressive pecks received and threats given by test hens during each 5 min observation period (Kruskal-Wallis *=$p<0.05$ and ***=$P<0.001$).

	Semi. 4	Unfam.4	Fam.4	Semi.44	Unfam.44	Sig.
Agg. pecks	1.1 ±0.6	1.8 ±0.5	0.2 ±0.1	0.1 ±0.1	0.1 ±0.1	***
Threats	0.1 ±0.1	0	0.2 ±0.1	0	0	*

Discussion

Unlike previous preference tests, these trials did not reveal any clear preferences and the hens appeared not to distinguish between the different levels of familiarity. However, differences in behaviour exhibited at different levels of social familiarity indicated that once in a group the test hens were affected by its familiarity. A lowered familiarity level resulted in increased intensity of agonistic interactions, while large group size resulted in very low levels of aggression, possibly because an entering hen was less conspicuous in a large group. In a more familiar group, threatening was more likely than direct aggression. Two main reasons are suggested for the lack of preference: (a) test hens may have been unable to determine the familiarity of the companion hens while in the T-maze, perhaps because of poor visibility or (b) based on a standard cost-benefit analysis prediction, the "investment" required to identify the familiarity level may have been unnecessarily costly to the test hens if little or no benefit resulted from choosing to enter a more or less familiar group. This may also have been affected by the relatively brief period of confinement in the chosen group. Further work to elucidate more precisely the effects of familiarity on behaviour would be desirable, controlling this factor more carefully.

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The Perception of Video Images by Laying Hens

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Introduction

Video technology provides an important potential tool for the study of animal learning and social behaviour. Pigeons can discriminate between video images in concept learning experiments, but do not respond naturally to video images of conspecifics (Ryan and Lea, 1994) raising questions about picture-object equivalence in this species. In contrast, a variety of social responses can be elicited from chickens in response to video presentation, including alarm calling (Evans and Marler, 1991) and feeding behaviour (Keeling and Hurnik, 1993; McQuoid and Galef, 1993). The appropriateness of these responses has led some to conclude that chickens perceive video images as equivalent to real objects, but this has not been demonstrated formally. Chickens may respond to general features of the video presentation, e.g. some combination of motion and colour, without perceiving images as real objects. Our aim was to investigate the ability of laying hens to discriminate between video images, and to determine the extent of generalisation between real objects and video images.

Experiment 1. Materials and Methods

Six hens were trained in an automated Y-maze to discriminate between two real stimuli. Correct responses were continously reinforced with 3s access to wheat. The position of the positive stimulus (S+) was determined randomly on each trial. Once subjects had attained a criterion of 90% correct responses per session, they progressed to an intermittent 40% reinforcement schedule. Video images (without soundtrack) were then presented as substitutes for both real stimuli, on a random 20% of non-reinforced trials. The number of correct responses towards 10 of these video 'probes' was determined. Finally, the ability of subjects to discriminate between video images of the two real stimuli previously trained was assessed. This general procedure was used to investigate the responses of the 6 subjects to the following stimuli (i) white hen vs white card (white hen S+ for all subjects) (ii) green card vs red card (green card S+ for 3 subjects, S- for 3 subjects) (iii) brown hen vs white card (brown hen S+ for all subjects).

Experiment Two. Materials and Methods

Six hens were trained in an automated Y-maze to discriminate between a brown hen and an orange basketball (group R). A further six hens were trained to discriminate between video images of these same stimuli (group V). The brown hen was S+ for three subjects within each group, and the ball was S+ for the remaining three subjects within each group. 80% correct responses during continuous reinforcement were required before progression to an intermittent 50% reinforcement schedule. 90% correct responses over 3 consecutive sessions were then required before exposure to substitute stimuli on a random 10% of non-reinforced trials. For Group R hens the substitute probes were video images of the brown hen and the ball. For Group V hens the substitute probes were the presentation of the real ball and brown hen. Twelve probes were given to each subject, presented randomly during 4 consecutive sessions.

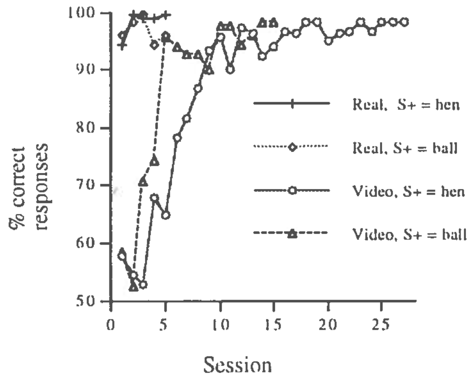
Results. Experiment One

All discriminations between pairs of real stimuli were performed to a high level of accuracy. Subsequent generalisation to the video probes averaged 55% correct for the white hen vs white card, 78% correct for the green card vs red card, and 68% for the brown hen vs white card. The hens showed highly accurate performance on the subsequent green vs red video discrimination, but failed to perform above chance levels on the white hen vs white card video discrimination. Their performance on the brown hen vs white card video discrimination was variable. Three hens reached the 90% criterion after 4,5 or 7 sessions. Two hens showed some improvement over 7 sessions but did not reach the criterion, and one hen showed no improvement in performance.

Results. Experiment Two

Group R hens reached 90% discrimination accuracy significantly earlier than Group V hens (5.0 vs 16.5 sessions, Mann-Whitney, $p < 0.01$). Since each session comprised 30 correct responses plus all incorrect responses, Group V hens made over 200 choices before their performance began to improve. Learning curves averaged for each group are shown in Fig 1.

Learning Curves for Experiment 2



Group R made only 48% correct responses to the 12 video probes. Overall, hens in Group V made 60% correct responses to the 12 real probes. However, subjects with the ball as S+ got more probes correct than subjects with the hen as S+ (78% vs 42%, Mann-Whitney, $p<0.05$).

Conclusions

In experiment 1 hens were given video probes before video discrimination tests. They performed well on both tests with red vs green images, with variable performance with brown hen vs white card images, and at chance levels with white hen vs white card images. In experiment 2, Group R hens acquired real discriminations rapidly, whilst Group V hens required hundreds of trials over a maximum of 28 sessions before making accurate video discriminations. If video experience is required before picture quality is perceived then it is not surprising Group R hens did not generalise from real objects to their video images. However, for Group V hens, known to discriminate between video images, generalisation to real objects might be expected. Our data were ambiguous. Generalisation occurred for ball S+ hens only. This may reflect a bias to avoid an unfamiliar real hen in a Y-maze of this type, or may show that hens do not take equal account of positive and negative stimuli in discrimination tests. The results suggest that video images are poor substitutes for real animals as stimuli.

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Dustbathing behaviour in featherless chicks: A case of central motivational regulation.

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Introduction

Several models for the regulation af dustbathing behaviour in gallinaceous birds have been proposed. Some authors emphasize external factors such as accumulation of preening oil in the feathers (e.g. van Liere et al., 1991), whereas other authors emphasize central (internal) factors. In the regulation of dustbathing in fowl two mechanisms may depend on central factors. These are the diurnal rhythm mechanism (Hogan & van Boxel, 1993) and the deprivation mechanism (Vestergaard, 1982); however, although likely (see Hogan et al., 1991), it has not yet been demonstrated definitively that there is a central deprivation mechanism. In this study two experiments were undertaken to examine the development of control by internal factors responsible for the deprivation effect in featherless chicks. We used chicks from a mutant breed called "*scaleless*", which lack several features of ectodermal origin, including feathers. These "naked" chicks were used in order to exclude changes in the feathers as a motivational factor for dustbathing.

Methods

In experiment 1 the effects of dust deprivation were investigated in pairs of chicks that were between 7 and 27 days of age. Twelve pairs of chicks were kept in wire floor cages from 0 to 27 days of age. During the first week after hatching the chicks were given training trials in sand and from day 7 they were observed for 1 h on test days, while placed in a cage with sand. The dust (sand) deprivation levels were 1, 2 and 4 days. All possible six orders of deprivation levels were used, with two subjects (one focal chick from each pair) for each order. Each chick was exposed to each deprivation level once in 7 days and the tests were repeated in the same order three times in total. The number of vertical wing-shakes (Kruijt, 1964) were used to quantify the amount of dustbathing.

In experiment 2 the development of dustbathing in the 2nd week of life was investigated in more detail. Eighteen pairs of chicks were housed and trained as in experiment 1. The birds were divided into three groups of six pairs each. One group was given the opportunity to dustbathe every day (days 7 to 14), the 2nd group every other day (days 8, 10, 12 and 14) and the 3rd group every 4th day (days 10 and 14), all for 1 h each day. To control for effects of accumulating oil and dirt on the skin all birds were powdered every day with potato flour by means of a brush.

Results

The results of experiment 1 showed that deprivation effects were apparent during the 2nd week of life and there was no change in these effects as the chicks grew older. The amount of dustbathing increased from the 2nd to the 3rd week, but decreased in the 4th week. The chicks performed an average of 19, 32 and 41 vertical wing-shakes when deprived for 1, 2 and 4 days, respectively, i.e. the amount of dustbathing increased with deprivation. A 3x3 completely within subjects analysis of variance confirmed the effects of deprivation ($p<0.001$), and age ($p<0.001$). The interaction was not significant.

In experiment 2 deprivation effects were apparent as early as 8 days of age and there was no change in these effects as the chicks grew older. Futhermore, there was a general increase in the amount of dustbathing over the course of the week. On average the 1-,2- and 4-day deprived groups performed 9, 15 and 24 vertical wing-shakes, respectively. A 2x4 mixed design analysis of variance, which compared the effects of deprivation and age between the 1-day and 2-day deprived groups revealed significant effects of deprivation ($p<0.001$), and age ($p<0.05$). In addition a 3x2 mixed design analysis of variance, which compared the effects of deprivation between all three groups on days 10 and 14 revealed significant effects of deprivation ($p<0.05$), as well as age ($p<0.05$). In neither analysis was the interaction significant.

Discussion

The results revealed that deprivation effects appeared in naked chicks as soon as dustbathing appeared exactly as in intact red junglefowl chicks, and that the effects of deprivation did not change over time (Hogan et al., 1991). This supports the contention that internal factors control dustbathing prefunctionally. In our naked chicks feather changes could not be responsible for the deprivation effect. Changes in the skin were also unlikely to control dustbathing behaviour because the deprivation effects were seen before the uropygial gland becomes functional by day 11, and because every day we powdered all chicks with potato flour to control for accumulation of lipid (Borchelt & Duncan, 1974) and dirt. We, therefore, conclude that the deprivation effect was due to a central deprivation mechanism. Such a mechanism may function as a "timer" that records the time from the last performance of dustbathing and adjusts the amount of dustbathing accordingly when the next possibility to perform appears.

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Measuring Behaviour

Behavioural measures as indicators of internal states

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Summary

The measurement of behaviour begins with careful observation and description. Issues of classification, analysis and interpretation are stems from these roots. My goal in this presentation is to show how both traditional and new approaches in ethological measurement can link basic research with applied perspectives.

Introduction

The assessment of adaptive patterning in animal behaviour often begins with questions concerning relations among internal state variables and external conditions. An important challenge is to provide measures of overt expression that permit the interpretation of these internal state variables. In ethology, concepts such as motivation have been designed to help us do this.

As Charles Darwin (1872) noted, concepts such as emotion in animals are often difficult to define, but with careful observation they may help us discern hidden variables that place behaviour within an appropriate biological (as opposed to mechanical) context. Obviously issues of animal welfare and other forms of application demand that we attempt to assess these internal variables. In this presentation I shall endeavour to outline approaches to behavioural taxonomy that may assist us in this task. I do this in four parts. First, I shall review some basic issues of behavioural organisation in general terms that I think we should be sensitive to. Secondly, I shall illustrate some of these issues through data on co-ordinated behaviour in individual animals (mostly rodents). Thirdly, I shall extend these considerations to issues of socially co-ordinated actions (mostly canids). Finally, I shall touch briefly on preliminary observations we have made on human perceptions and interpretations of animal actions.

My view is that participants in this conference should be heartened by the diverse approaches to behavioural measurement and interpretation taken. Oral presentations in the session on “Measuring Behaviour” include such important issues as experimental design, motivation, vocal behaviour, temporal organisation, welfare, and measurement consistency. Accompanying posters include the themes of development, field applications, physiology, deprivation, regulation, temporal ordering, aversion, stress, stereotypies, and novel approaches to behavioural design and quantification.

In summary, this is a rich and exciting menu! My task is to introduce this richness. To do so I shall move through four steps: 1) Basic issues in behavioural organisation, and thus measurement; 2) Properties of organisation in individual animals; 3) Socially co-ordinated actions; 4) Possible roles of human behaviour in the study of animal behaviour.

Issues of Dynamic Order in Behaviour

Behaviour is fundamentally *process*. That is, behaviour, by definition, is dynamically organised across multiple dimensions. Our models of behaviour must attempt to deal explicitly with underlying dynamic processes. This involves the examination of a number of relations in time. Relations among internal and external states, across classes of action, and phylogenetic plus ontogenetic processes are three cases in point. One valuable approach to this set of problems is to concentrate on the organisation of *pattern* in behaviour. This emphasis reminds us not only to dissect behaviour into reasonably fine detail, but also to look explicitly at how these details fit together within a larger package. Finally, since behaviour is also a *phenotype*, tracing the ontogenetic roots of adaptive behaviour can provide important insights. (Process, pattern, and phenotype are what I call the 3-little p's in behaviour; perhaps an affliction derived from my fascination with wolves and behavioural fairy tales.)

Following descriptions of behaviour (never an easy task!), a second set of issues concerns the separability, or specificity, of underlying organisational processes. Classical ethological models of hierarchy (e.g. Tinbergen, 1951) were attempts to recognise that some processes appear to operate within a more limited framework than do others. More recent research suggests that these basically static models of behavioural organisation must be at least supplemented by more dynamic perspectives in which rules of operation are more or less continually reassembled into novel, but still constrained, patterns. The outlook I favour, and for which I shall thus attempt to argue, is one in which the focus upon a dynamic interplay among processes of interaction and self-organisation (called "ISO" for short), as these processes are expressed across different levels and time frames. Much of our work has been trying to deal with the challenges this viewpoint provides (e.g. Fentress, 1991, 1992).

A number of observations relevant to the present conference can be derived from this standpoint, such as movement perseverance, fragmentation, conflict, and arousal. I hope that we shall have an opportunity to discuss these observations together. In recent years we have attempted to supplement our analyses of integrative functions with the ontogenetic assembly of these functions. Bringing these two perspectives together remains a major challenge, but progress is being made. This is best done through what I call "Dynamic Network Analyses" (the new DNA!).

Individual Action Patterns

Action patterns are defined by their components, combinations, and contexts of expression. For example, rodent grooming actions involve a number of distinctive movements that occur in hierarchically structured sequences, and are often facilitated by moderate conflict (e.g. "displacement activities") or stress (e.g. "arousal"). Importantly, this facilitation is characteristically replaced by grooming inhibition under severe conflict or stress. This illustrates that relations among classes of activity can be either facilitatory or inhibitory as a function of system dynamics, and it is important to work these out. In brief, data from our laboratory has indicated that during strong activation, behavioural systems can become more tightly focused, less susceptible to disruption from extrinsic perturbations, and more extensive in their own inhibitory influences (Fentress, 1991). Complete titration of these internal dynamics demands simultaneous consideration of quantitative (how strongly activated), temporal (when activated), and qualitative (what activated) variables as these operate together within integrative networks. The experimental perturbation of ongoing behaviour during different phases of expression provides a simple yet very powerful analytical technique.

Movement perseverance, stereotypy and fragmentation provide three important descriptors of behaviour that can be used in combination with simple experiments. Dependency upon extrinsic cues and sensitivity to perturbations are two valuable experimental measures. Persistent stereotypies (e.g. as in zoo animals) often provide valuable model systems, but similar principles apply to other forms of integrated action (cf. Mason, 1991). One focus of this presentation will be to demonstrate how detailed non-invasive descriptions and simple experiments on "movement syntax" can provide empirical dissection of both separate and shared processes of integrated action. Rodent grooming will be emphasised as a model system. Recent technical advances in movement notation and computer evaluation of movement kinematics permit levels of resolution that were previously unavailable. However, full interpretation of integrative dynamics also demands that these details be re-synthesised into broader patterns of expression, as measured by the various contexts within which individual movement properties are expressed. In this process of synthesis and interpretation of integrative processes, the conceptual skills of the investigator are of fundamental importance. It is, for example, often valuable to compare data collected from two or more distinct perspectives in our search for general principles of organisation. In this spirit, I shall include new data on the progressive refinement and assembly of movement during ontogeny. These data clarify further the dynamics of established integrative processes (for details see papers by Golani and Fentress, 1985; Berridge *et al.*, 1987; Coscia and Fentress, 1993; Bolivar *et al.*, in press).

Socially Co-ordinated Actions

Over the past decade, we have been interested in extending conceptual and technical refinements of individual action pattern analysis to socially co-ordinated behaviour in wolves (*Canis lupus*). A basic strategy has been to examine individual components and sequences of behaviour both within and between animals. The work I shall emphasise first involves socially co-ordinated movements and vocalisation patterns. I shall then relate recent information we have obtained from non-invasive physiological measures. These measures clarify internal state variables related to social ontogeny and animal well-being (absence of stress). This research has been made possible through the establishment of the Canadian Centre for Wolf Research. The centre is contained within the Nova Scotia Provincial Wildlife Park. Individual life histories of more than a dozen wolves born and raised undisturbed within a 10 acre boreal forest habitat form the main body of this research. Supplemental data have been obtained from hand-reared data and through colleagues in the field.

Early studies by G. Moran (e.g. Moran *et al.*, 1981) and Z. Havkin (e.g. Havkin and Fentress, 1985) demonstrated that many of the most important constraints in social behaviour are best assessed through evaluations of individual animals with explicit reference to moving social partners. These studies were extended by P. McLeod (1987) who traced movement displays from birth with specially constructed in-den monitoring systems (audio/visual). Combined auto-correlation and cross-correlation methods clarified the relative salience of individual and social constraints in behaviour during development. More recent studies by J. Goldman (e.g. Goldman *et al.*, 1995) and E. Coscia (1995) have dissected the ontogeny of wolf vocal patterns, including their behavioural contexts. In each case it has proven useful to examine explicitly the dynamic patterns of individual actions rather than merely to catalogue these actions without explicit temporal and social referents. It has also proven useful to examine the patterns of behaviour from explicitly different perspectives and across complementary levels of organisation. Only in this way do nodes of constraint and flexibility in behaviour by individual animals under specific contexts become apparent.

I shall focus my presentation on two recent lines of research that relate particularly well to the main themes of this conference. The first (a) concerns the ontogeny of vocal behaviour using refinements of our within-den monitoring system. Single pups are traced from birth for their individual behaviour, their interactions with peers, and their developing relationships with adults. The second line of research (b) concerns non-invasive measures of physiological states with reference to reproductive behaviour and natural social stresses.

(a) In a recent Ph.D. thesis, E. Coscia (1995) examined 108 hours of video tape (36 from each of three litters) and sampled from 99 hours of audio tape to examine both how individual sounds are differentiated and how they become integrated with other forms of behaviour, and with the behaviour of other animals (pup and adult). Eight basic sound patterns (pure tone, harmonic, noisy) were subjected to spectrographic analyses and classified with joint differences on two or more variables (e.g. amplitude, frequency modulation, rate of frequency modulation, spectral bandwidth). Certain sounds such as moans, squeals and screams developed early, while others such as squeaks developed later. Contexts of expression also varied ontogenetically. For example, early growls were not directed towards other animals while later growls were. During later stages of den behaviour, and following early den exits, the sound patterns became refined and linked to predictable interactions with particular individuals within the pack. Concurrent behavioural analyses permitted assessments of motivational state, which in turn corresponded with differential responses to the various vocalisation patterns.

Some sounds, such as early woofs, suggested behavioural ambivalence (as when pups made hesitating moves to leave the den). Other sounds occurred in mixed series, suggesting motivational transitions and conflict. Still other sounds (earlier work by J. Goldman) appeared not to elicit direct responses but to "prime" subsequent reactions to the animals' movements. I shall attempt to show how this combination of sound and movement patterns provides a sensitive yardstick for measuring internal states, including those that occur under social stress.

(b) Ongoing research with S. Gadbois, P. McLeod, W. Moger and J. Ryon has involved direct but non-invasive measurements of physiological state reflected in animal well-being or social stress. Urinary stress hormones (e.g. cortisol) are assayed from "yellow snow" samples collected for known individuals after documented social encounters and across the reproductive season. Field research has suggested that social stress for wolves and other social mammals is enhanced during seasonal courtship and mating, and that this change in behavioural well-being is differentially distributed across animals of different social ranks. By using natural social stresses, rather than artificial stresses, our combined behavioural and physiological data may help throw light upon social dynamics of wolves in the wild, and have further implications for evaluations of internal state variables more generally.

Measuring Human Observers

Clearly conclusions concerning interpretations of behavioural states in animals will benefit if we have a better handle on the cues used by observers to make these interpretations. I shall end my presentation with a brief note on work in progress where we have used original and selectively modified videotapes of animal movement patterns to document the cues used by observers in judging distinctions between motivational states (e.g. friendly versus aggressive). Although preliminary, these data suggest how future studies might be conducted, such as through computer generated representations of movement variables, to assist us in our major goal: the use of behavioural measures as indicators of internal states (see Anderson *et al.*, 1995 [in press]; Bolivar *et al.*, 1995 [in press]).

Conclusions

Applications of basic ethological research techniques have become increasingly important. These applications rest upon our basic measurements of behaviour, and upon the interpretations we make from these measurements. I argue that no single perspective in measurement is sufficient. Beyond details of particular measures we must attempt to evaluate behaviour in multidimensional terms. In this way we can not only evaluate better the internal states of our animals, but also the internal biases of ethologists who seek objective interpretation of animal action patterns. The present conference helps point us toward appropriate directions. My personal presentation emphasises the dynamic, relational, and multi-layered nature of behaviour as essential considerations.

Acknowledgements

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Analysing temporal synchronisation of behaviour by animals in groups

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Introduction

Quantifying synchrony of behaviour between animals in groups is important in understanding group dynamics. Synchrony may have adaptive significance, for example as an anti-predatory mechanism, or it may be needed simply to maintain group cohesion. Synchrony also has statistical implications because individual animals cannot be regarded as independent. Some synchrony of activities will occur by chance and must be accounted for.

At least six questions may be asked regarding synchrony. 1. What is the overall degree of synchrony and is this more than would be expected by chance? 2. Does the degree of synchrony differ for different activities? 3. Does the degree of synchrony differ over time? 4. Are some subgroups of animals more synchronized than others? 5. Do some pairs of activities occur together more often than would be expected by chance? 6. Do some individuals behave more synchronously than others?

Despite the importance of synchrony, the development of appropriate analytical techniques has received relatively little attention. The method proposed here allows a unified consideration of these questions and provides a test of the hypothesis that synchronisation is non-random.

Methods

Consider a group of k animals each engaged in one of m mutually exclusive activities in each of N periods. This is analogous to a group of k clinicians assigning each of N patients to one of m diagnostic categories. The so called kappa statistics (e.g. Cohen, 1960; Fleiss, 1971) are widely used for quantifying and testing agreement between clinicians and are here adapted as an index of synchrony.

An N x m table is formed with each cell containing the number, n_{ij}, of animals engaged in an activity (j) in a particular period (i). Since each animal engages in only one activity in each period all rows sums equal k. The column sums C_j are the total number of periods during which individual animals are observed in a particular activity. With complete synchrony, one cell in each row would equal k, the others all being 0. If, however, activities occur randomly, the total number in each cell in a row would be proportional to the column totals. The proportion of synchrony among the animals for the ith period is the proportion of the number of pairs of animals with a common activity to the total possible number of pairs. The mean proportion of synchrony across all periods is thus

$$P(A) = \frac{1}{N}\sum_{i=1}^{N}\frac{\sum_{j=1}^{m}\binom{n_{ij}}{2}}{\binom{k}{2}} = \frac{1}{N}\sum_{i=1}^{N}\frac{1}{k(k-1)}\sum_{j=1}^{m} n_{ij}(n_{ij}-1) .$$

·The proportion of periods spent in activity j by individual animals is $p_j = C_j/Nk$. If behaviour was random the expected proportion of synchrony for each activity would be p_j^2 and the total expected synchrony over all activities

$$P(E) = \sum_{j=1}^{m} p_j^2 \ .$$

The kappa coefficient of synchrony is the ratio of the total proportion of synchrony P(A) (corrected for chance synchrony P(E)) to the maximum possible proportion of synchrony P(M) (=1) (corrected for chance synchrony), i.e.

$$K = \frac{P(A) - P(E)}{P(M) - P(E)} \ .$$

K = 1 for complete synchrony and 0 for synchrony due solely to chance. Negative kappa indicates that synchrony is less than would be expected by chance.

The kappa statistic as defined above provides an overall index of synchrony (question 1). By appropriate definition of P(A), P(E) and P(M) the method may be generalised to study all the areas outlined above and to take account, for example, of different time budgets of individuals.

Example

Data were from 4 cows grazing together as a group. The predominant activity (eating, ruminating or idling) in each minute for each animal was recorded over a 426 minute period between morning and afternoon milkings. A full analysis of these data is given by Rook and Huckle (1995).

Overall synchrony was significantly different from random (K=0.29). This was mainly due to synchrony of eating (K=0.12) rather than ruminating (K=0) or idling (K=0.08). Eating and idling occurred together less than would be expected by chance (K=-0.62). These results suggest that because eating requires movement it needs to be synchronised to maintain group cohesion. Animal 1 was shown to behave less synchronously than the other animals (K=0.15 compared to mean K=0.36 for other animals). Animals 2 and 4 were found to be particularly synchronised as a pair (K=0.55). Further investigation of factors such as the dominance hierarchy is needed to establish the cause of this effect. Synchrony between animals was found to be particularly marked during the 3rd and 5th hours of the recording period. This corresponds to peaks in eating, which is more synchronised than other activities

Conclusions

The kappa method described here provides an easily generalizable, quantitative method for assessing the degree of synchrony of behaviour between animals in groups.

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Appropriate experimental design for the application of applied ethological research.

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Introduction

The scope of applied ethological research is extensive, ranging from fundamental scientific experimentation at one end of the process to the ultimate solution of practical problems at the other extreme. Clearly, the final stage of this process must have an appropriate contextual basis prior to practical, 'real world' application. Therefore, extreme care must be taken to assess the validity of results in the context of, for example, appropriate group sizes, stocking densities, age profiles, resource provision and time-scales that are relevant to common practice. Moreover, experiments must be designed such that they do not create artifacts upon which erroneous conclusions might be based. These considerations are critical since resource constraints often place limits on one or more of these factors. This paper describes an example of how such experimental errors may arise; and, in more general terms, identifies some potential problems that may be generated by inappropriate experimental design.

Materials and Methods

A commercial herd of 111 pregnant sows was group-housed in a covered barn of 320m^2 of which 135m^2 was lying area covered by straw. The reproductive experience of the sows ranged from 1st to 13th parity. The sows were fed by two identical walk-through electronic feeders (Nedap Poeisz, The Netherlands). Sows were allocated a daily food allowance and they were able to visit the feeders as often as they wished and at any time of day, irrespective of whether they had already eaten their daily allowance. There was no carry over of uneaten food allowance from one day to the next. The feeding cycle commenced at 0705 (G.M.T.). The sows were provided with a readily-available water at all times via bite drinkers.

A computerised interface continuously monitored the individual feeding patterns of the sows (Knowles *et al.*,1989), recording the time and duration of each visit, the identity of the sow making the visit, the amount of food delivered to a sow at each visit, and also the identity of the feeder visited. The results reported here specifically relate to the relative utilisation of the two feeders and are based upon a total of approximately 65,000 feeder visits.

Results

In an earlier report (Knowles *et al.*,1989), based upon two months of recordings, results showed that the two feeders were utilised to different degrees (t-test, $P<0.001$). This difference was apparent even when the visits were partitioned into those where food was delivered (t-test, $P<0.01$) and those where food was not delivered (t-test, $P<0.05$). Clearly, a differential use of seemingly identical feeders would be of potentially great significance to the way in which such systems could be used in practice.

The monitoring process continued for a further 16 months subsequent to that initial report and, in particular, the visiting patterns of sows to each feeder were examined (Eddison, 1992). This enlarged data set included the data that were analysed in the initial report.

The results of these analyses showed that specific sows tended to be associated with one or other of the feeders (χ^2, all visits: $P<0.0001$, feeding visits: $P<0.0001$; and non-feeding visits: $P<0.0001$). In total, 79 sows demonstrated a significant association with one or other of the feeders. Furthermore, during this lengthy period, there was no discernible difference in the extent to which the two feeders were utilised (t-test, $P>0.30$). The conclusion drawn was that sows exhibit individual preferences for feeders. Re-analysis of the earlier data failed to demonstrate sow preferences for feeders during that shorter time period.

There were clear differences in the results obtained from the two analyses that require explanation. The most obvious difference between the two studies was the duration of the data collection periods: 2 and 18 months, respectively. In the earlier study, no sows were present for an entire pregnancy since the normal production cycle is 19 weeks. The possibility exists, therefore, that individual preferences for a feeder, although they may have been present, were undetectable statistically simply because they were recorded for a relatively short time. Furthermore, during the early period, because of its relative brevity, any inequality in the presence or absence of sows preferring one feeder rather than the other could have produced the observed short-term bias in feeder utilisation. Over the much longer time-scale of the prolonged study, any imbalances would have disappeared.

Conclusions

The duration of observation periods was critical to the interpretation of these results and provides an example of a general problem in those areas of applied ethological research that are near the stage of practical application. There are, in fact, two groups of disadvantages associated with inappropriate durations of experiments.

Firstly, as illustrated here, erroneous conclusions may be drawn if the period of observation is too short. Effects caused by differences between individuals may not be apparent or may be manifested in another form, thus leading to conclusions that are fundamentally flawed. Moreover, there is a clear advantage to be gained in having very long experiments or investigations. They will have the effect of smoothing out any additional confounding effects due to variations between individual cohort groups within a flock or herd, or taking account of the effects of early experience on later behaviour. Therefore, observation periods should be determined before the start of an investigation in the context of the proposed application of the results.

Secondly, if experiments in applied ethology are long in relation to the reproductive cycle of the animal, other potential advantages of high welfare systems that would otherwise remain hidden may emerge, and some of these may be of economic importance. Examples, might include lower culling rates, increased longevity or productivity, and beneficial health advantages. Without long experiments, such advantages, if they exist, could not be observed.

Finally, these results have only described problems associated with duration of observation. There are many other scale variables (e.g. age and sex ratios, stocking density) that could generate similar problems if they are not examined carefully. The importance of large-scale applied ethological studies cannot, therefore, be understated.

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Intra- and inter-test consistency in behavioural responses of gilts to different challenges.

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Introduction

Individual differences in behavioural responses between animals are of increasing interest in the behavioural sciences. There could be significant benefits for animal husbandry if a simple test could be developed that would identify animals that have difficulties in adapting to challenges in later life. Most studies in this area have investigated behavioural response over time to an identical or similar test situation. The existence of behavioural categories within a species however, requires more than consistency in responses to *one* test: different "types" of animals would be expected to respond differently in a range of circumstances. So far, studies of consistency of behavioural responses in different tests or contexts, have given conflicting evidence (e.g. Lawrence *et al* (1991), Hessing (1994)). The present experiment was designed to investigate the existence of categories or types of pigs, by measuring both within and between test consistency in behavioural responses to a series of distinctly different tests.

Materials and methods

Sixteen groups of 7 gilts (weight 90.3 sem 1.3kg; age 148.0 sem 1.2days) were subjected to 4 tests. Test 1 measured the responses to a novel object (bucket or human) in an open field test which was carried out 4 times over a period of two weeks. Test 2 recorded aspects of the gilts feeding behaviour over 15 minutes after a 20 hour period of deprivation. This test was done three times during one week. Kendall's coefficient of concordance was used to determine individual behavioural consistency within Tests 1 and Test 2. Test 3 investigated the social status of the gilts in their group, by recording aggressive interactions during competition over a limited food source after 20 hour periods of food deprivation. Finally Test 4 scored general activity and feeding behaviour over a 24 hour period . Tests 3 and 4 could not be replicated. The variables within each test were numerous and often highly correlated. Principal components analyses was used to reduce the number of variables and produce a number of independent "components", each highlighting a group of behavioural response variables. Components that explained sufficient levels of variation in the original data ("Eigen value" > 1), were used to calculate a "factor score" per animal, one for each of the highlighted groups (McGregor 1992). The factor scores for all animals were then correlated between tests.

Results

Behavioural responses to both Tests 1 (Novel Object) and 2 (Food Motivation) were highly consistent during the testing period (e.g. Table 1 for the Novel Object test), and were averaged per test. Principal components analyses resulted in 4, 2, 1 and 2 components with Eigen values greater than 1, for tests 1 to 4 respectively (e.g. Table 2 for Novel Object test). These 9 components were used to calculate the factor scores, which were correlated across tests (Table 3). Only the 1st components of Test 1 and 2 provided factor scores that correlated significantly.

Table 1. Mean proportion of time (in seconds) spent performing various behaviours during the 4 replicates of the 5 minute Novel Object test. and level of consistency between replicates.

Location/behaviour	Bucket 1	Human 1	Bucket 2	Human 2	Kendal's W	
In kennel	0.065	0.046	0.052	0.044	0.489	***
Near object	0.222	0.147	0.286	0.287	0.439	***
Observing object	0.068	0.030	0.065	0.037	0.309	*
Contact with object	0.113	0.052	0.180	0.170	0.436	***

Table 2. First 4 components for the 11 analysed variables of the Novel Object test.

Component	1	2	3	4
Eigen value	4.19	1.78	1.36	1.01
Propor. variance	0.381	0.162	0.124	0.091
Freq. in kennel	0.180	0.102	0.301	-0.706
Time in kennel	0.331	0.152	-0.079	-0.355
Freq. near object	0.406	0.080	-0.188	-0.181
Time near object	-0.347	0.169	0.259	-0.261
Lat. near object	-0.337	0.278	-0.448	-0.126
Freq. observing	0.094	-0.349	-0.503	-0.137
Time observing	0.137	0.581	0.234	0.142
Lat. to observe	0.182	0.543	-0.165	0.340
Freq. of contact	0.371	0.107	-0.249	-0.101
Time in contact	-0.403	0.118	0.042	-0.212
Lat. to contact	-0.315	0.274	-0.449	-0.221

Table 3. Spearman rank order correlation between factor scores calculated from components (C1 to C4) with Eigen values greater than 1. of all 4 tests (T1 to T4).

	T1 C1	T1 C2	T1 C3	T1 C4	T2 C1	T2 C2	T3 C1	T4 C1
T1 C2	0							
T1 C3	0	0						
T1 C4	0	0	0					
T2 C1	0.317	0.210	0.163	-0.025				
T2 C2	0.150	0.102	0.018	-0.092	0			
T3 C1	-0.096	-0.180	0.054	0.220	-0.190	-0.011		
T4 C1	0.195	0.070	-0.225	-0.031	0.053	-0.002	-0.147	
T4 C2	0.048	-0.081	-0.086	-0.016	-0.076	0.022	-0.058	0

Conclusions

We conclude that the gilts responded consistently to specific challenges, at least over a short period of time. There was no evidence however, of a limited number of behavioural types linking responses to different challenges.

Acknowledgements

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To what extent can animal welfare be measured?

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Introduction

The idea that animal welfare is associated with the subjective feelings of animals presents a problem for those wishing to adopt a scientific approach to assessing welfare. That is that the subjective experiences of animals are not open to direct, objective measurement (Dawkins, 1980). Scientists have generally adopted one of three possible approaches to this problem.

Firstly, one can argue that science has no part to play in the assessment of animal welfare. However, the danger of making recommendations for improving animal welfare which are not based on scientific evidence was demonstrated by Hughes and Black (1973). They showed that hens actually preferred a floor type condemned (without scientific evidence) by the Brambell Committee (Command Paper 2836, 1965) to the one that the committee recommended.

Secondly, one can define welfare in terms of what can be easily and objectively measured e.g. changes in heart rate. However, this is really just expediency i.e. this definition of welfare has an 'opportune' rather than 'theoretical' basis, and cannot be accepted as being valid.

Finally, one can accept that animal welfare is concerned with the subjective feelings of animals, whilst still ensuring that its study is based on a valid, scientific approach. This paper argues in favour of this latter approach, and considers the limits that should be placed on the scientific measurement and study of animal welfare.

A Cognitive Model for Animal Welfare

In the simplest 'cognitive' model of an animal's response (r) to an stimulus (s), there are two functions; one relating stimulus intensity to mental state (m, i.e. the level of 'pleasure' or 'aversion'), $f_{s,m}$, and the second relating mental state to level of response, $f_{m,r}$. Given that we cannot directly measure the animal's mental state, it is impossible to determine the shape of these functions. We can only measure the function relating stimulus intensity to level of response, $f_{s,r}$. However, we can consider to what extent welfare can be measured if we make certain assumptions about the shapes of $f_{s,m}$ and $f_{m,r}$.

If $f_{s,m}$ and $f_{m,r}$ were both linear (Figure 1a), the animals mental state could be measured on a continuous, interval scale. However, given that most biological functions are non-linear (e.g. growth, enzyme activity and learning are all non-linear), it is very unlikely that functions relating stimulus intensity, mental state and level of response would be linear. Consequently, mental state (and therefore welfare) cannot be measured on an interval scale. However, if we assume that both functions are monotonic (i.e. not necessarily linear but without changing from a positive to a negative slope or *vice versa*, Figure 1b), we can measure mental state (and therefore welfare) on an ordinal scale (i.e. it is possible to rank treatments). Is this a reasonable assumption? It is unlikely that $f_{s,m}$ is non-monotonic i.e. it is unlikely that as the intensity of a stimulus was increased it initially became more aversive, but then became less aversive. However, failure of avoidance learning at high levels of stimulus intensity has been reported (Theios, Lynch and Lowe, 1966) suggesting that $f_{m,r}$ is not necessarily monotonic. It is therefore important in any study to ensure that high levels of aversion are not interfering with the animals response at high levels of stimulus intensity (e.g. by recording level of response over a wide range of stimulus intensities).

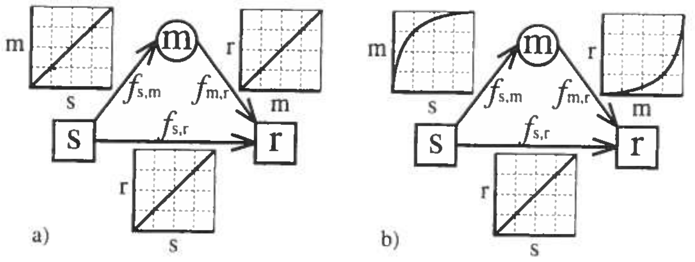

Figure 1. Two hypothetical models relating stimulus intensity (s), mental state (m) and level of response (r). Note that a linear stimulus-response function ($f_{s,r}$) does not necessarily result from linear stimulus-mental state ($f_{s,m}$) and mental state-response ($f_{m,r}$) functions.

Implications for Defining Welfare Standards

The fact that animal welfare can only be measured on an ordinal scale has implications for defining acceptable levels of animal suffering (or 'welfare standards'). Given that welfare cannot be measured on an interval scale, there can be no 'units' of welfare. Welfare standards would have to be set in relation to one or more specific treatments e.g. prohibiting any husbandry practice that was more aversive than a certain period of food deprivation.

The process of deciding exactly what level of animal suffering is acceptable is purely subjective; there is no way that this can be determined objectively. Consequently, welfare standards cannot (and should not) be defined by scientists. Indeed, any attempt by scientists to do this could prejudice the contribution that science can make, in that one research group could (and probably would) set completely different welfare standards to another. This would almost certainly result in the public loosing confidence in the scientist's role in the assessment of animal welfare in general. Welfare standards should, therefore, be defined by governments.

Summary

Animal welfare can, at best, be measured on an ordinal scale, although care must be taken to ensure that high levels of aversion are not interfering with the animal's response at high levels of stimulus intensity. Scientists should not attempt to define welfare standards; this should be the responsibility of government.

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Problems in measuring feeding motivation in sheep

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Introduction

The transportation of sheep deprives the animals of food for considerable periods. The effect on the welfare of the animals involved is as yet unclear. Sheep have been observed to spend the majority of the first 3 hours after unloading feeding (Jackson, 1993), suggesting this has a high priority. The measurement of motivation has become increasingly important in animal welfare as it attempts to provide objective measurements of subjective states. Two experiments were done in an attempt to measure the feeding motivation of sheep. Firstly using operant conditioning techniques, frequently used in motivation studies, and secondly using a push-door in an attempt to overcome some of the problems found with operant conditioning.

Experiment 1-The feeding motivation of sheep after food and/or water deprivation

Operant conditioning is a technique that has been successfully used with several farm species including pigs, poultry and sheep, with a variety of required responses (Kilgour et al., 1991). This experiment aimed to look at the feeding motivation of sheep after food and\or water deprivation of up to 24hrs, using pressing a panel with the nose to obtain small amounts of whole oats as a measure of the feeding motivation.

Materials and Methods

A group of 12 gentled Suffolk ewes were trained to use an operant crate that had previously been used with rams (Blisset et al., 1990). Each sheep was each exposed to 4 treatments (a control treatment involving no deprivation; food with no water; water with no food; no food and no water) for 4 deprivation lengths (6/12/18/24 hours) in a random order. Feeding motivation was tested by allowing the sheep access to the operant crate for 1 hour, with the crate running on a progressive ratio schedule. A session was considered finished when there was an interval between pushes of greater than 2 minutes.

Results

Only 3 out of the 12 sheep became fully trained. Results from these animals found no differences between treatments, but there was high individual variation .

Experiment 2-The feeding motivation of sheep after food deprivation using a push-door

Push-doors have been used with chickens to assess a number of motivational strengths (Duncan & Kite, 1987; Petherick & Rutter, 1990). The response required of the animals is primarily locomotion, one that is more naturalistic than that of the previous experiment. This experiment aimed to look at the strength of feeding motivation in sheep after deprivation times of up to 24 hours.

Materials and Methods

Ten gentled sheep were trained to use a push-door to reach food. Each sheep was exposed to 6 treatments (control1-no food deprivation; control2-no food deprivation; 6 hours food deprivation; 12hrs food deprivation; 18hrs food deprivation and 24hrs food deprivation). On completion of a treatment, the sheep were moved to a test pen, and then released into a race with the push-door at the end. Time to enter the race, reach the door, reach the food and the rate of push were recorded. This was repeated 5 times with the door at 5 levels (unweighted; +4.4kg; +8.8kg; +13.2kg and +17.6kg). Control1 differed from control2 in that there was no food beyond the push-door. Chi-square tests were performed, comparing food-deprived with non-food deprived, and control1 with control2.

Results

Food deprivation resulted in more sheep going through the push-door (***), with all sheep going through the door when food deprived. For the controls, more sheep went through the door when food was present in the reward pen (***). For those that went through the door, the mean time to reach the food was lower for the treatments involving food deprivation. No differences were found in the mean time to reach food at the different weightings of the door.

Conclusions

In experiment 1, isolation was found to be a problem when training the sheep. This has been shown to be aversive to sheep (Douglas-Hudson, 1992). Leaving the crate open, so the sheep could enter and leave as they wished, resulted in the sheep being presented with a choice: remain with another sheep or obtain food.

There were also problems attracting sheep to the switches. Attempts to increase the attractiveness and visibility of the switches did not increase the number of sheep becoming trained. It has been suggested that incompatabilies between response and reinforcer make it difficult to train animals to make operant responses to obtain rewards (Dawkins, 1990).

Experiment 2 attempted to overcome this by using a response more closely related to the feeding behaviour of sheep. More sheep learnt the task, suggesting that it is more appropriate than the response required by the operant crate. Food deprivation increased the number of animals completing the task, and the speed at which they did so, suggesting a stronger motivation to feed exists after only 6 hours without food. Further improvements to the door may enable distinctions to be made between different lengths of food deprivation, if differences do exist.

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Chicken vocalisations as indicators of physical and psychological condition: a detailed analysis

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Introduction

Signals of animals could be indicators of feelings and/or emotions (i.e. emotional expressions), although interpretation of the meaning of these signals remains a problem. They can be a reliable indicator of underlying emotions, but can also be used by the sender to deceive the receiver (Gyger and Marler, 1988). Thus, the variations in the use of vocalisations can be dependent not only on the context in which we are interested, but also on the honesty (goal) of the animal. Interpretation of vocalisations is therefore difficult. Discrete (stereotyped) calls may contain global information, for example about the individual and its condition. Graded (variable) calls may contain local (or actual) information, for example about the motivation of an animal. An example of a discrete vocalisation is the crow of a rooster. It is thought to be a means of declaring the presence of a territory and may be an indication of the rooster's strength. The temporal relations between crows in a sequence show that the last note of the call is the most probable indicator of strength (Koene, in press). Some hen sounds correlate well with aspects of the bird's environment, i.e. hens consistently produce the laying call (Konishi, 1963) when they are deprived of a laying nest, but also after deprivation of a dustbath (Koene and Wiepkema, 1991). In battery cages, this sound occurs more than in straw yard systems (Huber and Fölsch, 1978) and is interpreted as an indication of increased frustration and decreased welfare. To investigate to what degree information can be extracted from vocalisations, a comparative frequency analysis of a stereotyped (crow) call and a graded call (laying call) was carried out.

Materials and Methods

The analysis was carried out with the Signal sound analysis system (Engineering Design, 1992) that incorporates a macro language to analyse large amounts of vocalisations. The crows of one single red Burmese jungle fowl *Gallus gallus spadiceus* rooster were recorded. A microphone and a light bulb were located in the ridge of its roost. During the night at 5 o'clock an automated timer switched on the light bulb and a cassette recorder. The rooster started crowing (four notes) after the light went on and audio recordings were made. Laying calls of one red jungle fowl hen were collected during the day (the first four notes of each call were used). The time signal of a call was analysed as follows: the envelope was determined, smoothed, the gate function was determined, i.e. the signal was detected relative to a amplitude threshold (rms power) and the onset and offset locations in the gate function were determined, i.e. the starting and ending points of the notes and intervals within the calls. The fundamental frequency of each note was determined by analysis of the power spectrum. Comparison between crows and laying calls was performed visually.

Results

Crows (n=124) were very characteristic: the third note was the longest. There was little variation in note duration: the last two notes showed most variation (figure 1: left panel). The fundamental frequency was consistent in each note: the second note had the highest fundamental frequency (figure 1: right panel). Frequency variation increased in the last 2 notes. Durations of individual notes were not related; frequencies of the four notes were positively correlated (table 1). Laying calls (n=119) were very variable and there was a high degree of variation in note duration (figure 1: left panel); the last two notes show less variation than the first two (figure 1: left panel). The fundamental frequency was very variable in each note (figure 1: right panel). The durations of the second, third and fourth note in the laying call were strongly related (table 1). The duration of the first note was negatively correlated with the frequency: the longer the first note the lower the fundamental frequency. Other correlations were difficult to interpret.

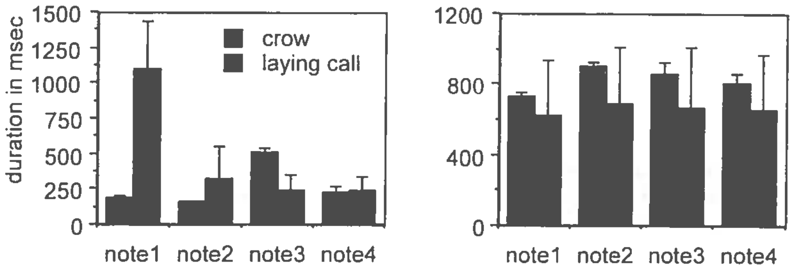

Figure 1. Mean duration and standard deviation (left panel) and mean fundamental frequency and standard deviation (right panel) of the four notes of the roosters' crow and the first four notes of the hens' laying call.

Table 1. Correlations between note durations (dur) and fundamental frequencies (frq) in the rooster (above diagonal) and in the hen (below diagonal).

	dur1	dur2	dur3	dur4	frq1	frq2	frq3	frq4
dur1	.	.00	.12	-.05	.07	.20*	.00	.22*
dur2	-.11	.	-.18*	-.17	.40***	.19*	.24*	.04
dur3	-.02	.52***	.	-.04	.02	.16	-.17	.18
dur4	.13	.45***	.45***	.	-.08	-.24***	-.16	.11
frq1	-.25***	.19*	.14	-.05	.	.30***	.33***	.28***
frq2	-.06	-.04	.02	-.06	.06	.	.24***	.22***
frq3	-.03	.17	.09	-.05	.05	.15	.	.19*
frq4	-.04	-.09	-.09	-.01	-.06	.15	.14	.

Conclusions

In conclusion, the crow of the rooster is a highly stereotyped call with strong frequency relations and with more variation in the duration in the last notes. The laying call is a very variable call with strong temporal relations in the last notes and more variation in the first note. Comparison between both calls shows more variation in the laying call which makes it more suitable for quickly changing information transfer, especially in the first long note. The higher variation in duration in the last note of the crow of the rooster could be an possible indication of tiredness and thus of condition (Koene, in press). Experiments in which the condition and the motivation of roosters and hens are influenced are imperative. The automated analysis of call parameters appears to be efficient.

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Development of a protocol for the welfare assessment of group-housed dry sows

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Introduction

A simple and robust protocol for assessing sow behaviour and welfare was developed for use in a wide variety of commercial housing systems. This was part of a project designed to build up a file of "case studies" of group housing systems, to be used as reference material by scientists, pig producers and advisers.

Material and Methods

In summary, the protocol included assessment of the following: general activity, feeding/rooting behaviour, agonistic interactions, skin damage and body condition. Nine systems were assessed in total, consisting of two wet, two trickle, and five floor feeding systems (either dump or manual). In all systems, with the exception of one large group study, a minimum of five groups were observed. Groups had been established for at least a week before observations began, so results were not affected by recent mixing. Observation of each system was conducted over a two-week period. Sows were always observed in the two hours following food drop. Group size varied from five to 72. In those systems with more than 35 sows, a random sub-sample of 15-20 sows was observed.

General activity was recorded during the two hour interval post food-drop. Each pen was divided into a number of functional regions (e.g. feeding, dunging/drinking) and the position, posture and activity of all sows were recorded at five minute intervals. The time and nature of all agonistic interactions occurring during observation were recorded. For the purposes of this work, individual sow identity was not recorded, but this would be possible. The interaction categories were, head swing with closed mouth, head swing with open mouth, push, bite/slash, attempted bite/slash, vulva bite, chase and fight (any combination of the above lasting more than 10 seconds). Fresh skin lesions (i.e. pink or bleeding) were recorded at the end of the second observation period, using a method adapted from Stewart *et al*, 1993. Lesions were recorded as a scale of one to five, referring to the number of lesions on the epidermis, and the body was considered as eight regions (face, ears, neck, shoulder, flank, rump, vulva and tail). Body condition was recorded on a nine point scale from one to five with increments of 0 5, based on Whittemore (1980).

Because of the close relationship between environment and pig behaviour, background information on building environment was recorded in all cases studies. Temperatures inside and outside the building, air speed and ventilation patterns were recorded during the course of each case study, using maximum/minimum thermometers and smoke tubes. Levels of noxious gases (CO_2, CO, NH_3 and H_2S) were recorded using gas detector tubes and a fixed volume aspirator.

Results

In the first two systems studied, each group was observed three times. This was subsequently reduced to two, as within-pen variation in behaviour from day to day was not high (Spearman's rho = 0.7 or higher).

The results of one case study are reported below to provide an indication of the range of values which may be expected using this protocol. A dump feeding system was installed in a converted stall house, in which pregnant sows were housed in groups of 35, from five weeks post service onwards. Each group was fed via six dump feeders, each of which dispensed a ring of pelleted feed approximately 1.5m in diameter. Total area per sow varied from 1.84 to 2.32 m^2, compared to the PWAG (1993) recommendation of 2.33 m^2 per sow.

Table 1. Behavioural characteristics of groups of 35 sows in a dump-feeding system

	mean	s.d.
proportion of sows lying one hour post-food drop	0.22	
rate of agonistic interactions (no./sow/h)	2.52	2.35
mean skin lesion score	2.05	0.35
body condition score	3.2	0.35

Comparison within pens between days, and between pens displayed high levels of correlation in terms of sows settling over time (Spearman's rho ranging from 0.64 to 0.93, $P < 0.001$). Data were pooled to give a predictive pattern for sows settling to lie following feeding.

The majority of skin lesions occurred on the shoulder and flank. The bite/slash and attempted bite/slash accounted for 0.74 of all agonistic interactions recorded. The distribution of skin lesions is contained in Table 2.

Table 2. Distribution of skin lesion scores

region of body	proportion of scores*
shoulder and flank	0.70
neck	0.11
face, ears, rump and tail	0.29

* All differences between proportions in Table 2 are significant (two-sample t-test, $P<0.05$)

Discussion

The method has proved reliable and is applicable to a wide variety of housing systems. One of the most useful measures has been the calculation of "settling time", defines as the time taken for half of all sows in a group to lie down following food drop. In general, sows kept in small groups, and/or trough fed settled two to three times as quickly compared to floor-fed sows such as the group described above. In future assessments, skin lesion scoring methods will be simplified and more accurate estimates of condition will be made using ultrasonic backfat measurements. Otherwise, the protocol will be used, with minor modifications.

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Field-use of a hand-held global positioning system (GPS)

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Introduction

Global Positioning Systems (GPS) were developed by the U.S. government to provide consistent, reliable information for use in military navigation, the receipt of which would be unaffected by rough terrain or bad weather. They have been used in the U.K. to study the movements of sheep (Rutter et al, 1993) and in vegetation mapping (D.G.Raffaelli, pers. comm.). GPS Satellite transmissions available to civilians vary according to Selective Availability (SA), a random error introduced by the U.S. Department of Defence for security reasons. The size of this error varies, but rarely exceeds 100 m (Magellan Systems Corporation, 1993). This study assessed a hand-held GPS receiver during an investigation of the movements of ponies in an enclosed area of moorland (40 acres).

Materials and Methods

1. Co-ordinate drift. A Magellan Meridian GPS Satellite Navigator (Forth Area Marine Electronics Ltd., Edinburgh), with an operating accuracy of 12 - 25 m without SA, was used to determine the 3D co-ordinates of a fixed point at 2 h intervals to assess co-ordinate drift over time. Universe Transverse Mercator (UTM) Eastings and Northings were used in preference to degrees latitude and longitude, since UTM is equivalent to distance in metres. Altitude was displayed as metres above sea level. UTM at time zero was compared to UTM at zero + 2 h for 30 pairs of 3D co-ordinates (Table 1) over a period of 2 weeks.

2. Distance travelled. A total of 70 data sets were collected over 2 weeks using the following protocol. The position fix of a pony was recorded every 15 mins over a period of 2 h using both 2D GPS and Ordnance Survey National Grid (within 100m quadrats). Both GPS and quadrat data were analysed using a commercial package "Wildtrack"$ to determine the distances travelled by the ponies (8). The methods were compared on the basis of the number of 100m quadrats entered by an animal within each 2 h period (Table 2).

Results

1. Co-ordinate drift. Eighty percent of Easting and Northing deviations fell within a radius of 50m from the original position. Even though SA was in operation the median value in each case, 24.5m, was close to the upper range of operating accuracy (25m) suggested by the manufacturer in the absence of SA. The deviation in altitude ranged between zero and 293m.

2. Distance travelled. When the mean distance travelled, as calculated from GPS data, was compared to that calculated from 100m quadrats the differences ranged from 154m (± 99m s.d.) to 206.5 (± 190.3m s.d.). GPS distances were consistently the greater of the two values, the reverse was true in only 4 cases, 2 in the 4 quadrat category and 1 each in the 5 and 6 quadrat categories (see Table 2).

Table 1. Deviations[1] (m) in the position fix of a stationary object according to 30 sets of GPS coordinates (UTM) taken at time zero and zero + 2 h.

	Easting deviation	Northing deviation	Vertical deviation
Minimum	2	2	0
Maximum	189	160	293
Median	24.5	24.5	54.5
Quartile 1	13.5	16.75	31.2
Quartile 3	35.5	50.75	88.5
n	30	30	30

[1] Deviations were regarded as positive integers whether East, West, North, South, up or down.

Table 2. A comparison of the distance travelled (m) by ponies in 2 h according to 2 methods of location: 2D GPS and 100m quadrats (based on the number of quadrats entered within 2 h).

No. of quadrats entered in 2 h	n	Mean distance travelled (m) according to:- 100m quadrats	GPS	Difference	(+/- s.d.)
0	10	0	154	154	99
1	10	116.52	330.1	213.6	131.1
2	10	204.13	393.5	189.4	75
3	10	312.39	472.9	190.9	79.4
4	10	420.67	478.6	160.5	90.3
5	10	576.0	755.5	179.5	123.9
6	10	668.32	874.8	206.5	190.3

Conclusion

This study has shown that a hand-held GPS receiver was inaccurate in locating animals in small areas. However it may be useful in situations where animals are migrating or hunting over large distances. When used in combination with Differential Beacon Receivers, GPS technology can give accuracies of 1m or better for 90% of fixes (Rutter et al, 1993).

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Aversion of broiler chickens to whole-body vibration using a passive avoidance technique

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Introduction

Scott (1994) suggested that the levels of vibration which occur during transport are potential sources of stress to broiler birds due to likely resonances in their internal organs. Indeed, Rutter and Randall (1993) showed that domestic fowl found whole-body horizontal vibration of 1Hz (1.52 m/s^2) and 0.5Hz (0.59 m/s^2) aversive and slightly aversive respectively. Studies of human response to vibration involve imparting single frequency motion in a given direction (for example, vertical or horizontal) and quantifying the response. Rutter and Randall (1993) utilised a passive avoidance technique to quantitatively measure the level of aversion of birds to the specific vibratory motions. In their experiments sinusoidal fixed frequency horizontal motion was used. This type of motion is very regular and perhaps uncharacteristic of the transport journey. A different approach would be to use a random narrow band of frequencies. This would produce an irregular motion perhaps more akin to transporter motion. The aim of this experiment was first to validate the technique and ensure that differentiation between three levels of vertical motion could be achieved. The second aim was to compare sinusoidal fixed frequency motion with random narrow band frequency motion.

Materials and methods

Birds were obtained from a commercial farm, singly housed and allowed to habituate to their novel environment. Once habituated, birds were maintained at approximately 75% of their ad libitum weight. The response of broiler chickens was obtained each day during a two hour session using a variable ratio 20 schedule of food reinforcement. Birds responded by pecking a key (a plastic disc) between 1 and 39 times per food reward. Concurrently, treated birds were exposed to 30 seconds of vertical motion following every 20th key peck. Only if the animal continued to respond did it receive the aversive stimulus (motion) again. The bird was therefore in conflict between the motivation to respond for food and the motivation to stop responding and avoid motion. Food intake was supplemented at the end of every session to maintain weight.

In the first experiment 9 birds were randomly allocated to one of three treatments: 3Hz, 5Hz or 10Hz fixed frequency motion at 1.5m/s^2 rms acceleration.

In the second experiment 20 birds were randomly allocated to one of four treatments: 5Hz fixed frequency motion, 4.5-5.5Hz narrow band random motion, 10Hz fixed frequency motion or 9-11Hz narrow band random motion again all at 1.5m/s^2 rms acceleration.

The degree of suppression of the behavioural response reflects the intensity and duration of the aversive stimulus. Cumulative number of pecks were recorded automatically, and each bird acted as its own control. Data were log transformed and analysed using a mixed model ANOVA.

Results

In the first experiment there was no suppression in responding with exposure to two frequencies of sinusoidal motion: 3Hz (1.5m/s^2) and 10Hz (1.5m/s^2). At a third frequency, 5Hz (1.5m/s^2), there was significant suppression in responding (F=4.49;df=2;$P<0.05$) indicating that differentiation between treatments was possible.

In the second experiment response was not affected by exposure to 10Hz (1.5m/s^2) sinusoidal fixed frequency motion or 9-11Hz (1.5m/s^2) narrow band random motion. At the lower frequency, response appeared to be suppressed following 5Hz (1.5m/s^2) sinusoidal motion but it was significantly so following 4.5-5.5Hz (1.5m/s^2) narrow band motion (F=3.49; df=3;$P<0.05$, Figure 1).

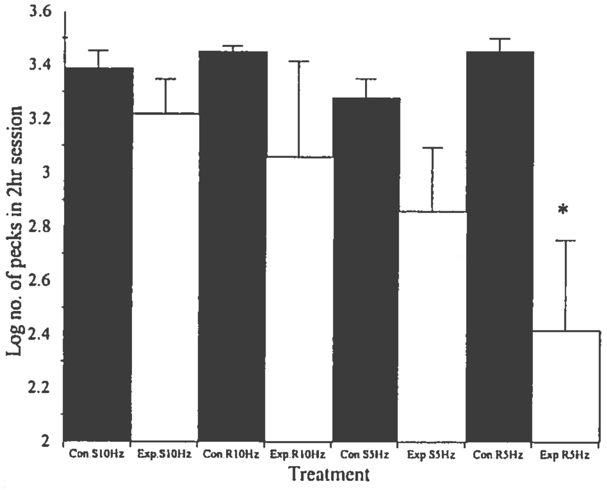

Figure 1. Comparison of fixed frequency sinusoidal motion (S) with random narrow band motion (R) at two frequencies 5Hz (1.5m/s^2) and 10Hz (1.5m/s^2). Control data are represented by black bars and treatment data by white bars. Values are the mean ± SEM of 5 birds. Significant differences are represented by asterisks ($P<0.05$ vs control).

Conclusion

Differentiation between treatments was possible and results showed that 5Hz was more aversive than 3Hz and 10Hz. Sinusoidal motion, however, is highly regular and predictable. Perhaps a better method for assessing aversion is to use a random narrow band motion which is less predictable and may be more characteristic of the transport journey. Indeed, results indicated that at the lower frequency aversion occurred to random narrow band motion and not to sinusoidal motion. This is likely caused by the greater displacement of the platform for a given value of r.m.s. acceleration at the lower frequencies and consequently birds may be able to distinguish between the two types of motion.

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Effect of food deprivation upon aversion of broilers to whole-body vertical vibration

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Introduction

A passive avoidance operant conditioning technique which superimposes a fixed ratio motion schedule over a variable ratio reinforcement schedule can be used to study aversion of broiler birds to whole-body vibration (Rutter and Randall, 1993). Such variable ratio reinforcement schedules are characterised by high pecking response rates with little pausing either after reinforcement or at other times. The potency of the appetitive reinforcer, food, is thought to depend upon deprivation from that reinforcer. Ferster and Skinner (1957) found that the average post-reinforcement pause (PRP) increased with increasing body weight of a pigeon, although running response rates were less affected.

If motivation is thought to depend upon the level of deprivation from the reinforcer, it is reasonable to assume that such deprivation will also increase resistance of an animal to the aversive stimulus. Azrin et al. (1963) varied the pigeons body weight during sessions in which food reinforced responding was punished with electric shock. Suppression was least when the birds were maintained at 60% of their ad libitum weights but was progressively reduced as body weights were increased to 85%.

The aim of the following experiment was to assess whether the level of deprivation from food affects aversion of broiler chickens to whole-body vertical vibration in the passive avoidance technique. This would affect long term experimental protocols since broilers kept at, for example, 60% of their free-feeding weight may render the technique insensitive to varying levels of vibration.

Materials and Methods

Birds were obtained from a commercial farm, singly housed and allowed to habituate to their novel environment for at least 5 days. At 28 days old birds were randomly allocated to one of three feeding regimes which maintained them at 65%, 75% or 90% of their free-feeding weight.

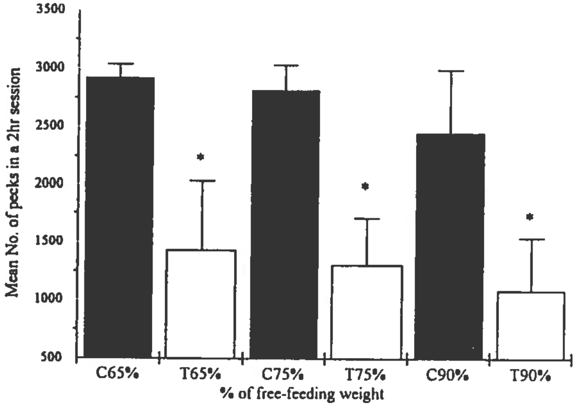
The response of the broiler chickens was obtained using a variable-ratio 20 schedule of reinforcement where birds responded by pecking a key (a plastic disc) between 1 and 39 times per food reward. Concurrently, treated birds were exposed to 30 seconds of random vertical motion of 4.5-5.5 Hz; 1.5 m/s^2 rms following every 20th key peck. Only if the animal continued to respond did it receive the aversive stimulus (motion) again. The bird was therefore in conflict between the motivation to respond for food and the motivation to stop responding and avoid motion.

The degree of suppression of the behavioural response reflects the intensity and duration of the aversive stimulus. Cumulative number of pecks were automatically recorded, and each bird acted as its own control. A mixed model analysis of variance was performed to assess the effects of the three deprivation levels.

Results

In all cases significant suppression in responding occurred following exposure to treatment ($P<0.05$). However, the level of deprivation (65%, 75% or 90% of free-feeding weight) does not affect the amount of suppression which occurs to the experimental treatment (Fpr=0.922; Fig.1).

Figure 1. Effect of three levels of food deprivation upon aversion of broiler chickens to random vertical motion of 4.5-5.5 Hz; 1.5 m/s^2rms acceleration. Values are the mean +/- SEM of 7 birds.



Conclusion

In contrast to results found with other species where suppression in responding is dependant upon deprivation level, this experiment indicates that this effect is not so clear in broiler chickens. Experimental results indicate that when birds are exposed to random vertical motion of 4.5-5.5 Hz, 1.5 m/s^2 rms acceleration, suppression in responding is not affected by deprivation level. One of three conclusions may be drawn from this interesting result. The number of birds used in this experiment may need to be increased so that any differences become apparent. The aversive stimulus used was too severe and therfore all birds suppressed responding accordingly. Or, broiler birds deprived of food are so highly motivated to obtain the reward that the level of deprivation does not increase resistance to the aversive stimulus.

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Estimation of herbage intake by dairy cows from measurements of grazing behaviour and weight change

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Introduction

For many years intake of herbage by grazing ruminants has been estimated from measurements of faecal output and the digestibility of the ingested material (Le Du and Penning, 1982). The principal limitation of such techniques is that in order to provide an accurate measurement of faecal output they require a relatively constant daily rate of herbage intake over several days. Where faecal output is estimated by dilution of an external marker, this period is further extended due to the requirement for prior dosing to achieve equilibrium in the rate of marker excretion. In many grazing experiments it is impossible to maintain sward conditions in a steady state for such a time without manipulation of grazing pressure, which may itself compromise the investigation being conducted. Furthermore, overestimation of faecal output can occur from incomplete recovery of the marker, and errors in determination of digestibility can lead to incorrect intake values.

An alternative method is to estimate intake as the product of total time (minutes day^{-1}) spent grazing, and intake rate (g $minute^{-1}$) estimated from the animal's change in weight over a 1-hour period of grazing. This method, developed and employed successfully with sheep since 1983 (Penning and Hooper, 1985), is currently being used for work with dairy cows.

Materials and methods

Grazing, ruminating and idling behaviour are measured over a 24-hour period using miniature tape recorders to record signals from nose-band transducers. The tapes are then processed through a replay unit (Huckle, Clements and Penning, 1989) to define the temporal patterns of grazing, and to measure the total time and number of grazing jaw movements.

To estimate intake rate accurately from measurements of the cows' weight change, correction must by made for the rate of insensible weight loss (IWL) by the cow, i.e. due to gaseous and evaporative losses. Weight changes due to ingestion and IWL are measured over periods of 1 hour. Cows are weighed at the beginning and end of the measurement period, using a 1.5-tonne capacity electronic balance (K-tron) interfaced to a portable computer (Husky Hunter), providing an accuracy of ±60 g. The precise time spent grazing during the hour that the cow spends at pasture is measured using the tape recorders. Excreta are collected in bags held in position with light-weight harnesses.

Results

Since rate of IWL cannot be measured simultaneously with weight change during ingestion, it is essential that estimates of rate of IWL are as representative as possible of that occurring during grazing. Climatic factors influence the rate of evaporative losses contributing to IWL. Regression analyses have shown that an increase in relative humidity of 10% reduces rate of IWL by 2.3 g $minute^{-1}$, whilst an increase in air temperature of 1°C increases rate of IWL by 0.9 g $minute^{-1}$. Thus, rate of IWL should be measured under climatic conditions as close as possible to those pertaining during measurement of intake rate.

In addition, activity and physiological state may influence the rate of IWL. Muscular activity increases heat production and evaporative losses. When walking at a speed of 50 metres minute^{-1} for distances of 1.2, 1.8, 2.4 and 3.0 km rates of IWL were 38.2, 29.1, 30.4 and 34.7 g minute^{-1} compared with 14.5 g minute^{-1} for cows whilst standing. During the subsequent hour evaporative losses were still elevated at 19.7, 21.3, 19.0 and 30.4 compared to 16.2 g minute^{-1} for cows at rest. Thus, distances travelled between different treatment paddocks need to be kept short and as similar as possible.

Figure 1 shows the temporal pattern of grazing activity by six cows over a 24-hour period.

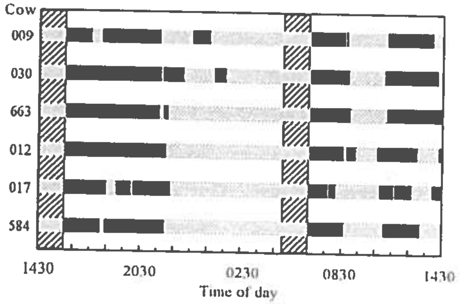

Fig.1. Example of daily pattern of grazing ■ and non-grazing □ activity, with cows removed from pasture between 0500 and 0630 h, and 1430 and 1500 h for milking ▨.

Typically, dairy cows between weeks 11 and 15 of lactation, when grazing grass swards with a surface height of 7 cm, spend a total of 604 minutes grazing in 24 hours, with an organic matter intake rate of 23.5 g minute^{-1}, thus achieving a daily organic matter intake of 14.1 kg.

Conclusions

The technique described provides an accurate estimate of herbage intake from measurement of total grazing time and intake rate, together with information on the mechanics of grazing. However, care must be taken: (1) to measure grazing time and weights accurately; (2) to measure rate of IWL under climatic conditions comparable to those during measurement of intake rate; (3) to measure rates of IWL and intake during periods of the day when the cow would normally be idling and grazing, respectively; (4) to reduce differences in rate of IWL between treatments, for example, due to walking.

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Time budgets of zoo mammals in relation to housing: an application of correspondence analysis

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Introduction

Time budgets of animals reflect the daily habits of animals. General behavioural categories are correlated with the necessary functions an animal has to fulfil to maintain homeostasis; e.g. feeding, vigilance and resting are important behavioural categories and are often on a tight budget in nature. Time is necessary for survival, i.e. feeding can limit resting behaviour and social behaviour and can result in animals in habitats of poor quality appearing to live under 'ecological stress' (Dunbar, 1992). Animals in captivity show time budgets that are less tight but still reflect the influences of housing (physical or social; Koene, 1995), maintenance, behaviour of caretakers (Bock, 1990; Koene and Janssen, 1994) and of the public. Time budgets of free-living animals and captive animals will generally show large differences resulting from the different living conditions and constraints. The time budgets of free living animals are sometimes used as a baseline for estimating the welfare of captive animals (Dawkins, 1989). Thus, a comparative approach of time budgets in relation to environmental conditions can indicate the relative welfare of the animals we are keeping (i.e. the amount of 'ethological stress').

Materials and Methods

Data from 185 animals were collected (of which 24 were elephants). The behaviours of each species were put in 12 (functional) behavioural categories that were based on Tembrock (1980) with a number of additions: adaptation in space (1: identification label = space), adaptation in time (2: time), sexual and reproductive behaviour (3: sex), social behaviour, i.e. positive (4: 'socpos') and negative (5: 'socneg'), seeking shelter (6: hide), exploration and play behaviour (7: 'info') care giving or care taking behaviour (8: care), and behaviour related to metabolism (9: metabolism). Further categories were: deviant behaviour (10: deviant) and stereotypies (11: 'stereo'), and miscellaneous behaviour (12: other). The observation procedure consisted of several stages within one week: exploration (Monday), i.e., interview with the zoo biologist(s) and the relevant zoo keeper(s), explore the zoo and the relevant enclosure(s), make a description of the enclosure(s), and determine which animals will be observed. Data were collected according to the following procedure: Tuesday: making short continuous protocols (5 minutes duration), Wednesday: scanning (instantaneous and scan sampling the behaviour of the selected animals in each enclosure and walking in-between or scanning one group of one species), Thursday: as on Tuesday, and Friday: the same as on Wednesday. One 'post' scanning day was carried out after at least a 14 day interval. Time budgets of each animal were calculated based on the scans of at least 3 days and on the short continuous records. All behavioural elements were assigned to one of the 12 functional behavioural categories. A data matrix (contingency table of measured frequencies) was produced with individuals, behaviours, and housing conditions (see Boy and Duncan, 1979). Multiple Correspondence Analysis (proc CORRESP: SAS, 1990) was carried out to reveal relationships between the time budgets of different individuals, different species and different housing conditions. The results are points in multidimensional space, which are often presented as points in a two dimensional graph. Proximity of the points in the graph indicates the level of association of the items in the table. Dimensions of the space could be interpreted and labeled.

Results

The difference between abnormal ('stereo' plus deviant) and normal (others) behaviours is shown in detail in figure 1. There were strong behavioural differences between males and females. In zoos 1 and 3 (the smaller ones with fewer animals) more abnormal behaviour was found especially in the male (the two dimensions of the plot could be interpreted as the sex difference and the enclosure size; highly correlated with number of animals and the normal-abnormal behavioural dimension).

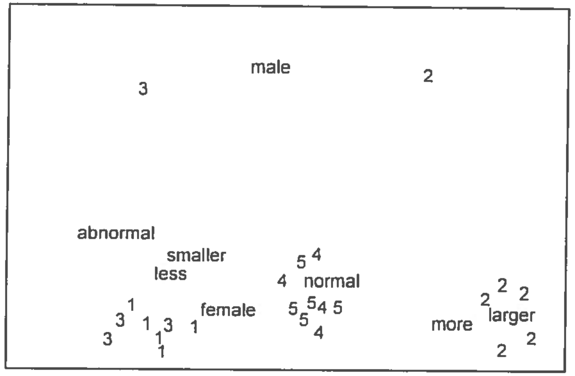

Figure 1. Individual time budgets of elephants split in two behavioural categories (normal vs. abnormal) in relation the factors sex (male vs female), relative size of the enclosure ('relsize': larger vs. smaller than average) and relative number of conspecifics ('relsoc': more vs less than average). Each digit represents one individual in one of the five zoos. The graph is based on multiple correspondence analysis with the factors individual, behaviour, sex, 'relsize', 'relsoc'. See text for tentative interpretation of both axes.

Conclusion

Time budgets of different species and different individuals were compared the effects of keeping condition (physical and social) on the behaviour of zoo animals was estimated. Abnormal behaviour in elephants appears to be associated with small enclosures and fewer animals. By characterising animals by their time budget it is possible to pinpoint abnormal individuals and find the causes of their abnormalities (using data collected concerning housing and maintenance). The time-budgets of animals can be used to assess and ameliorate the quality of life in the zoo.

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GABAergic modulation of behaviour in restricted-fed broiler breeders

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Introduction

Growing parent stock (breeders) of meat-type chickens (broilers) are fed routinely on restricted rations in order to limit their body weight at sexual maturity. As a consequence, they show stereotyped oral behaviour directed at non-food objects, and their expression of this behaviour is correlated positively with the level of food restriction imposed (Savory and Maros 1993). From earlier work it was concluded that this behaviour is mainly under the control of the central dopaminergic system, and that adrenergic and opioid peptide mechanisms may play a contributory role (Kostal and Savory 1994, Savory and Kostal 1994).

GABA (γ-aminobutyric acid) is an inhibitory neurotransmitter, and there is substantial evidence of functional interactions between GABAergic and dopaminergic pathways in the brain. One hypothesis proposes that GABA regulates activity of dopamine cell bodies in the substantia nigra via a striatonigral feedback loop (Paredes and Agmo 1992). Another suggests that dopamine controls activity of the striatonigral GABAergic pathway, and hence GABA-mediated inhibition of non-dopaminergic efferent neurons in the substantia nigra (Scheel-Kruger 1986). There appears to have been no previous investigation of involvement of GABA in control of environmentally induced stereotypies, and the work described here was intended to see whether pharmacological manipulation of GABA-A and GABA-B receptor subtypes with preferential antagonists (Experiment 1) and agonists (Experiment 2) influences the oral stereotypies of broiler breeders.

Materials and Methods

In each experiment, 8 immature female broiler breeders (Ross Breeders Ltd., Midlothian, UK) were caged individually and fed daily according to a commercial programme of food restriction. They received 8 intravenous injection treatments (2 drugs at 3 doses and 2 saline controls) on 8 days over 3 weeks, each bird receiving a different treatment on each day according to a Latin square design. The antagonists tested in Experiment 1 were bicuculline (GABA-A) and 5-aminovaleric acid (GABA-B), and the agonists in Experiment 2 were muscimol (GABA-A) and baclofen (GABA-B). Feeding time was 09.00 h, food was all eaten in 10 min, injections were 1 h after feeding, and behaviour was recorded on videotape for 3 h after injection. Measurements were made from the videorecordings in alternate 15-min periods, by noting each bird's behaviour every minute according to one of six categories: sitting, standing, pacing, preening, object pecking, or drinker directed activity. The last two activities were stereotyped in form.

Results and Discussion

The only significant ($P<0.05$) effects on behaviour were with the GABA-A agonist muscimol. The high dose (1 mg/kg) caused increased sitting and standing, and decreased preening, in the first hour after injection, while the medium dose (0.2 mg/kg) caused increased pacing in the third hour. Similar biphasic action of muscimol on motor activity has been reported in mice (Tirelli et al 1991). Although the oral stereotypies of broiler breeders were not affected significantly, there appeared to be some suppression of object pecking with the high dose of muscimol, and some stimulation of object pecking with the antagonists bicuculline (GABA-A) and 5-aminovaleric acid (GABA-B). Central injection of bicuculline has been found to stimulate stereotyped behaviour in fowls (Nistico 1980).

Conclusion

There were no significant effects of GABAergic compounds on the oral stereotypies of restricted-fed broiler breeders within the range of doses tested.

Acknowledgement

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Basal heart rate of group-housed sows in relation to stage of gestation

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Introduction

Heart rate has been acknowledged as a useful indicator of an animal's internal physiological state (Fraser and Broom, 1990) and has been widely used in studies on a number of species. Heart rate is affected by posture, locomotion, individual identity and seasonality. In sheep and deer, the seasonal effects on heart rate have been attributed to the seasonal changes seen in food intake (Kay, 1979) and basal metabolic rate (Blaxter and Boyne, 1982). The majority of breeding sows, however, are housed indoors and protected from environmental extremes. Most are fed a restricted diet with changes in food intake dependent on stage of gestation and lactation. The aim of this experiment was to determine the effect of stage of gestation on the basal heart rate of sows.

Animals, materials and methods

The heart rates of 6 LW x Landrace sows, of similar age and parity and housed in a group of 37 sows in a single pen (16.5m x 5.5m), were monitored using a Polar Sport Tester™. The pen was divided into a strawed lying area and a dunging area, part of which was occupied by an Electronic Sow Feeder system. The feeding cycle started daily at 1500hrs and all sows were fed between 2.2kg and 4kg per day, depending on stage of gestation. Water was available *ad libitum*. The housing system was thermostatically ventilated by two fans and was lit both by natural daylight and artificial lighting with lights switched on at 0600hrs and off at 2200hrs, ensuring similar daily temperature and daylength throughout the period of study.

The heart rate monitor consisted of an electrode belt, a clip-on transmitter and a wrist-watch receiver with data memory function. ECG Gel was applied to the electrode surfaces and the belt was placed around the thorax of the sow, caudal to the forelimbs. The signal was tested and the receiver was then fastened around the belt and activated to start recording. After completion of data collection, the receiver was downloaded via a Polar Interface and the data were displayed using Polar Heart Rate Analysis Software - Version 4.00.

Each sow was monitored on five occasions (days i-v) at intervals of approximately 20 days over four consecutive months. Heart rate and behaviour were measured continuously between 0900 hrs and 1140 hrs, the period during which sows were least active. From the behavioural data, the periods of lying with eyes closed, which equated to basal heart rate, were marked on the resulting heart rate graphs. The corresponding numerical data were then analysed to give a daily mean basal heart rate from 3 x 10 minute periods for each sow on each day.

Results

Individually, the sows showed an increasing basal heart rate as gestation progressed towards full term (see Table 1). The rate of increase also became greater as pregnancy progressed but total basal heart rate change over gestation was not correlated with litter size. When stage of gestation and basal heart rate were correlated for individual sows, the best fit was obtained using second order polynomial regression. For three sows, the line of best fit was significant and for the other three, the line of best fit tended towards significance.

Table 1. Basal heart rate (beats per minute) and stage of gestation (days after service) for individual sows on five separate days.

Day	Sow A	Sow B	Sow C	Sow D	Sow E	Sow F
Day (i)	54.3	52.5	44.6	48.7	50.0	48.7
Day (ii)	57.2	53.8	40.3	43.5	55.4	55.1
Day (iii)	72.5	58.2	45.4	50.4	56.4	60.4
Day (iv)	76.6	67.4	50.7	59.9	59.6	66.6
Day (v)	78.0	71.7	54.0	68.7	66.8	70.4

When all data points are included, the line of best fit is again second order polynomial (see Figure 1). From the equation, the average minimum and maximum heart rates are 48.8 bpm and 70.1 bpm respectively. This represents a basal heart rate increase of 21.3 bpm or 43.6% over pregnancy from the start of gestation.

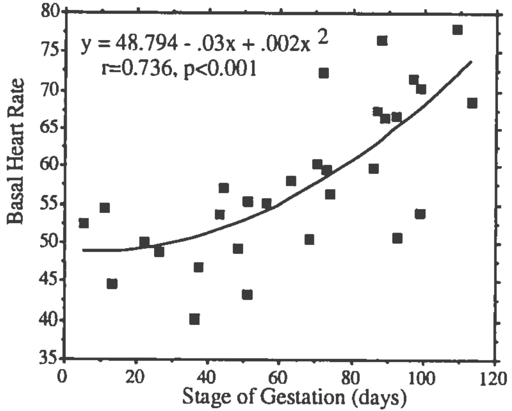

Figure 1. Graph showing correlation between basal heart rate and stage of gestation.

Discussion and Conclusions

The results indicate that basal heart rate increases as gestation progresses for all sows, but the amount of increase depends on the individual identity rather than the potential litter size. The results also demonstrate that the increase is not constant, and that the rate of increase rises towards the last third of gestation. This is expected, because it is during the last third of pregnancy that the fœtal growth rate and oxygen demand are maximal, and hence, uterine blood flow is maximal. It is also possible that basal heart rate of sows continues to rise after parturition, as shown in sheep (Baldock *et al.*, 1988), when metabolic demands of lactation are considerable and feed intake is maximal. This effect of stage of gestation on heart rate is likely to be a major factor in the seasonal variation reported in sheep (Baldock *et al.*, 1988) and red deer (Price *et al.*, 1993). Both these species are seasonally polyoestrus and the results presented here suggest that the effects of stage of gestation, may have been underestimated.

The results demonstrate that the basal heart rate of sows is greatly affected by stage of gestation. It is likely that the basal heart rate of other animals will similarly be affected by stage of gestation and thus, for experiments studying the heart rate of pregnant animals to be valid, it is very important to match experimental treatments for stage of gestation. Any bias towards early or late gestation will have a major influence on results, both in terms of absolute values obtained, and also in their interpretation.

Acknowledgements

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Time structure of distress vocalization

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Introduction

Objective evaluation of behavioural reaction in farm animals is a problem of major importance for welfare research. With the introduction of a numerical analysis of sound signals in chicken we have an ability to quantify this behaviour. Therefore we use the distress call as model for an examination of environmental influences on animal behaviour.

Behaviour is always a process in time. Variation in the time structure of behaviour contains information about the animal. The short time structure of vocalization is characterized by the parameters from numeric sound analysis of distress calls (Collias & Joos, 1953, Marx, 1993). This study was designed to investigate the long time structure of distress vocalization.

Animals and methods

33 broiler chicken were reared in three groups. On day 6 or 7 of life each animal was taken carefully from the home box and placed in a sound proof test box. The animal in the test box could not see or hear its companions. Distress vocalization from each chicken was recorded on a tape recorder (REVOX BR99).

The first two minutes were used for analysis of vocalization. Therefore we measured the beginning and the end of each call in the sonagram on a signal analyser MOSIP 3000 (MEDAV). From this time data we calculated the duration of inter-call-intervals (ICI).

Numerical sound analysis was made for selected calls - single call and calls from short bouts (6 call/bout) or long bouts (21 to 30 calls/bout).

Results

The distribution of ICI is typical for a behaviour with a bout structure (Colgan, 1978). We can use an ICI of about 0,5 sec as inter-bout-interval. The bout length varies in a wide range (1 to 120 Call/bout). The highest frequencies have the shorter bouts. 71,1 % of the bouts are shorter than 10 calls per bout. But the majority of calls were emitted in long bouts (52,95 % of calls in bouts with 20 and more calls). Only 2,53 % of the calls were emitted as single calls. The formation of bouts varies between the animals. We determined the median of bout length (MBL) and the number of first long bout with 10 or more calls per bout (FLB) for each animal. The parameters of long time structure of distress vocalization - median of bout length, latency of first call (t_0), the number of calls (n) in two min and first long bout - were compared with body condition and reaction in the social-reinstatement-test (Marx & Leppelt, unpublished) as shown in table 1. In the social-reinstatement-test we estimated the orientation speed by time to reach the group and the social relationship by degree of turn to group for each animal.

Table 1: Means of the bout parameters for animals arranged in groups by body weight and by degree of turn to group or orientation speed in the social reinstatement test

	body weight		turn to group		orientation speed	
	< mean	> mean	< 0.5	> 0.5	< 5 min	> 5 min
t_o in sec	2.53	3.37	4.82	2.08	4.16	1.25
MBL	22.50	5.17	20.00	9.03	14.82	9.77
n	161.28	150.0	160.84	154.13	151.45	159.92
FLB	4.64	8.00	5.538	6.333	6.40	6.85

Animals with lower body weight show significantly more calls in longer bouts. Chicks with a fast orientation reaction in the social reinstatement test have shorter latencies of the first call.

The comparison of call features between single calls, short bouts and long bouts show differences. Single calls are in general shorter and have a lower energy. This is a sign for lower distress (MARX & LAUBE, 1994). The calls in short or long bouts do not show not such clearly differences. The differences in call parameters between the animals may be significant, too but they have the same direction in calls from short as in calls from long bouts. Figure 1 shows for example the coefficients of energy concentration for three animals in different bouts.

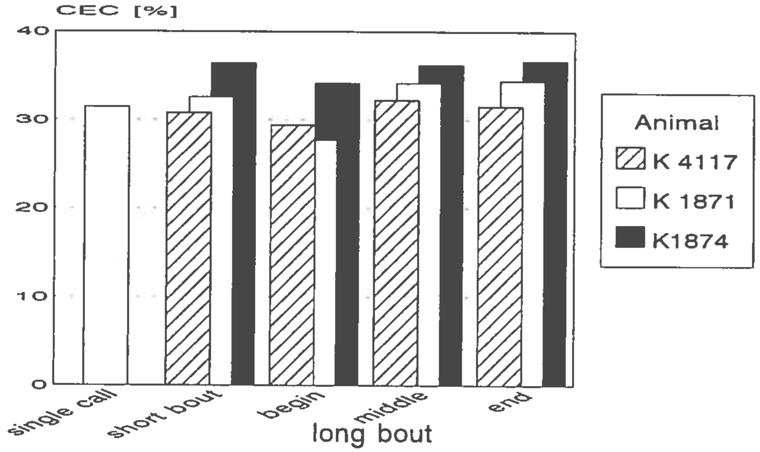

Figure 1: Means of the coefficient of energy concentration for several animals dependent on the length of bouts.

Conclusion

The bout structure is an important feature of distress vocalization. The calls in bouts between 6 and 30 calls show the same differences between the animals. So we can recommend this range of bout length for special experiments. The interactions between body condition, orientation behaviour and vocalization in isolation show the sensitivity of the control system of vocalization. The analysis of time structure can be provide more information about animal-environment-interactions.

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Long-term consistency in behavioural and physiological responses of heifers to a novel environment test

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Introduction

Individual differences in behavioural and physiological reactions to environmental change may reflect the existence of stable individual characteristics mediating stress responsiveness. In order to substantiate this idea, experimental evidence should be provided showing at the least consistency in response to the same challenge, both in the short and in the long run, as well as correlations between behavioural and physiological measures (Jensen, 1994). In dairy cows, Hopster and Blokhuis (1993) have found a high consistency in response to acute social isolation over a period of one week. We examined consistency of individual differences in response to a novel environment test in dairy cattle, from the age of 3 weeks up to the age of approximately 22 months.

Materials and methods

We started with 25 Holstein Friesian heifer calves. Until the age of 7 months, calves were kept in straw littered group-pens of 5 animals each. Calves were assigned to a group by order of birth date. After completion of testing at the age of 7 months (see below), all calves successively entered a single group kept in a cubicle house. The animals were individually exposed to a novel environment test at the age of 3 weeks, 4 months, 7 months and 22 months. In the first three tests group mean age served as age of testing. In the final test actual ages ranged from 21 to 23 months. At that time all heifers were pregnant and in the second half of gestation.

In each test the animal was confined in a starting box for 3 minutes and subsequently allowed to enter the novel arena. Here, ambulation and vocalisation were monitored for 10 minutes. Blood samples were collected by venipuncture immediately before and after each test and analysed for plasma cortisol. The testing procedure slightly differed between ages. Until the age of 7 months calves were transported to and from the novel arena in a lorry. Area of the test arena was increased with age: from 4x4 m at the age of 3 weeks to 6x6 m at the age of 22 months.

Mean differences between ages were compared pairwise with paired t-tests. Correlations were analysed using Spearman rank correlation coefficients (R_{SP}).

Results

Mean differences between ages in behaviour and cortisol are summarized in table 1. In particular, measures recorded at 3 weeks of age differed from those recorded at other ages. At 3 weeks of age the animals, on average, exhibited low levels of ambulation, a moderate change in plasma cortisol and almost no vocalisations during testing.

Individual differences in time spent walking were consistent over time in all age comparisons from 3 weeks to 22 months (R_{SP} ranged from 0.43 to 0.76, $P<0.05$), whereas number of walking bouts and number of vocalisations only showed consistency beyond the age of 3 weeks (R_{SP} ranged from 0.57 to 0.74 for walking bouts, from 0.43 to

0.88 for vocalisations, $P<0.05$). Individual differences in cortisol response at the age of 7 months reliably predicted differences in cortisol response at the age of 22 months (R_{SP} 0.49, $P<0.05$). No significant correlations were obtained between measures of ambulation and number of vocalisations, except at the age 22 months, or behavioural measures and rise in plasma cortisol.

Table I. Mean ± SD for behaviour during and rise in plasma cortisol in response to a novel environment test, recorded at the age of 3 weeks and 4, 7 and 22 months

	Age of testing			
Parameter	3 Weeks	4 Months	7 Months	22 Months
Walking (sec)	$68.8^a \pm 47.5$	$118.5^b \pm 37.8$	$152.5^c \pm 47.9$	$132.6^{b,c} \pm 45.64$
Walking bouts (number)	$20.0^a \pm 13.4$	$35.0^b \pm 11.7$	$38.0^b \pm 9.5$	$25.5^a \pm 7.5$
Vocalisations (number)	$1.1^a \pm 2.1$	$14.1^b \pm 13.5$	$12.5^b \pm 11.0$	$2.9^c \pm 4.7$
Cortisol response (ng.ml^{-1})	$6.2^a \pm 6.3$	$19.9^b \pm 12.3$	$14.1^c \pm 10.1$	$7.0^a \pm 7.0$

Means with different superscripts in the same row differ significantly $P<0.05$

Conclusions

In rodents individual differences in stress reponsiveness seem to relate to discrete categories of individuals (a bimodal distribution at population level) (Bohus *et al.*, 1987). It has been questioned whether similar distinctions are also present among domestic animal species (Jensen, 1994). Although the present data demonstrate long-term consistency in responsiveness of heifers, they do not support the existence of few separate categories of animals. At best our results may point to a range of categories of individuals which are consistent in displaying specific combinations of behaviour and rise in cortisol. Alternatively, in accordance with a suggestion recently made by Chaouloff *et al.* (1995), the lack of correlation between physiological and behavioural measures might be explained by assuming that the novel environment test provided behavioural indices of activity rather than indices of stress or anxiety.

Differences between ages in mean level of behaviours and cortisol may reflect developmental changes and/or habituation. In relation to individual variation, the latter phenomena need further attention.

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Automated recording of ruminating behaviour in the diagnosis of BSE in cattle

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Introduction

Clinical observations on cows suffering from bovine spongiform encephalopathy (BSE) and on sheep with scrapie have shown that the proportion of time they spend ruminating is consistently reduced although time spent eating in most cases is maintained at normal values (Austin and Simmons, 1993; Austin, Hawkins, Kelay and Simmons, 1993). During the clinical progress of BSE, the proportion of time spent ruminating often declines to less than 7% or ceases altogether. Values for the proportion of time spent ruminating by normal animals are usually in excess of 30% of 24h. Affected cattle also display other jaw movements, associated with nose licking and tooth grinding, at a much increased frequency. Jaw activity therefore appears to show disease-specific characteristics and in the context of overall behaviour may be a useful diagnostic measurement.

Materials and Methods

A robust, computer based jaw activity recorder has been developed (Champion, Rutter and Penning, 1994). A transducer incorporated in a cattle head harness produces an analogue signal of jaw activity. This signal is digitised and stored by a micro-computer which is attached to the harness. The computer records the animal's jaw activity for a period of up to seven days. At the end of this period the recorder is removed and the recorded data transferred to a personal computer. Analysis of the recorded pattern of jaw activity gives the amount of time the animal spent eating, ruminating and idling.

Results

The system is currently being used in field trials in association with veterinary surgeons. The results from field cases of BSE to date have supported the laboratory findings (Austin and Simmons, 1993, Austin *et al*, 1993) in demonstrating reduced rumination in many cases.

Conclusion

The system has proved to be robust and generally reliable, and could be useful in the differential diagnosis of suspect cases of BSE and other diseases characterised by eating disorders.

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Experimental design - a required component of experiments in measuring behaviour and physiology

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Introduction

Although a lot of methods of statistical experimental design have been developed in this century (Fisher, 1966; Cox, 1992), experimental design fails to be part of many scientific papers concerned with investigations on randomly influenced biological processes like behaviour and / or physiology of animals. However, experiments should be carefully designed before they are carried out in order to ensure that inferences can be drawn with the desired accuracy and precision and that the desired result will be achieved with minimum effort.As well, it is more and more expected from an experimenter to conduct experiments on a small scale, not least because of prevention of cruelty to animals.

Statistical experimental design

The starting point of an experiment is a biological formulation of the task to be investigated. This formulation often is a vague one. For this reason the prerequisite for designing an experiment is a precise formulation of the biological problem i.e. answers to the questions: "What does one want to find out?", "How accurately does one want to find out?", "For which population / purpose does one want to find out?". In answering these questions the experimental conditions are defined resulting in a statistical formulation of the problem including model choice and analysis procedures. Because the objects investigated are randomly influenced some knowledge on their variability is indispensable. A useful measure of the variability is the standard deviation σ. A value of σ is sometimes available to a reasonable approximation through either pilot studies or similar studies previously reported in the literature. Having specified the precision requirements in accordance with the answers to the three questions above the minimal necessary size of the experiment can be calculated. How can we determine the minimal necessary size? We can do it by hand calculation using sometimes difficult iterative algorithms. But most of the experimentalist are not interested in a very extensive hand calculation. Nowadays, computer programs can be used e.g. **CADEMO** (Computer **A**ided **D**esign of **E**xperiments and **MO**delling) developed to solve problems of experimental design in agricultural research (Darius, 1994).

In our poster problems of designing an experiment dealing with some aspects of postnatal behaviour (e.g. parts of suckling behaviour) and physiology (e.g. development of weight, temperature, immunoglobulines) in piglets are presented in dependence on other biological parameters (e.g.parity of sows, sex and mortality of piglets). For reasons of limitation we can only give two examples of experimental design summarized in tables 1 and 2. The first aim of our experiment is to estimate the mean of the characters listed in table 1 using a symmetric confidence interval estimation. As values for the standard deviations σ of the characters investigated we used the sample standard deviations s of a pilot experiment. The minimal necessary numbers of observations for each character using a confidence interval of the expected width 2d that overlaps the corresponding mean with probability 1-α are given in table 1. The experiment should be performed with the largest n within the last column.

Table 1. Minimum necessary sample sizes n for symmetric confidence interval estimations of selected characters in dependence on the precision requirements (confidence coefficient 1-α, half expected width d of the confidence interval) and the sample standard deviation s.

characters to be investigated	s	d*)	1-α	n
birth weight [kg]	0.290	0.1	0.95	35
rectal temperature post natum [°C]	0.608	0.2	0.95	38
time from birth to first udder contact [min]	9.800	3	0.95	44
time from birth to first milk intake [min]	17.475	5	0.95	50
rectal temperature 1 hour post natum [°C]	0.701	0.2	0.95	50
blood γ-globuline 24 hours post natum [g/l]	8.500	3	0.95	34
weight on day 21 [kg]	1.290	0.4	0.95	43
blood γ-globuline on day 21 [g/l]	2.000	1	0.95	18
stability of suckling at preferred udder region [%]	13.090	5	0.95	29

*) d can also be expressed in standard deviation units i.e. $d=c\sigma$, where $c\in(0,1)$.

The second aim of our experiment is to test the effect of primiparous and multiparous sows on the parameters investigated. Using the sample standard deviations s_1 (primiparous sows) and s_2 (multiparous sows) of a pilot experiment and specifying the precision requirements α (probability that the null hypothesis will be rejected when it is correct), upper bound for β (probability that the null hypothesis will be accepted when it is incorrect) and the smallest meaningful difference d between the group means that should be detected with the experiment the minimal necessary sample sizes for each group can be calculated (table 2).

Table 2. Minimum necessary sample sizes n for testing the effect of the factor levels primiparous and multiparours sows on selected characters in dependence on the precision requirements (first kind risk $\alpha=0.05$, upper bound $\beta_0=0.20$ for the second kind risk β and the smallest meaningful difference d between the group means to be detected) and the sample standard deviations s_1 of primiparous sows (PS) and s_2 of multiparous sows (MS).

	PS	MS		PS	MS
characters to be investigated	s_1	s_2	d	n_1	n_2
birth weight [kg]	0.222	0.302	0.2	24	32
rectal temperature post natum [°C]	0.646	0.591	0.5	27	24
time from birth to first udder contact [min]	12.192	8.817	5	81	58
time from birth to first milk intake [min]	20.192	16.374	10	60	48
rectal temperature 1 hour post natum [°C]	0.635	0.699	0.5	28	30
blood γ-globuline 24 hours post natum [g/l]	8,500	8,500	5	47	47
weight on day 21 [kg]	0.835	1.268	0.7	29	44
blood γ-globuline on day 21 [g/l]	2.000	2.000	2	17	17
stability of suckling at preferred udder region [%]	16.055	12.049	10	37	27

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Principal Component Analysis (PCA) of behavioural reactions of sheep submitted to three different fear-eliciting situations

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Introduction

Fear influences a variety of fundamental behaviours, adaptation of animals to their environment and thus welfare. Fearfulness can be considered as a general characteristic of an individual which could modify its behaviour in the same manner in different situations. Expression of fear can vary greatly depending on species and characteristics of the threatening stimulus but measuring methods often used only few parameters. Furthermore, the interpretation in terms of fear can sometimes be problematic. The aim of this work was to assess the relationships between a number of behavioural variables displayed by sheep in three different fear-eliciting situations, using PCA.

Materials and Methods

In order to quantify the fear reactions of sheep, we have previously designed 3 tests involving social isolation (**I**), a surprise effect (**S**) and the presence of a human (**H**). 265 different animals, belonging to different groups used to assess the influence of several factors on fear reactions, were individually submitted to each of these 3 tests. 24 (**I**), 27 (**S**) and 27 (**H**) fear-related behavioural items, as described by Romeyer and Bouissou (1992), were recorded. PCA was used to analyze the relationships between behavioural variables in the whole set of tested sheep, independently for each test.

Results

Using all the behavioural items, the first two PCA factors explained 42% (**I**), 41% (**S**) and 46% (**H**) of total variance. The behavioural items can be grouped according to the sign of the loadings in factor 1 in each analysis: these two groups (positive and negative loadings) are the same as those described in Romeyer and Bouissou (1992), the first group of variables reflecting the expression of fear (e.g. high locomotor activity), the other reflecting the absence of fear (e.g. long time spent feeding).

Eight items whose loadings were not higher than |0.5| in any of these two factors, for the three tests, were discarded for further analysis. These items measured behaviours which were in fact rarely expressed: more than 45% of the animals didn't show any of these behaviours during at least 2 of the 3 fear-eliciting tests.

Using 16 (I), 19 (**S**) and 19 (**H**) behavioural items, 71% (**I**), 62% (**S**) and 71% (**H**) of total variance are explained by the first 3 PCA factors among which the first factor accounted for 41% (**I**), 35% (**S**) and 44% (**H**). A set of 8 items showed consistent and high loadings (0.66-0.94) on factor 1 for the 3 tests (Table 1). They are related to feeding, locomotor activity and localization in the test pen. This first factor could be interpreted as anxiety or fear induced by social isolation which is common to the 3 tests.

A fear score was computed by PCA using the 3 major items related to factor 1 for the three tests (mean loadings > |0.8|; see Table 1). This fear score can be calculated for each animal using the following equations: isolation test: - 0.00677 T5 - 0.00776 F(t) + 0.008787 T123 + 0.299826; surprise test: - 0.00773 T5 -0.00901 F(t) + 0.007523 T123 + 0.13741; human test: - 0.00544 T5 - 0.00744 F(t) + 0.004695 T123 - 0.19887.

Table 1. Loadings of 8 behavioural items on factor 1 for the 3 PCA analysis using 16 (I), 19 (S) and 19 (H) behavioural items.

Feeding:
- F(f): Feeding frequency
- F(t): Time spent feeding
- FL1: Latency to go to eat for the first time

Locomotor activity:
- W(f): Walking frequency
- I(f): Immobilization frequency

Localization in the test pen:
- T5: Time spent in square 5 (middle of the test area)
- T123: Time spent in squares 1, 2 and 3 (away from the stimulus and the trough)
- T456: Time spent in squares 4, 5 and 6 (near the stimulus and the trough)

Behavioural items	Isolation test	Surprise test	Human test	Means
F(f)	- 0.69	- 0.77	- 0.88	- 0.78
F(t)	- 0.91	- 0.91	- 0.94	**- 0.92**
FL1	0.72	0.72	0.93	0.79
W(f)	0.83	0.78	0.66	0.76
I(f)	0.75	0.74	0.68	0.72
T5	- 0.82	- 0.87	- 0.94	**- 0.88**
T123	0.78	0.79	0.89	**0.82**
T456	- 0.67	- 0.77	- 0.87	- 0.77

Significant Spearman correlations ($P<0.05$) were found for experimental subgroups of sheep between this score and the previously published score which used all the behavioural items (Vandenheede, Bouissou 1993a, 1993b), especially for the isolation test.

Conclusions

The same set of variables explains most of the variation in fear reactions of sheep in our three tests. Unlike the previously published score, this new method of scoring allows to locate an animal on a continuous "fear scale" available for various experiments using the same test procedure. As very little information is lost by reducing the number of variables, at least for the isolation test, this should enable the test procedure to be simplified and possibly automated. Further analysis of factors 2 and 3 are under way and they enlighten the understanding of specific behavioural reactions towards the surprise and the human stimuli.

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Companion Animal Behaviour

What is Companion Animal Ethology, and is it relevant?

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In order to address the title of this paper, it is important first to decide what is a 'companion animal'. From the contributions given at companion animal symposia, it might be concluded that the term refers to a particular group of species. Certainly, most work considered under the umbrella of 'companion animal behaviour' relates to dogs, cats and horses, with a strong bias in favour of research into the dog. Are these particular species companion animals and others not? Or, as the psychological studies indicate, can a wide variety of species, such as fish (Riddick, 1985) and budgerigars (Baun *et al.*, 1992), fulfil a functional definition of companion, namely that of 'one who associates with or accompanies another' (Allen, 1990)? I would suggest that the term 'companion animal' *only* has a functional meaning and thus applies to various species, many of which fulfil other, primary, utilitarian roles such as laboratory or farm animal.

This is an important distinction for those of us who are interested in the behaviour of companion animals. It could be argued that we need to be more specific with regard to our interests. For example, if we are predominantly concerned with a single species we should declare it. Alternatively, we may be interested in the functional role of companion animals and how different species fulfil it. Finally, we may be concerned with the effects of being a companion animal on the behaviour of the species, or individual subjects. If referring to the latter two categories, we should not confine ourselves to the study of only one or two species, and in all cases, we should be considering the contributions of colleagues working in other areas of ethology and how their findings can be brought to bear on the companion animal arena. Data from laboratory animals (Grant and Mackintosh, 1963; Hubrecht, 1995; Stauffacher, 1992), pharmacological literature (Cooper & Hendrie, 1994) as well as studies of feral (Bell, 1980) and wild (Mykytowycz, 1964) populations can all contribute to our knowledge of species placed in the role of companion animal.

If we are working as counsellors in companion animal behaviour, then how we define ourselves to the public is important. There are obviously those of us who are working solely with a single species, such as the dog, cat or horse; this is commendable but should be stated. It is to the profession's credit that the public is increasingly aware that behaviour problems can be resolved. Stemming from this is a growing realisation that behaviour problems occur in many pet species and an assumption that help for all of them is available from those claiming to be 'companion animal', or 'pet', behaviour counsellors. Certainly, the majority of problems presented by the public relate to the dog, as these impinge most significantly on the public and are highlighted by the media and the legal system. But, both in terms of behaviours considered problematical by owners and in terms of welfare issues, we should be widening our horizons to include other species kept as pets. For example, my own clinical work has included pet species as diverse as tortoises, parrots, rabbits and mini-pigs; the latter being kept on a modern housing estate as if they were dogs.

It is a truism to say that a behaviour is not a problem unless it is regarded as such, be that by the owner or another individual. It is human perceptions which alter, rather than the animals themselves. For example, stereotypical movements in farm, laboratory and zoo animals were not considered a welfare problem until relatively recently. As professionals working in the companion animal field, we have a responsibility to be aware of how to prevent potential problems and how to resolve existing problems in a variety of pet species. Likewise we have a responsibility to be aware of, and be able to respond to welfare issues for pet species in general. Moreover, we have the opportunity to influence public perceptions positively to the betterment of those animals kept as pets. In this paper I would like to suggest one or two avenues of exploration which may assist this endeavour.

In order for a relationship between humans and another species to be successful, from both participants point of view, it is essential that the human knows the species and is able to communicate his intentions and wishes effectively. In the case of some species, in particular the dog, it is also important that the human is aware of breed characteristics.

Knowing the Species

Whilst human-companion animal relationships are primarily concerned with social interactions, knowing the species means that the human should be aware of the animal as a total organism. This includes an understanding of the physical attributes and demands of the animal as well as of other areas of behaviour such as reproduction, development, activity rhythms, feeding and play.

As already suggested, the domestic dog is the species most prominent in 'companion animal' literature. Yet what is a domestic dog? The species Canis familiaris has its ancestral roots in several races of wolf. Whilst much work has been done on the social behaviour of the Northern wolf, less is available on other wolf races or on the domestic dog itself. Until recently, it has been assumed that the domestic dog retains much of the communicative skills of the Northern wolf and behaviourally resembles wolf pups. However, recent work at the Anthrozoology Institute in Southampton (Goodwin *et al.*, 1995) on breed differences in social communication indicates that this concentration on the behaviour of a single wolf species may be naive. The studies suggest that not all breeds of dog produce the same signals as the Northern wolf, or even as each other. It may be that different breeds functionally employ these signals in different contexts, that is they 'speak different languages'. If so, then this could have implications for various aspects of the human-dog relationship. In order to understand the dog, we need to study both the dog and other races of wolf more intensively.

The dog has been domesticated for at least 10,000 years and it would seem reasonable to assume that it has undergone some form of evolutionary change in that period, even if this has been primarily directed by artificial selection. Other species of companion animal, like the rabbit, have only been subjected to domestication comparatively recently. Moreover, many of the exotics, such as tortoises and parrots, are at the beginning of this relationship, having only been subjected to a few generations of captive breeding and selection for physical and behavioural attributes. Indeed, in many instances individuals are wild-caught. In these species we should be looking at what is known of their ethology and physical requirements from data gathered from the wild and from other captive breeding establishments such as zoos and laboratories. A good example of the relevance of this approach is the rabbit.

The domestic rabbit, Oryctolagus cuniculus, comes in a range of morphological types, many of which would be hard put to survive in the wild. Yet it has only been associated with man for about 1500 years, and only subjected to intensive selection for breed characteristics since the Industrial Revolution. A behaviour problem commonly presented to veterinary surgeons is that of rabbits becoming aggressive. Male rabbits are often castrated, but members of both sexes are frequently euthanised for such behaviour, to the distress of young and older owners alike. Yet a consideration of the animal's ethology and biology can often rectify the problem.

Rabbits are social, territorial animals which have a hierarchical structure, particularly noticeable during the breeding season. Apart from the obvious need to socialise rabbits to humans at a young age, they should also be provided with 'safe' areas, such as a piece of pipe in which to hide, without being dragged out by the owner. Rabbits, like many herbivores, spend much of their daily activity budget eating (McBride, 1986). Their digestive system has evolved to extract the maximum amount of nutrition from low quality feed (McBride, 1988). Yet modern commercial diets provide high quality feed in a concentrated form, thereby reducing the time the animal spends foraging and increasing its energy intake. These factors in combination can easily lead to increased aggression. Reducing the feed quality, by providing hay and greenstuff as forage, and providing 'occupational therapy' in the form of activity foods, such as suspending apples and carrots from the roof of the cage, can help to substantially reduce aggression.

Unlike dogs, cats and horses, many companion animals spend their entire lives in the same environment, the confines of their cage. In contrast, the natural environment, aerial, terrestrial or aquatic, is one of constant and varied stimulation, albeit for some dominated by the need to be vigilant for predators. For all species, and especially the opportunistic rodents and intelligent psittacidae, the barren conditions of cage life poses questions concerning the psychological welfare of these pets (Dawkins, 1988).

Animals maintained in environments which are sub-optimal may develop stereotyped behaviours (Mason, 1991). These behaviours can indicate an environment which is barren and restrictive in some way, for example a lack of tunnelling opportunities for caged rodents. Alternatively, stereotypies may be indicative of some other unavoidable source of fear or stress, such as constant ultrasound (Sales *et al.*, 1988) or excessive exposure to light. For example, a pet gerbil kept in the living room is exposed to natural daylight and artificial light at night (Van den Broek *et al.*, 1995).

Many owners try to provide their pets with stimulation, which they perceive as positive and rewarding. This includes the exercise balls in which hamsters are confined and can traverse the room. Just how rewarding, rather than stressful, this is to the hamster requires investigation. A more common example is the exercise wheel. Pet hamsters, rats, mice and gerbils can spend considerable portions of their daily activity cycle running in these wheels. It has been assumed that this a positive activity and not indicative of a welfare problem. Yet it would seem that wheel running can be a stereotyped behaviour, often resulting from social and/or environmental deprivation. Gerbils maintained in a semi-natural environment with conspecifics and the opportunity to burrow, forage, gnaw and nest build, as well as wheel run, showed significant differences in their behaviour compared to solitary animals kept in normal caged conditions (Roper and Polioudakis, 1977). For example, group housed gerbils were diurnal, as indeed are wild gerbils. Yet the isolated animals tended to be nocturnal. Perhaps more surprising was the degree of difference in wheel running. Solitary animals ran at speeds up to 2,000 revolutions per hour, exceding 20,000 revolutions per day, running for hours on end with only brief pauses. In dramatic contrast, the animals housed communally in a semi-natural environment rarely stayed in the wheel for more than a few revolutions at a time and never reached speeds above 50 revolutions per hour. These findings suggest that wheel running is actually a stereotyped activity indicating a sub-optimal environment. Perhaps as interested professionals, we should be advising owners, breeders, cage makers and the like of the behavioural needs of these, and other, social, opportunistic rodents.

Knowing the Breed

Certainly there are now different breeds in a variety of companion animal species. For the majority of species, selection has been concerned with morphological rather than behavioural characteristics, such as the rat and rabbit fancy breeds. The cat breeds are also based primarily on morphological characteristics, though there are distinct behavioural differences between oriental and non-oriental types. Indeed, highly selective breeding of any species for physical characteristics is almost certainly going to have effects on emotional and behavioural traits. But it is only really in the horse and the dog that there has been deliberate selection for both behavioural characteristics and conformation. I am not knowledgeable enough to talk about the horse, so I would like to restrict this discussion of the importance of 'knowing the breed' to the dog.

Over the years attempts have been made to classify dogs either by form or function. Groupings include hounds, terriers, guarding, herding and toy breeds. Whatever the classification, it is important to understand and take account of the fact that breed characteristics have a profound influence on reactivity and trainability (Scott and Fuller, 1965). All too often this is not taken into account when a puppy is purchased or when advice is given on how to prevent or rectify problems.

All of the groups of domestic dog have as their basic working characteristic a modification of the ancestral wolf-like predatory behaviour. In those bred primarily for companionship, such as the Cavalier King Charles Spaniel, this instinct has been significantly reduced by selective breeding. In contrast, in the terrier group the predatory instinct has been emphasised. In other groups the predatory instinct has been modified. In the herding breeds it has been inhibited at the point of the kill bite, while precursor elements of the hunt, such as the stalk and chase have been emphasised. It is perhaps pertinent to note that in 1994, of 1500 cases analysed one the breeds most commonly presented to members of the Association of Pet Behaviour Counsellors was the Border Collie, which showed a high incidence of inappropriate chase behaviours (Appleby and Magnus, 1995).

In order for some breeds to perform their functions, for example the herding breeds, they must be highly trainable. Other breeds, such as the guard and terrier groups, are expected to perform with little, if any human guidance. In these breeds traits of independent action has been emphasised and they are thus more difficult, though by no means impossible to train. Low trainability should not be confused with low intelligence; rather it means that the trainer will require more imagination in motivating the dog to perform.

As in all things, generalisations about breeds must be made with caution; breed lines can be influential as of course can the experiences of an individual animal (McBride, in press). However, it is necessary to be aware of the original function of the breed and the behavioural traits which have been positively selected. By original function I am referring to utilitarian function and not current non-utilitarian uses such as 'pet', 'companion' or 'show dog'. Knowledge of the breed can help find means of motivating a dog for training - for example, some dogs are more motivated by toys rather than food. Also, being aware of breed-specific behavioural tendencies can prevent the development of behavioural problems. For example, counsellors tend to see cases of aggression relating to possession of objects (including food) primarily in Labrador retrievers and spaniels. In many instances this has developed initially because the owner does not know the breed and is thus unaware of the breed specific traits. Then, because they are unaware of dog communication, the problem is exacerbated by their attempts to rectify the situation; finally resulting in the dog showing aggression.

Gun dogs (even those bred for show) have a basic behavioural trait to carry and retrieve objects, any objects. They do not distinguish between their own toys and the owner's prized possessions. Owners who do not understand this trait, respond in a confrontational manner to the pup carrying what is perceived (by the owner) as an inappropriate item. Such confrontation can include hitting the dog, prizing its jaws open or sprinkling pepper on its nose. The puppy becomes confused and fearful and, given sufficient experience of a confrontational reaction from its owner, will develop fear aggression when in possession of an object. This is often interpreted as unprovoked aggression, resulting in remedial treatment for the lucky ones, or euthanasia for many. Though this problem can be cured it requires substantial effort to rebuild trust on both sides of the canine-human partnership. Yet prevention of this situation is simple, simply requiring an awareness of species and breed behaviour and being able to communicate effectively. Namely, informing the owner of the trait of retrieving, advising that valued objects are removed out of reach and providing advice on how to teach the puppy to drop using positive reinforcement methods. Puppies as young as eight weeks can successfully be taught to drop objects on command.

Effective Communication

A major problem in human-animal communication, in particular with those species which share many of our modes of communication, such as vocalisations and visual signals, is the human tendency to anthropomorphise. In the above example the owner attributes to the puppy the ability to know right from wrong, of being able to understand the rationale behind the punishment (often inflicted some time after the event) and of being able to understand the assignment of quality values to objects. However, animals do not think like humans. Modern training methods for dogs and horses take this into account and are increasingly based on positive reinforcement methods (Pryor, 1991).

These principles are based on work done in many laboratories, usually on species such as the rat and pigeon (Ferster and Skinner, 1957). Other areas which contribute to how we can communicate effectively with animals are based on child psychology. For instance the principle of social referencing. Many cases seen by counsellors relate to fear, be it of objects or people. Naturally, positive socialisation experiences of young animals is becoming increasingly recognised as an important preventative tool in this area. Yet many owners are unaware of the importance of their actions in transmitting appropriate information (McCune *et al.*, in press). For example, the dog who shows a fear reaction to its first thunderstorm is 'comforted' by the owner patting and talking to it reassuringly. From the dog's viewpoint this is merely reinforcing its fearful behaviour, the owner is rewarding the behaviour. A better tactic would be for the owner to start to play a game, thereby showing the dog that there is nothing to be fearful of. In the case of the puppy who baulks at a new object or person, the owner who ignores the puppy and makes positive responses towards the target of fear, in other words the owner who "makes friends" with the object, is providing social cues to the animal of the appropriate reaction.

Effective communication is also needed when dealing with other companion animal species. Again this is based on an awareness of the animal's ethology and likely perceptions of the situation. Small vertebrates are often viewed as ideal companions for children. Yet, as these species tend not to form social attachments, it is unlikely that they perceive humans as conspecifics. Rather, animals which have become habituated to and recognise the sensory cues of an individual handler probably perceive the human as part of the inanimate environment. Alternatively, the human may take on the role of potential predator (Caine, 1992).

Most of the species regarded as children's pets are prey species, and thus vigilance and evasion of predators are constant conditions pervading their daily life. It follows that they will not naturally perceive humans as benign aspects of the environment. To the hamster, being picked up from above resembles the swooping of a predator and is likely to initiate the anti-predator behaviour of turning on its back and biting. If repeatedly picked up in this manner the hamster is likely to become more rather than less fearful, thus leading to increased aggression. Effective communication can prevent such a problem by teaching the animal to perceive handling as a positive experience. This is easily done by placing small bits of food on an open palm and allowing the animal to climb on to the hand. Initially, this should be done within the animal's safe environment, its cage, only gradually proceeding to gently hold the animal when it is on the hand and lifting it out of the cage. (McBride, in press)

Summary

Ethology when applied to the field of companion animals is an extremely wide ranging subject. This is partly because of the variety of species which are incorporated under the term and because information about their behaviour is spread across many disciplines, from those working on behaviour in the wild, in laboratories, in domestic or agricultural situations.

In addition, the field of companion animal behaviour requires knowledge of how animals learn and the relevance of individual experience. Because of the interspecific nature of the companion animal role, the applied ethologist needs to be aware of both intra and inter-specific communication and of relevant areas of human psychology and how this influences and is influenced by the animal's behaviour.

Where modification of behaviour is the aim, namely in the arena of companion animal behaviour counselling, the counsellor also needs to have knowledge of psychopharmacology: the influences of hormones and psycho-active drugs. Finally, if treatment is to be successful then the owner must be motivated to comply. This means the counsellor must have appropriate counselling skills.

Thus, good knowledge of companion animal ethology is certainly a necessity, but is not sufficient for the successful application of that knowledge.

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Dog behaviour problems: the owner's contribution.

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Introduction

Despite the popular idea that dog owners are often responsible in some way for their animals' behaviour problems (eg. Woodhouse, 1978), current evidence for causal links between owners' behaviour, attitudes or personality and their dogs' behaviour tends to be either anecdotal or inconclusive. Some studies have failed to detect any relationship (Borchelt & Voith, 1986; Voith *et al.*, 1992), while others suggest that some behaviour problems may be associated with certain aspects of the owner and/or the owner's relationship with the pet (Campbell, 1986; O'Farrell, 1987; Clark & Boyer, 1993).

Using retrospective data from a sample of 737 dogs, the present study investigated the association between the prevalence of different behaviour problems and various aspects of either owner behaviour or the owner-dog relationship.

Results

A number of statistically significant associations were detected between various owner attributes or practices and the prevalence of particular behaviour problems in dogs. For example, (a) between obedience training and reduced prevalence of possessive aggression ($\chi^2 = 5.68$, $P < 0.02$), separation-related problems ($\chi^2 = 11.98$, $P < 0.001$), and escaping and roaming ($\chi^2 = 3.7$, $P = 0.05$); (b) between the timing of the dogs' mealtimes and the occurrence of territorial aggression ($\chi^2 = 10.39$, $P < 0.01$), (c) between sleeping close to the owner and increased prevalence of competitive aggression ($\chi^2 = 8.39$, $P < 0.01$) and separation-related problems ($\chi^2 = 8.01$, $P < 0.01$); (d) between first-time ownership and the prevalence of dominance-type aggression ($\chi^2 = 10.32$, $P < 0.01$), separation-related problems ($\chi^2 = 4.18$, $P < 0.05$), and various fears ($\chi^2 = 17.39$, $P < 0.001$) and manifestations of overexcitability ($\chi^2 = 7.75$, $P < 0.01$), and (e) between owners' initial reasons for acquiring a dog and the prevalence of dominance-type ($\chi^2 = 9.41$, $P < 0.01$), competitive ($\chi^2 = 8.32$, $P < 0.01$) and territorial aggression ($\chi^2 = 5.89$, $P < 0.01$).

Conclusions

The results provide evidence that obedience training, timing of mealtimes, and sleeping arrangements, as well as owners' prior experiences of dog ownership and their reasons for acquiring a dog, are all significantly related to the prevalence of certain behaviour problems. These findings are substantially at odds with those of some previous studies (eg. Borchelt & Voith, 1986; Voith *et al.*, 1992). Unfortunately, the nature of the present data makes it impossible to do more than speculate about the causal relationships between the various owner variables and the prevalence of dog behaviour problems. The results do, however, point to a need for more detailed prospective and cohort studies to elucidate the true nature of these associations. Although 'blaming' owners for their pets' problematical behaviour is generally considered to be counter-productive to successful treatment (Mugford, in press; O'Farrell, in press), it is nevertheless important to establish precisely how, if at all, owners' attitudes, personalities, actions and/or experiences can affect the likelihood of their pets developing behaviour problems. Such information would not only improve our overall understanding of the human-dog relationship, but may also help in the design of more appropriate treatment programmes.

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Temperament testing dogs in a rescue shelter: Improving owner-dog compatibility

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Introduction

An estimated 200,000 dogs are abandoned at rescue shelters in the UK each year (Soulsby, 1988). These statistics attest to the large numbers of owner-pet relationships which are unsuccessful, in part because dog breeders and rescue societies have failed to match owners with a suitable choice of pet. RSPCA records have revealed that 23% of dogs brought to the RSPCA are given up because they have displayed behaviours perceived as problematic and intolerable by their owners. Of dogs found new homes by the RSPCA, 19% are later returned back to the shelter. The incidence of behavioural problems in these dogs rises to 68%.

Successive owners of the same dog report different behavioural problems in that dog in 72% of cases. This suggests that the perception of a behavioural problem will vary between individual households. Different households may also vary in the presence of specific stimuli which elicit particular behaviours.

There is evidence that the personality of people can be differentiated by their responses to specific situations (Eysenck, 1994). Species-specific and breed-specific behaviour has also previously been described in dogs (Hart & Hart, 1985), and in cats (Karsh, 1983). The different personalities that distinguish members of the same species are the basis on which we attempt to improve owner-dog compatibility. The type of behaviour displayed by a dog in a home will be constrained by the underlying temperament of the dog. In order to ensure that we have a successful owner-dog match we will attempt to develop a method for assessing dog temperament before a dog is homed. Matching a dog who has been temperament assessed with owners whose home characteristics, needs, expectations and tolerance have also been determined, will improve the quality of their relationship and hence reduce the risk of that animal's abandonment.

Method

Examination of RSPCA records

RSPCA records were examined, and the reasons that dogs are brought to rescue shelters was recorded. Information about the behavioural problems that are displayed, was in some cases available for the same dog in two separate households.

Assessing temperament in the rescue shelter

Reviewing literature revealed over 80 methods of assessing dog temperament. These published tests were refined and elaborated in the course of the present project within the context of human personality factor theory, to produce a theoretical model which relates specific temperament tests to generic temperament traits. Tests were then designed to elicit behavioural responses associated with the identified temperament traits. The dimensions of temperament around which tests were designed were

Excitability	Responsiveness to change
Sociability	Propensity to seek the companionship of others
Biddability	Extent to which an individual desires to possess, control or dominate a resource or situation over another individual
Predatoriness	Propensity to chase or capture for food or play
Fearfulness	Apprehension or distress experienced
Adaptability	Habituation and recovery to a stimulus

24 key temperament indicating tests were developed which clustered around these 6 temperament dimensions. Tests incorporated a range of stimuli, which would be workable for

rescue centres to use, for example, humans, animals, toys and food. These tests are currently being carried out on dogs at one RSPCA rescue shelter. Behavioural responses of 120 dogs to 24 tests are recorded on the second and seventh days of stay at the shelter, if they have not then been homed. This will indicate how the behaviour of dogs changes during their stay at a rescue shelter and also the stage at which temperament testing is most predictive.

Validating the tests

A questionnaire was constructed containing 80 questions. Owners bringing their dogs to the RSPCA for adoption were asked to complete the questionnaire. The same questionnaire was then sent to new dog owners, one week and five weeks after adoption. Owners are asked to describe how their dog behaves when confronted with particular stimuli. Categorising behavioural response avoids owners describing their dog's behaviour in terms of how problematic, desirable or intolerable they are. We investigate the predictive value of the tests by comparing the behavioural responses of dogs in the rescue shelter with old and new owner description of dog behaviour. Responses from successive owners of the same dog reveal how consistent dog temperament is between different households. The way in which dog behaviour changes during the first 5 weeks in a new home will also be determined.

Results

Examining RSPCA records revealed that where the same dog has been returned to the RSPCA on two occasions by successive owners (N=83), only 18% of owners cited the same behavioural problem as the reason for returning the dog.

54 dogs have so far been assessed in the rescue shelter (from a projected total sample size of 120 dogs). In addition, questionnaires have been completed by 30 owners. Analysis of this data so far has revealed that dogs significantly change the amount of fearfulness and confidence they display in different households (Wilcoxon, $P<0.05$). There was also a significant difference in how obedient successive owners of the same dog thought they were (Wilcoxon, $P<0.05$). There were no significant differences in how aggressive or excitable dogs were in successive households. Factor analysis of the completed data will reveal which tests correlate highly with one another and therefore which tests measure the same trait.

Conclusions

There are clearly mechanisms, other than the underlying temperament of a dog, instrumental in the process of owner-dog compatibility. Dog excitability and aggression are consistent between households, yet some owners find it necessary to return a dog because it fails to meet their own needs and expectations and the behaviour becomes intolerable. Assessing the temperament of individual dogs will lead to a successful method of matching dogs and owners, once the owner and household characteristics important to the success of a relationship, have also been investigated. Minimising the risk of behavioural problems occurring and being recognised will improve the quality of relationship between dog and owner and hence reduce the chance of that animal's return.

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Factors predisposing dogs to separation problems

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Introduction

Undesirable behaviour displayed by dogs when left alone constitutes a major group of problems seen by behaviour counsellors. Known as separation problems, these include repetitive vocalisation (barking, whining or howling), house-soiling and destruction of furniture and fixtures. It has been estimated that, where behaviour problems are given as the reason for rehoming, 33% of such problems relate to separation (Bailey, 1992). In addition, animals appear to develop separation problems as a result of being in rescue. The research described attempts to elucidate those factors predisposing dogs to develop this problem. Such information could be usefully employed by breeders, veterinarians, trainers, dog wardens and behaviour counsellors in both advising owners of preventative measures and in resolving problems where they have already developed.

Materials and Methods

In collaboration with two Blue Cross rescue shelters in southern England, all dogs adopted between July and October 1993 were followed up with regard to the occurrence of separation problems being displayed in their new homes. Data was collected in two stages.

When a dog was brought to the rescue centre to be put up for adoption its age, sex and breed were recorded and, where possible, details of any previous homes and abnormal behaviour. Adoptive owners were given a letter informing them of the research and that they would be contacted between one and three months after they had taken the dog. The new owners were contacted where possible by telephone or, otherwise by post. A structured interview was conducted in the form of a questionnaire. This provided details of the household, the dog's new environment, routine and behaviour. The sample comprised 211 dogs. Of this number 14 had never been left alone in their new home and thus were excluded from the database.

A separation problem was said to occur when any one of the three behaviour patterns, vocalisation, elimination or destruction, occurred only when the dog was left alone in the house. The analysis comprised an investigation of those dogs showing separation problems and those which did not. Further analysis looked at trends within the group of separation problem dogs. Chi-squared tests were used to analyse discrete variables such as age, sex and previous history of separation problems. Independent t-tests were used to compare the two groups of dogs and Kolmogorov-Smirnov two-sample test was applied after the t-test where appropriate in order to determine whether the two samples came from the same distribution.

Dogs were put into the following age classes. 1 = 3-6 months; 2 = 6-12 months; 3 = 1-2 years, 4 = 2-4 years; 5 = >4 years. In order to test the effect of the frequency of re-homing on the occurrence of separation problems a index of frequency was used: Number of previous homes/age class. Thus, an older dog having had few homes would score <1 whilst a young dog having several homes would score >1.

Results

Of the 197 dogs included in the database, 44 (22.3%) displayed at least one behaviour indicating a separation problem. Of these 44 animals, 84% were destructive, 41% barked or howled and 18% eliminated. Of those showing vocalisation or destructive behaviour, 27% displayed both. The following factors were not significantly associated with the occurrence of separation problems. The sex and neuter status, time in the rescue shelter, the number of previous homes, the number of people in the new home, the length of time per day left alone, whether or not the owner made a fuss of the dog prior to leaving, or it on returning. The presence of other dogs in the home was not significant, but the presence of at least one cat in the home was associated with a significant reduced occurrence of separation problems ($\chi^2 = 4.188$, *). There was a significant association between the tendency of a dog to form a strong attachment to a particular person in the household and occurrence of a separation problem ($\chi^2 = 4.82$, *). Dogs displaying separation problems were significantly less likely to remain alone voluntarily in a room ($\chi^2 = 6.5$, *), tending rather to seek out the company of a human member of the household. The age at rehoming significantly affects probability of separation problems developing ($\chi^2 = 13.91$, **). Further tests showed that this significance was due solely to the effects of those animals rehomed between 6 and 12 months of age (Table 1).

Table 1: Percentage of dogs which displayed separation problems distributed by age.

Age	% of dogs showing separation problems
3-6 months	20.8
6-12 months	42.5
13-24 months	25.6
25-48 months	12.1
>48 months	13.7

Conclusions

The study clearly shows that the age at which a dog is rehomed through a rescue shelter can significantly effect its predisposition to develop separation problems. The only other factors which were significantly associated with separation problems were the tendency of the dog to seek company and the development of a strong attachment to a particular person. The first of these, the seeking of company, may be interpreted as a symptom of a separation problem rather than a pre-disposing factor. However, the tendency to form strong attachments to a particular member of the household may be a valid indicator relating back to a second critical period in the development of the dog during which it is especially vulnerable to social upheaval. The primary socialisation period occurs between 3 and 12 weeks of age in the dog and has been well documented as the period in which the animal learns both its species and individual identity. It is likely that there is a second critical period during the juvenile stage of development when the dog forms specific attachments to members of its group. It would be advantageous to a member of highly social, group hunting species to be able to form such individual attachments to animals on which it relies to hunt efficiently and to function within a hierarchical social structure.

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The effect of clomipramine on monoamine metabolites in the normal canine brain

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Introduction

Clomipramine (CMI) is a tricyclic antidepressant, Tricyclics act by blocking the re-uptake of serotonin (5-HT) and norepinephrine (NE) into the presynaptic nerve terminal. In vitro, CMI blocks 5-HT re-uptake more than NE re-uptake (Asberg *et al.* 1977) and it is the only tricyclic to be clinically effective in treating obsessive compulsive disorders (OCDs) in people (Murphy *et al.* 1992). Up to 2% of all dogs may suffer from behavioural disorders analogous to OCDs (Luescher *et al.* 1991). Affected dogs are reported to respond to CMI (Rapoport *et al.* 1992; Overall 1994). This experiment tested the hypothesis that CMI affects the central turnover of 5-HT, dopamine and NE in dogs. Turnover was assessed by measuring the cerebrospinal fluid levels of the respective metabolites: 5-hydroxyindoleacetic acid (HIAA), homovanillic acid (HVA) and 3-methyl 4-hydroxyphenylglycol (MHPG).

Materials and Methods

Six mixed-breed, behaviourally normal, male dogs (average weight 23kg) were enrolled in a randomised, placebo-controlled AB/BA crossover trial. Each treatment period lasted six weeks and there was a two-week 'washout' period between treatments. The dose rate of CMI and placebo was 3mg/kg, given each evening by mouth. The dogs were kept under standard conditions. They were fed once daily and a fixed amount of additional food was given with treatments.

At the end of the first, second, fourth and sixth weeks of each treatment period, 3-4ml of cisternal cerebrospinal fluid was taken from each dog under general anaesthesia (thiopental-isoflurane-nitrous oxide), without premedication. An aliquot of each sample was analyzed for routine cytology and total protein within twenty minutes. the remainder was stored at -80 °c. Fifteen months later, the samples were analysed as follows: (i) HIAA, HVA and MHPG: high performance liquid chromatography with coulometric detection, after the method of Scheinin *et al.* (1983) (ii) CMI: gas chromatography with mass spectrometric detection (Sioufi *et al.* 1988).

For each dog within each period, metabolite levels and their ratios to each other were summarised as means and as slopes (change in metabolites and ratios per treatment week). These data were analyzed using a general linear model (SAS®) with dog, period and treatment as independent variables. Anaesthetic factors (thiopental dose and the interval between induction and sampling) were included as covariates.

Results

All samples were normal on routine analysis. CMI was not detected in the cerebrospinal fluid (limit of detection = 2ng/ml). The summarised metabolite data showed marked between-dog variability. Slopes showed no significant treatment, period, dog or anaesthetic effects ($P > 0.05$). There were no significant effects on period means ($P > 0.05$) except for HIAA-MHPG (Table 1).

Table 1: Parameter estimates and confidence intervals for the ratio HIAA:MHPG, with period, dog and treatment as main effects (R-Square for the model = 0.99) * = $P<0.05$, ** = $P<0.01$

PARAMETER	ESTIMATE	STD. ERROR	C.I.
TREATMENT	-2.11 **	0.2	-2.96 < y < -1.26
PERIOD	3.48 *	0.35	1.98 < y < 4.98
THIO DOSE	-33.6 **	2.46	
INTERVAL	-0.21 *	0.03	

Dog effects were also significant ($P<0.05$).

Conclusion

The ratio HIAA:MHPG was significantly affected by treatment and period as well as by between-dog variability and anaesthesia. CMI produced a ratio that was 1.25-3 times lower than it was with placebo; this is consistent with CMI's predominant 5-HT-reuptake blocking effect in vitro. The ratio was 2-5 times higher in the first period compared to the second; period effects can occur in any experiment and in this case would reflect the dogs' habituation to the study routine. There were no significant effects on HIAA, HVA, MHPG, HIAA:HVA and HVA:MHPG. This contrasts with results in depressed people in whom CMI significantly reduced HIAA and HIAA:HVA (Asberg *et al.* 1977).

The findings must be interpreted with caution because of the statistical limitations of the study design and sample size, the dose of CMI (preliminary results from a pharmacokinetic study indicate that 3mg/kg once daily is inadequate) and the fact that the dogs were behaviourally normal. Given that dogs with compulsive disorders respond to CMI, the present findings support the notion that affected dogs may have a similar norepinephrine-serotonin dysfunction to humans with OCDs. The results provide the basis for calculating samples size for other studies. They also demonstrate the importance of anaesthesia as a confounding factor.

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How should we conceptualise person-pet relationships?

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In the last two decades there has been a steady increase in the number of empirical studies of the benefits of pet ownership. The evidence points to advantages in both physical health and psychological well being (eg Serpell 1991; Anderson et al 1992). Assuming that these findings reflect direct causal effects, it is likely that the relationship between person and pet will play an important part in any explanatory model. This motivates us to explore a number of issues concerning the nature and functions of these relationships.

It is not likely that the human species has evolved or otherwise acquired a set of psychological processes whose primary function is to serve relationships with companion animals. It is much more likely that processes are "borrowed" from those underlying human-human relationships and utilised for human-animal relationships.

Can we identify a particular category of person-person relationships that will help explain the characteristics of person-pet relationships? The classic categories of relationship are child-to-parent attachment relationships, parent-to-child caregiving relationships, child-to-child peer relationships, and adult-to-adult sexual relationships, which are generally presumed to have distinct psychobiological substrates (Harlow & Harlow 1965). Other types of relationship could be added to this list, perhaps most importantly sibling relationships and adult friendships. Where would person-pet relationships fit in?

In the literature on companion animals, person-pet relationships are most commonly characterised as bonds or attachments, but it is not always clear how these terms are being used. In its narrow technical meaning, an attachment refers to the close relationship, based on feelings of security, of a young child to a parent (Bowlby 1969). A slightly broader technical usage could encompass other relationships for which there were good grounds for believing are derived from child-parent attachments or based on the same narrowly defined psychobiological mechanisms (Ainsworth 1989). The concept of a bond, even in its technical usage, is considerably broader than attachment. A bond is the affection and attraction felt by one individual for another particular individual - not for a group or a species (Bowlby 1979).

To further clarify the issues, Ainsworth suggests that a subset of adult human relationships are properly regarded as *affectional bonds* if they are based on a long-enduring tie in which the partner is important as a unique individual. The key psychological process underlying the tie is an internal cognitive model of the relationship built up during the history of the relationship. The tie may be maintained during absences, but there is a desire to come together and pleasure on so doing, so there are affectional aspects to the tie. Typically, separation will cause distress, and loss will cause grief. Some, but not all, affectional bonds are attachments; the criterial feature of an attachment is the experience of security and comfort in the presence of the partner (which is a consequence of the activation of the attachment motivational system). Ainsworth quite explicitly indicates that a mother's bond to her child is not properly called an attachment because this feature is lacking. Any particular affectional bond may have *components* from different affectional systems. For example marital relationships typically involve sexual attraction, caring for offspring, caring for the partner, and experiencing comfort and security from the presence of the partner. Only if the last component is present would such a relationship properly be called an attachment.

Unfortunately, of all the concepts used in psychology to characterise involvement in relationships, bonding and attachment are probably the most widely used outside that discipline, often loosely as a synonym for almost any kind of relationship. It is likely that some uses of the terms bond and attachment in companion animal studies are of this kind. However, the technical concepts of attachment and bonding have important antecedents in ethology (Bowlby 1979). Phenomena with similarities to attachment are well known from a variety of different species of birds and mammals. It is therefore not unreasonable that a discipline such as companion animal studies should attempt to apply these concepts to human-animal relationships. This seems more compelling than concepts allied to symbiosis and other forms of inter-specific co-operation, which superficially might seem an alternative source of concepts in ethology for person-pet relationships (Serpell 1987).

The concepts of attachment and bonding, as developed in ethology and psychology, are primarily concerned with child-parent relationships. The most striking feature of child-parent relationships is the asymmetry between the thinking and language skills of the adult, and the relative lack of sophistication of these skills in the child. It might therefore seem attractive to apply these concepts to person-pet relationships which are also asymmetrical. However, the similarity is more apparent than real. The classic formulation of attachment (Bowlby 1969) is about psychological benefits accruing to the less cognitively sophisticated individual, the child, who is attached to the parent. In person-pet relationships, the asymmetry is the other way round. Here we think of the cognitively sophisticated person as being attached to the less sophisticated animal, and we think of the psychological benefits accruing to the person. There is a superficially similar theoretical framework that was developed to cover the bond of a parent to the child (see Myers 1984). The parent-child relationship is an important and perhaps archetypal example of a relationship based on caregiving, but it is not an attachment since it is not primarily motivated (in the parent) by feelings of insecurity (Ainsworth 1989).

It also seems very unlikely that felt security is particularly important in most person-pet relationships. In evaluating this claim it is important to distinguish between felt security in the rather unspecific affective sense found in talking about attachments, with a more focused cognitive appraisal of a specific role for, say, a large dog in acting as a deterrent or defence against mugging or burglary. We propose an empirical test of this assertion. We predict that among owners of more than one dog, knowing which dog they rated as most useful as a source of security would not help one predict which dog they felt most attached to.

We feel that the attachment metaphor is not particularly helpful as a way of characterising human-animal relationships which are presumed to borrow from a pool of motivational and cognitive components, strategies and dispositions available in human-human relationships. Child-parent attachment may have contributed to this pool but, in our view, it is not particularly helpful to look to attachment rather than any other kind of relationship for help in understanding the implications of pet ownership.

Moreover, we suggest that the question how pet-person relationships exert beneficial effects on health is best answered not by parallels with a particular kind of relationship such as attachment, but in relation to *social support*, which can be afforded by various different kinds of relationship. Four different kinds of social support can be distinguished (Cobb 1976): emotional support, instrumental support (practical assistance), informational support (advice etc), and support of self esteem. We suggest that the first and last of these, which are known to help in the alleviation of stress and the enhancement of physical health, are important facets of many pet-person relationships (McNicholas, Collis & Morley, 1995).

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Allogrooming in domestic cats in confinement

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Introduction

Adult domestic cats (*Felis silvestris catus*) groom one another (allogrooming) under a variety of conditions (e.g. Van den Bos & De Cock Buning, 1994a,b; Brown, 1993). Several possibilities regarding its role exist: (I) a cooperative hygienic behaviour, (II) a way of establishing relationships with individuals with whom it may be advantageous to affiliate, (III) a way of redirecting aggression and (IV) a way of reducing tension between animals.

It has been found that (i) the distribution of grooming bouts in pairs is skewed, (ii) allogrooming occurs more often from higher to lower ranking cats than the other way round, (iii) cats receive more allogrooming from cats from whom they also receive more offensive behaviour, and (iv) proximity scores (being within 0.5 m of another cat) and the number of allogrooming bouts correlate positively (Van den Bos & De Cock Buning, 1994a, 1994b). These observations seem to support hypotheses III and IV.

In order to find further support for and to differentiate between hypothesis III and IV grooming interactions were studied in detail.

Materials and Methods

Grooming interactions in a colony of neutered male (n=14) and female (n=10) cats (coefficient of relatedness: 0-0.632; Brown, 1993) were videotaped. Cats were observed for one hour between 11.00-15.00 hrs in either the outside or the inside enclosure after being moved to either area.

Cats were either labelled initiator (cat which approached another cat or invited another cat for an interaction) or recipient (partner). The occurrence of allogrooming, autogrooming, offensive behaviour and defensive behaviour was recorded (cf. Van den Bos & De Cock Buning, 1994a). Postures (standing, sitting up, sitting and lying) of groomer and groomee were also recorded. An interaction was considered to have ended when one of or both animals moved away (distance >0.5 m) or when none of the four behaviours was shown within 60 s after the last bout.

It was determined whether interactions started while animals were less than 0.5 m apart and whether animals remained within 0.5 m of one another at the end of an interaction (proximity). Sequence analysis (analysis of intra- and inter-individual transitions) on the one hand and factor analysis (Principal Components Analysis followed by varimax rotation of a product-moment correlation matrix of either frequencies (freq) or durations (dur) of behaviours) on the other, were used to detect the relationship between behaviours of initiators and recipients. It was furthermore determined whether allogrooming was directed to the head-neck area, shoulder-chest area or the abdomen area.

Scores for interactions were totalled to obtain one score for each behaviour per pair of cats (freq, dur). Scores were analysed for the different combinations of sexes: male-male (MM), male-female (MF), female-female (FF). Coefficients of relatedness were correlated with the scores of the four behaviours (freq and dur) to assess the effect of kinship.

Scores of individuals were totalled to obtain one score per behaviour per individual (freq, dur). Correlation matrices (freq, dur) were subject to factor analysis as indicated above.

Results

Eighty-three (of 92) interactions from the outside enclosure were analysed (23h 45min; 3.9 int/h). In 16% of the interactions cats were already within 0.5 m of one another when an interaction started. Grooming started on average 13 sec after cats got together. In 18% of the interactions cats remained within 0.5 m of one another after grooming bouts had been exchanged. Most grooming bouts were directed to the head-neck area (freq: 78%; dur: 88%). Groomers adopted higher postures while grooming than groomees (standing, sitting-up vs sitting). Groomers showed more often offensive behaviour than groomees. Factor analysis of individuals' behaviour revealed that allogrooming, autogrooming and offensive behaviour comprised one factor and defensive behaviour another. Offensive behaviour as well as autogrooming occurred most often after bouts of allogrooming. The majority of interactions (92%) were unidirectional.

Thirty-seven different pairs were observed to interact (13% of all possible pairs): MM: 49%; MF: 43%; FF: 8%. The distribution of grooming (freq,dur) in pairs was skewed. In those pairs in which clear rank differences existed (n=14) higher ranking cats groomed lower ranking cats more often (79%) than the other way round (χ^2_1 Goodness-of-Fit, vs. 50-50%: 4.571, *). No kinship effects were found.

Observations in the inside enclosure (23 interactions; 22h55min; 1.2 int/h) appeared to confirm the major findings from the outside enclosure. The main differences were that (i) cats were more likely to be already within 0.5 m of one another when an interaction started (52% of interactions), (ii) cats were more likely to remain within 0.5 m of one another after grooming (57%), and (iii) less agonistic interactions occurred (all *, χ^2 tests).

Discussion

This study showed, and confirmed, that (i) allogrooming is not elicited by proximity per se, (ii) allogrooming does not elicit proximity per se, (iii) allogrooming is associated with offensive behaviour and autogrooming, (iv) higher ranking cats are more likely to groom than lower ranking cats, (v) the groomer adopts a higher posture than the groomee, (vi) grooming is directed to the head-neck area, (vii) allogrooming is not related to kinship per se, and (viii) the distribution of grooming bouts is skewed in pairs. These data along with those of previous studies (see Introduction) suggest that in confinement grooming may be a form of redirecting aggression.

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Validation of several chronic stress parameters to establish welfare problems in dogs : a model of housing stress in the Beagle dog

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Introduction

Housing and handling conditions of domestic animals may lead to poor welfare. Welfare problems have been the subject of many studies, mainly focusing on practices in animal intensive husbandry. Relatively little attention has been given to welfare problems in dogs. Therefore, a project was initiated to investigate methods to be used to assess welfare in dogs.

The postulate of analogous reasoning, and the consideration that animals are intrinsically active, goal seeking, flexible, exploratory and learning individuals, leads people to assume feelings and emotional states exist in vertebrates. As direct measurements of animal emotions are not possible, welfare has been defined operationally in such a way that its assessment has become possible. Instead of focusing directly on animal emotions, welfare may be assessed indirectly by measuring (stress) parameters mirroring physical and mental states. Thus, biological responses to stress are keys to the assessment of problems in animal well-being.

Approach

Three principles guided our investigations into the stress parameters that may be indicative of the welfare state in dogs. We aimed to measure several parameters from (1) different biological systems, (2) preferably assessed in non-invasive ways, (3) to establish chronic stress. Chronic stress was applied by housing 15 animals (5 bitches and 10 males, mean age 1.6 years ± 0.2) for 6 weeks, individually in indoor kennels of restricted size (1.15 x 1.45m). Prior to this, control measurements were taken during a period in which animals were kept outdoors, in an enriched spacious group housing system. Previously , the animals had lived in such a system for more than a year.

During the control and stress periods, computer aided behavioural observations were made, urinary cortisol, catecholamine and creatinine levels were determined and saliva samples were assayed for cortisol. Blood samples were taken to perform leucocyte counts and lymphocyte proliferation tests, and finally various physiological (CRH, dexamethasone) and behavioural challenges were performed. Here we report on our findings of behavioural observations and the activity of the pituitary-adrenal-axis, as measured by the urinary cortisol:creatinine ratio (CC-ratio).

Naturally voided urine samples were collected at the end of the 6.00pm-7.00am interval ("nocturnal" samples that were collected only during the stress period), or during the 8.30am-noon interval (morning samples collected during both the control and stress period). Radioimmuno assays were performed to assay cortisol (nmol/L), and creatinine concentrations (mmol/L) were determined using a WAKO-20R Biochemical Analyzer. Behavioural observations were conducted using 'The Observer' software package (Noldus Information Technology). Raw data (frequencies and durations of behavioural elements and CC-ratios), were log transformed to achieve normality, and analysed using a multivariate analysis (MANOVA) of repeated measurements.

Measures for each week of individual housing (six 10min of behavioural observations and 1 to 3 urine samples per dog per week) were compared to control values (twelve 10 min of behavioural observations and an average of 5 urine samples per animal). CC-ratios of one dog were omitted, as its mean ratio during the control period was at least five times higher than the mean of the remaining animals.

Results

Individual housing induced elevated CC-ratio's in morning samples during week 1 (mean of 10.3 vs 8.3 in the control period, *), week 2 (10.4, *) and week 6 (11.1, **). Week 3 (10.5) tended to differ (*P*=0.06) from control values. Week 4 and 5 were not tested because of an insufficient number of samples. Nocturnal CC-ratios (mean = 7.9), were significantly lower (***) compared to morning samples, and were significantly increased (**) during the first week of stress (9.5), compared to the subsequent weeks (7.2). Throughout the period of individual housing, the dogs showed a lower posture (a state characterized by flattened ears, tail down and bended paws). Grooming and circling were increased, and the animals increasingly performed paw lifting and mouth associated elements like tongue out, mouth lick and swallow, elements we have previously shown to be induced by acute stressors. Other behaviour such as stretching and sighing were only elevated during the first 3 weeks of stress, where as others did not change at all (yawning, nosing, tail wagging, quiver).

Conclusion

Establishing urinary cortisol:creatinine ratios and specific behavioural characteristics (low posture, increased paw lifting and increased frequencies of tongue out, mouth lick and swallow), appear a useful non-invasive method for assessing chronic stress in dogs. Assessment of chronic stress by measuring CC-ratios and behaviour, may provide objective information to evaluate welfare problems in dogs.

Noise levels in dog kennelling: influence of housing and husbandry variables

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Introduction

Sound levels often exceed 85-90dB in some dog kennelling (Ottewill, 1968; Peterson, 1980). Such an environment would not be considered suitable for unprotected humans to work in for long periods. Dogs can detect sounds ranging in frequency from 40Hz (cycles per second) up to around 50kHz. and are most sensitive to sounds at frequencies from 500Hz to16kHz (the equivalent human range is of the order of 20Hz-25kHz). Within this range their threshold of sensitivity can be 24 dB lower than that of humans (Fay, 1988), so that they can hear sounds up to four times quieter than the human ear can detect. If sound in dog housing is a nuisance and potentially damaging to humans, it is very likely to have similar if not more marked effects on the dogs' hearing. Clearly, any physiological damage reduces the dogs' welfare.

In this study we carried out a survey of dog kennels in shelters and laboratories to identify features in the design of the kennels and husbandry techniques that lead to barking and high noise levels. The aim was to survey the extent of the problem, and to produce a set of recommendations to limit noise.

Materials & Methods

Noise levels at various locations within the laboratories and shelters were recorded for 24h at a height of about 0.5m from the floor. Maximum Noise Level (Lmax), Equivalent Continuous Noise Level (Leq) and Maximum Peak (MaxP) were extracted from the data over two frequency bands (1Hz-20kHz, and 12.5kHz-70kHz) and plotted. In addition we carried out reverberation tests (time for an echo of sound to reduce by 60dB), and measured frequency spectra for noise associated with various husbandry events (cleaning out, etc.).

Results

High noise levels were recorded at many of the sites during the working day. In one example noise levels were circa 110dB in the frequency range 1Hz-20kHz and 80-90dB in the frequency range 12.5-70kHz. Between 1600 and 0600hr there were occasional periods of high levels of noise. Reverberation time was low at one site with a suspended fibreglass ceiling but high at a site with plasterboard ceilings and breeze block walls. Recordings of barking, the main source of sound, showed peak energy at 1-2kHz, but the exact spectra differed between the breeds.

Discussion

The data showed that there was a noise problem in a range of different dog housing establishments, although there can be substantial differences between sites. Sites with levels of noise that are considered unsuitable for unprotected humans may be even more unsuitable for dogs which have more sensitive hearing and are there for longer periods.

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Teaching riding horses to be safe

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Introduction

There has been a dramatic increase in horse-related accidents in the last few decades. According to a German survey, the increase in sport-related accidents, in general, from 1959 to 1974, was 11 per cent, but was 344 per cent for horseback riding during the same period. This increase is related to the fact that more people ride; the way horses are housed and managed, and the fact that riders generally have less experience with horses. There has been a clear trend towards keeping horses on private farms or in backyards as opposed to keeping them in more professional riding stables. Consequently, an increasing number of people are unsupervised when they ride and handle horses. In addition, people now taking up horseback riding are generally inexperienced with large animals, coming from an urban or suburban background, and they are generally more interested in recreational as opposed to competition riding. These trends result in relatively less experienced people handling and riding horses under less supervised conditions, leading to an increased probability of accidents. According to surveys in Germany, horseback riding ranks tenth on a list of sport-related accidents (number one being football). However, when the severity of the accidents is considered, horseback riding ranks second (number one being car racing).

Apart from affecting the health of people, modern housing and management systems also appear to affect the health of the horses. According to studies in Germany, the average life span of modern riding horses is 8 years. Considering that horses are about 3 years old when starting their career, this extremely short life span raises serious welfare questions (e.g. Butler and Armbruster, 1984).

General safety precautions

Most accidents happen when the horse shows a natural behavioural response, either a flight response after being frightened or because it shows some kind of play behaviour. Consequently, to handle and ride horses safely, a detailed knowledge of normal horse behaviour is essential. Horses are flight animals that respond to sudden stimuli by jumping away or running off, and a handler must be prepared for this possibility. Serious accidents have happened because a person has wrapped the halter rope, the reins, or the lunge lines around their hand instead of holding it in a way that they can drop it instantly. The rider must be prepared for the horse suddenly stopping, jumping to the side, turning around or running off.

Horses are social animals that under natural conditions live under the constraints of a social hierarchy. It is therefore essential that the handler establishes a dominant position over the horse i.e. for the rider to be in control, the horse must accept them as the "lead animal".

Riding safety can be further increased by housing horses according to their species-specific requirements (see Kiley-Worthington, 1990). Housing horses in social groups, as opposed to individual confinement, and providing daily access to a pasture or a paddock ensures that they are less excitable. The increased stimulation in group housing renders a horse less likely to show fear or play behaviour when being ridden. Similarly, feeding a horse too much concentrates and too little roughage can increase the likelihood that a horse shows fear or play behaviour.

Specific safety training

Some riding organisations attempt to improve safety in horseback riding by propagating safety equipment (i.e. the use of protective helmets, gloves, boots, and safety stirrups). In addition, the need for better education of riding instructors in safety measures has been identified. Specific and goal oriented training of riding horses to become safer in otherwise accident-prone situations is also needed. Many horses have specific anxieties (e.g. fear of motor cycles or of being isolated from other horses) or they have developed bad habits (e.g. charging towards the stable) that makes them risky to ride. It is possible, however, to train horses to change their behavioural responses to such anxieties or habits by applying behaviour modification programs similar to the ones used in companion animal behaviour clinics (Hart and Hart, 1992). The training of the horse according to such programs is similar to any other training (such as to train a horse to wear a saddle and rider) and is best administered during daily training sessions.

Example 1: It is necessary to modify fear of motor cycles before a horse can be ridden safely on a public road. The behaviour modification needed entails habituation to motor cycles either through successive approximation (i.e. repeated exposure to a gradually intensified stimulus and avoidance of the usual behavioural response) or by means of the flooding technique (i.e. repeated exposure to an intense stimulus until the fear behaviour subsides).

Example 2: Many accidents happen when a rider is out riding on a trail alone. In order to make this kind of riding safe, the horse must learn not only to be away from other horses (i.e. to be taken out of the stable alone for the ride) but it must also learn to walk away from other horses (in case it should meet other horses during the ride). Both situations must be trained during special sessions in which the duration of the separation is gradually increased and the desired behaviour (i.e. that the horse remains calm) rewarded.

Example 3: Behaviour modification programs can also be used to modify unwanted behaviour, such as bad habits that make handling and riding a horse dangerous. For instance, some horses develop the habit of charging towards home at the end of the ride. To break this potentially dangerous habit, an extensive programme can be applied, in which the unwanted behaviour is completely avoided over a long time. One way to achieve this is to initially make the ride home so short that the horse does not get a chance to charge. i.e. on day 1, the rider rides away from the stable only a short distance, turns around and rides back. On day 2, the distance is increased a little bit, etc. By gradually, but slowly, increasing the distance daily, but never allowing the horse to charge, the horse will eventually stop the habit. Another way to break the habit is to completely avoid the behaviour by restraining the horse in such a way that charging is impossible, or for the rider to get off and lead the horse home if needed. After enough repetition (which may take months), the unwanted behaviour will eventually be replaced by the desired behaviour.

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Environmentally enriched housing for dogs

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Introduction

The Waltham Centre for Pet Nutrition (WCPN) has maintained colonies of dogs and cats since 1965. From 1973 the colonies were moved into converted and new buildings on our present site. Following a review of WCPN needs and future requirements, it was decided to rehome the WALTHAM animals in surroundings that would make them more representative of pets in the outside world thus improving the quality of the information generated from their study which is applied directly to domestic pets and working dogs. This required the design, construction and operation of buildings which provide maximum environmental interest to the pet while being consistent with the requirements of nutritional and behavioural studies. The husbandry systems use best healthcare practices, with emphasis on canine and feline companionship and the human-pet relationship.

Materials and Methods

Discussions were held to generate ideas that had the following features:- 1) practical working buildings easy to clean and use for studies 2) individual buildings to avoid the spread of disease 3) a more "domestic" homelike ambience 4) avoidance of long corridors and rows of animals in "cells" 5) avoidance of cages 6) a feeling of light and space 7) access to the outside in all weathers where appropriate 8) provision of environmentally enriched living accommodation for the animals 9) provision of access for visitors to all parts of the facility 10) buildings that blended well into the countryside gaining support of the local community and planning authority.

The concept of the whole design is to provide a ring of linked but separate single storey petcare buildings around which personnel and visitors can circulate and see both the inside and outside of the buildings, with no inaccessible areas. The dogcare buildings designed for adult maintenance, breeding, puppy growth and digestibility studies are a basic design consisting of two or three kennel wings housing the dogs around a central services area, modified to meet the specific needs of the studies.

It is considered that the octagon shape provided a form enabling creation of environmentally interesting and functional areas both for housing the dogs and the work areas. The kennels for the pairs of dogs are formed by dividing the basic octagon into two, each kennel then being further divided to give an internal area for sleeping and eating and an external exercise area available 24 hours a day whatever the weather.

The pairs of kennels face into a central top lit court allowing the dogs to see, hear and smell other dogs in addition to all activities carried out in the kennel wing including feeding, weighing, examinations and assessments allowing the dogs to be involved in the working day. All inner pen doors facing the central court are low enough to allow the dogs to be patted, stroked and talked to, allowing maximum human-pet interaction. The windows and transparent exit flaps in the kennels provide visibility to the outside allowing the dogs to choose whether to be inside or out. From the outer exercise part of the kennel the dogs can observe the activities in exercise areas and all movement and activity in the glazed corridors linking each building. The generous use of glass in the building provides sunlight throughout working and kennel areas, whilst the corners provided by the octagon design of the kennels provide a choice of shade in some areas of the living accommodation at all times and also allow areas where the dogs can rest and relax, free from the attention of other dogs.

Each building is ringed by grass and paved exercise areas which are used during daylight hours for supervised exercise, allowing socialisation and interaction between dogs and their carers. All dogs receive regular outdoor exercise and socialisation, young dogs who enjoy active play are exercised in larger groups, while older dogs and pregnant bitches are exercised in small groups or individually. Carers spend considerable time playing with the dogs and a variety of toys including balls, hard chews and ropes are provided each day to give variety and novelty. During the summer water baths and pools are provided. In addition to paddock exercise, all dogs are lead walked at least once a day. Lead walking is restricted to the extensive grounds of WCPN to ensure that no contact with dogs other than our own occurs helping to prevent transmission of infectious diseases or parasites.

At 8 weeks of age all puppies are named and assigned a handler who is responsible for their training. Trained handlers with qualifications in instructional techniques run dog training classes regularly giving basic control of the dog both inside the accommodation and while at exercise, as well as providing physical and mental stimulation for both dog and handlers with each dogs' training tailored to match their individual abilities and requirements. Initially they undergo a programme of basic puppy training followed by a course in basic obedience. At the end of these courses dog and handler are formally tested and then progress to other courses including agility training, field work, tracking and further obedience training. In order that training and exercise can continue in all weathers, both grass and paved areas have been provided adjacent to the buildings.

To provide canine companionship, dogs are housed in pairs or trios and spend as much time as possible in paddocks interacting in larger groups. When lead walking adult dogs from different buildings are allowed to socialise and this socialisation is increased at training classes. In order to further develop inter-dog social skills in puppies, a retired stud dog is housed in the puppy building allowing puppies between 8 and 18 weeks of age to become familiar with the behaviour of adult dogs.

Conclusions

The decision to build a relatively open facility to meet the needs of animals and staff has proved successful and rewarding. Our many breeds of dogs, that represent a cross section of domestic pets bred to be companions and working dogs, have been provided with comfortable housing, choice of environment, sensory stimulation, physical and mental exercise with emphasis on canine companionship and human-pet socialisation. The provision of a dedicated husbandry team whose primary objective is the care of the animals has enabled welfare to maintain its importance alongside a vigorous and productive research plan. The exercise and socialisation of the dogs has given WCPN a population of friendly, adaptable "forward coming" pets, visibly outgoing and stimulated as measured by our experience and by comments from both scientific and non-scientific visitors.

Psychological support as a mechanism underlying health benefits associated with pet ownership.

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Recent studies have reported that pet ownership is associated with benefits to physical and mental health, including survival of and recovery from angina pectoris and myocardial infarction (Friedmann, 1990); adjustment to human bereavement (Akiyama *et al.*, 1986); reduction in risks for cardiovascular disease (Anderson *et al.*,. 1992); and a generalised enhancement of physical and psychological well-being on acquiring a pet (Serpell, 1991). However, there is little firm evidence about the mechanisms mediating these associations.

There are three broad classes of explanation for the apparent health benefits of pet ownership. Firstly, there may be a non-causal association between pet ownership and health in that some other factor may be associated with both health advantages and the propensity to own a pet. We examined whether people classed as Type A (coronary prone, high stress) personalities were less likely to incorporate pets into their lifestyle. If this were the case, non-Type A personality could be said to contribute to both health benefits and the likelihood of pet ownership. Contrary to this hypothesis, our findings from a survey of 544 adults showed that pet owners were more likely to show Type A characteristics than non-pet owners. These data clearly rule out the non-causal explanation of an association between pet ownership and health as a consequence of Type A high-risk lifestyles being under-represented among pet owners.

The second type of explanation is that there may be indirect effects on human health. For example, it is well known that pets act as social catalysts in enhancing social interactions with other people (McNicholas, Collis, Morley & Lane, 1993) and it might be this augmented network of human relationships that exerts an influence on health.

The third possibility is that a pets have direct effects on human health. It is widely believed the such effects are most likely mediated by the person-pet relationship. There is less consensus, and little empirical exploration, as to how relationships might exert their effects. It has been suggested that, for some owners, the pet is perceived as a significant relationship that can provide psychological elements of social support at times of stress. However, there has been little conceptual analysis and no empirical test of how this might work.

Social support may be defined as the "social, emotional and instrumental exchanges with which the individual is involved, having the subjective consequence that an individual sees him or herself as an object of continuing value in the eyes of significant others" (Pilisuk & Parks, 1986). Research in Health Psychology attests to the importance of social support in recovery from a wide range of medical conditions as diverse as hip fracture, major depression, osteoarthritis, myocardial infarction (Glass *et al.*, 1993) and in coping with stressful life events such as bereavement of a human partner (Littlewood, 1992). Social support is commonly broken down into a number of subcategories, including emotional support and esteem support. Emotional and esteem support are seen as particularly valuable in early stages of serious illness or a major stressful life event.

Whilst person-pet relationships are clearly not identical to person-person relationships, they do seem to have a great deal in common, particularly as a resource for support. Many pet owners regard their pets as valued members of the family, affording them similar status to some human companions, and may seek them out as a source of comfort at times of stress. The relationship may frequently involve confiding and talking to the pet, a feeling of empathy and a sense of loving and being loved which can combat loneliness and depression, particularly in individuals who feel socially isolated. Pets also meet an esteem function in providing a 'need to be needed'. These aspects of pet ownership mirror elements of human relationships that are believed to have important implications for health, elements which collectively fall within the concept of "social support".

An important theme in studies of the efficacy of support is that it must be perceived by the recipient as supportive. Inappropriate support, for example offers of practical help in place of emotional comfort, is unlikely to be perceived as supportive and unlikely to bring about benefits. Human relationships frequently offer inappropriate support. Support may also fluctuate in quality and quantity according to the provider's own perceptions of need, his/her own emotional state, whether he/she is also affected by the same stressor, or as a consequence of sustained demand for support. In addition, the seeking of social support may involve risks or strains to the relationship that may be perceived as undesirable. In contrast, a person-pet relationship involves no hidden agenda or conditions to be fulfilled within the relationship, nor does turning to that relationship impose strain upon it. A pet remains a constant, unquestioning companion whose behaviour is predictable, unconditional, and largely unaffected by any change in the owner's status as perceived by self or others.

In the project 'Pets as providers of social support in human bereavement: a test of the social support model' funded by the Waltham Centre for Pet Nutrition, we investigate the role of pets as providers of social support for people experiencing a bereavement. The following propositions (McNicholas, Collis & Morley, 1995) are explored.

1. Pets may provide emotional support and esteem support, similar to that received in close human-human relationships.

2. Social support perceived from pets may operate it the following ways;

- As a constant source of additional support that may be relatively low level on its own but which nevertheless may significantly top up existing human social support;
- As a replacement to lacked human support:
- It may cushion against the effects of fluctuations in human support or inappropriate support.

3. Pets may help re-organise and re-establish routines and initiate social contacts in a particularly normalising way that is unconnected with the presence of a stressor.

4. No social skills are required to elicit pets' attention, thus removing the potential problem of assessing how to mobilise support, as exist in human-human transactions. Individual abilities in social competence in negotiating or regulating social support are not applicable, avoiding mismatches in required or received support or perceived shortfalls in received support within this particular relationship.

5. Pets may provide a refuge from the strains of human interactions, allowing a freedom from pretences or barriers that may necessarily be erected between giver and recipient of support to mutually protect the relationship. This release from relational obligations may provide breathing space and opportunity for naturalness that has particular relaxation benefits.

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Pathophysiological conditions in companion animal behavioural therapy practice

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Current regimes for the treatment of abnormal behaviour in companion animals are generally based on a thorough knowledge of the natural history of the species and an extension of techniques used in human psychotherapy including Behaviour Therapy, Cognitive Therapy, Gestalt Therapy and therapy based on the Medical Model of Abnormal Behaviour. None of these imply a need for traditional veterinary diagnostic skills. The role of the veterinary surgeon in the evaluation and management of these cases is unclear. The veterinary profession has a legal obligation and responsibility for "the diagnosis of diseases in ...animals" and "the giving of advice based on such diagnosis" under the Veterinary Surgeons' Act 1966. The medical model implies that abnormal behaviour is a disease and so, in animals, the responsibility of the veterinary profession. Such a model for abnormal behaviour in people has been criticised (Szasz,1960.) on the basis of a fundamental difference between "physical" and "mental" health. The relevance of this distinction to the role of the veterinary surgeon in the management of abnormal behaviour in animals is debatable. Nonetheless, there are many recognised pathophysiological causes of problem abnormal behaviour in companion animals (Reisner,1991.) the management of which are undeniably the responsibility of the veterinary profession.

Voith (1981) reported that 3 out of 62 (4.8%) canine cases referred to the University of Pennsylvania Animal Behavior Clinic had a pathophysiological/neurological cause. The current review is of 292 canine and feline cases presented to the author in the three year period prior to July 1994. In all cases, the owner considered the behaviour of their pet both abnormal and a problem but not one of a medical nature. The data therefore exclude cases presented for obedience control advice. 38 (13%) had a significant ongoing underlying medical condition. 29 of these were from the 245 canine patients examined giving an incidence of 11.8% in this population and 9 from the 47 feline cases (Incidence 19.1%).

The behaviour of cases is classified according to the physical signs witnessed by the owner rather than any suggested diagnosis which may be inconsistently described by different clients. In this context the term "apparent phobia" relates to signs such as hiding or avoidance behaviour, witnessed by the owner.

Amongst these cases the most frequently diagnosed diseases in dogs were a focus of musculo-skeletal pain (9 cases), dietary sensitivity (3) and anal sac impaction (2). Behaviour problems in dogs with a medical problem were presented most frequently with the following complaints: aggression (65.5%), apparent phobia (10.3%), and noisiness (10.3%). The incidence of the most common complaints within the total canine behaviour caseload was: aggression 72.2%, housesoiling 20.0%, destructiveness 14.3%, noisiness 6.1% and apparent phobia 4.1%. Note; these percentage figures are based on the behaviour or behaviours given by the owner as the basis for seeking assistance with a case. One animal may be represented in more than one behaviour category and so the total of the individual frequencies exceeds 100%. They exclude secondary complaints about behaviour which were made once a consultation had been obtained.

The most frequently diagnosed diseases in cats were chronic renal failure (3 cases) and cystitis (2). The presenting signs of medically based behaviour problems in cats were:

apparent phobia (66.7%), aggression (33.3%) and housesoiling (22.2%); this compares to the following incidence frequencies within the total feline behaviour caseload of: housesoiling 61.7%, apparent phobia 44.6% and aggression 31.9%.

These data may be higher than those previously reported as they include both first opinion and referral cases. In contrast to this, also excluded from the data, are animals with physical lesions as a result of abnormal behaviour (eg trichotillomania and other forms of self mutilation) as it was believed that these would ordinarily be presented to a veterinary surgeon in the first instant. Also excluded are cases in which an episode of ill health is believed to have resulted in a learned behaviour problem or temperament change eg protectiveness over a *previously* inflamed body region. The recognition of the involvement of such historical pathophysiological problems is important as it will result in a misdiagnosis and either ineffective or unnecessary treatments.

These figures do not include cases of known breed specific behavioural disorders such as star gazing in Schnauzers, details of which can be found in veterinary neurological texts (*e.g.* Chrisman,1991.) as the pathophysiological nature is debatable. Also excluded are behaviour changes associated with a normal physiological state eg oestrus, pregnancy or pseudopregnancy and cases in which localised encephalitis may have been suspected but not supported by any of the diagnostic criteria given below, eg cases of feline immunodeficiency virus in which relevant central lesions were not confirmed. Hopper (personal communication) has however listed the following behaviour changes in such cases: a change in personality, cold intolerance, reclusiveness, aggression and persistent licking.

The significance of an ongoing medical problem diagnosed in the cases cited was determined by one or a combination of the following factors: relevant lesion identified, response to treatment of the disorder, and/or case progression relative to progression of the suspected medical cause.

The particularly high incidence of medical conditions presenting as feline behaviour problems is possibly a reflection of the increasing number of pet cat owners with no prior experience of cats and their behaviour during sickness and health. The tendency to hide away and apparent timidity may be a sign of general malaise not recognised by some cat owners. Three cats were presented with such signs, but also had recognised clinical signs suggestive of chronic renal failure and were over the age of 10 years at the time of onset of the behaviour change. When the renal condition was managed medically and with the assistance of a controlled diet, the behaviour improved without the need for psychological intervention.

The combination of a medical history to identify factors such as the nature and age of onset of the condition, together with a routine clinical evaluation, including ophthalmic and proprioceptive evaluation was sufficient to at least suggest further investigation of an underlying medical disorder in the majority of these cases. However it is important not to consider clinical veterinary and behavioural therapy as exclusive options since the welfare of patients is optimised by an approach combining both.

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Pet ownership and human health

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Introduction

Previous studies of the relationships between pet ownership and attachment, and human health, have detected beneficial changes in both the physical and psychological health of people. For example, Friedmann *et al.* (1980), investigated the effects of pet ownership upon myocardial infarction and acute angina pectoris patients. They found that pet owners appeared to have a greater likelihood of survival one year after myocardial infarction or acute angina pectoris than those patients that did not own a pet. Recent evidence suggests that by providing companionship, pets may also decrease feelings of loneliness and depression in some owners (Goldmeier, 1986; Zasloff & Kidd, 1994), and may increase owner morale and self esteem (Robb, 1983; Connell & Lago, 1984).

However, there have also been studies which have shown no effects or even negative effects associated with pet ownership (Friedmann *et al.* 1984; Watson & Weinstein, 1993). The conflicting evidence for the potential link between pet ownership and improved owner health prompted the initiation of the current study.

Methodology

The methodology of the study has been designed to examine the effects of pet ownership on myocardial infarction patients differentiated as pet owners (the test group), and non-owners (the control group). An estimated total sample population of 400 myocardial patients are currently being recruited through two hospitals and data are being collected through the use of a series of self-report questionnaires. To lessen the chance of bias in the responses, the patients are only told that the study is concerned with the effects of lifestyle on human health, and responses are sent to a private address.

Measures

Demographic and personal lifestyle characteristics are recorded through the employment of a Lifestyle questionnaire. Demographic characteristics assessed include gender, age, marital status, and employment status. Among the questions on patients' lifestyles, are ones seeking details on risk factors for cardiovascular disease, including: diet and exercise habits; smoking habits; alcohol consumption; and recent life stresses. Additionally, questions on living arrangement ask whether or not other people are living with the respondent.

The number of social contacts, and the patients' satisfaction with this are assessed by the 12-item Social Support Questionnaire (Sarason *et al.* 1983). This questionnaire asks respondents to list people whom they can rely on in various situations, and to rate their degree of satisfaction with the social support that they receive in those situations. From this, both a social contact score, and a patient social satisfaction score can be calculated.

All subjects are asked to complete a Pet Ownership Questionnaire. Respondents identifying themselves as non-owners are asked a series of questions about their previous pet owning experience, including species owned and degree of attachment to it. Questions concerning whether or not they would like to own a pet, and the reasons given, are also included. Pet owning respondents are asked considerably more detailed questions concerning their relationship with their pet(s). Questions focus upon the type of pet(s) owned, who is responsible for their care, and the frequency and intensity of interactions with them. Respondents are also asked about the perceived benefits and negative aspects of pet ownership.

Both pet owning and non-owning subjects are asked to complete the 28-item General Health Questionnaire (GHQ-28), a psychiatric screening test designed to measure psychological components of ill-health (Goldberg & Hillier, 1979). The questionnaire is divided into four sections, from which four symptom scores can be calculated. The sum of the four scores provides the main severity score.

These instruments are currently being administered to patients following hospital release, and again six months later. The preliminary results, derived from the data obtained from 100 patients will be presented.

At the six month follow-up, a Medical Information questionnaire is also administered to patients, and asks patients about their medical details, including their current medication. Information concerning readmittance to hospital and development of further complications is also being collected.

The results of this study will provide an assessment of the impact of pet ownership on the health status of persons following myocardial infarction, and thus, a further insight into the effects of pets on human health.

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The behaviour and welfare of cats in a quarantine cattery

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Introduction

The UK Rabies Order (1974) states that every cat imported into Great Britain must be detained and isolated in approved quarantine premises for six months. Cats are confined to a small, enclosed space, and are relatively isolated from people and from other animals. In this study, behavioural observations and changes in urinary cortisol output are used to assess the welfare of cats in quarantine.

Materials and Methods

Seven cats, housed singly in a quarantine cattery, were observed. Cats arriving at the cattery were filmed for the first three days of the first week (days 1, 2 and 3), the first three days of the second week (days 8, 9 and 10), and the first three days of the fifth week (days 30, 31 and 32), and then for one day a month from the third to sixth month of quarantine (day 60 in week 9, day 90 in week 13, day 120 in week 17 and day 150 in week 21). Fourteen mutually exclusive behaviours were noted, as well as the location of the cat in the cage. This information was recorded continuously for the first five minutes of every half hour, from 06:00 to 20:00, and the percent time (minutes/total time observed) of each behaviour was calculated, as well as the percent time spent in different locations in the cage. The presence of a person in the cat unit or in the cat's cage was also recorded.

Changes in urinary cortisol output have been used to measure stress sensitivity in domestic cats (Carlstead et al 1992, 1993). In the present study, urine samples were collected once daily, from modified litter trays, on the days of the observations. Cortisol was analysed using a radioimmunoassay technique (SCL Bioscience Services Ltd., Cambridge), and cortisol concentrations were indexed by urinary creatinine concentration to account for changes in fluid balance.

Behaviour, location and cortisol concentrations over the thirteen days of observation were compared using Friedman's two-way analysis of variance. Post-hoc comparisons were made between days in weeks 2, 5, 9, 13, 17 and 21 and the first day in quarantine.

Results

Cats spent significantly less time ($p<0.05$) out of sight, concealed in a small cat house on the floor of their cage, on days 31 and 32 (week 5) and on subsequent days 60, 90, 120 and 150, compared with day 1. By week 5, cats groomed more ($p<0.01$, days 31 and 32) and slept more($p<0.01$, day 32), and more time was spent on the shelf in the cage ($p<0.01$, days 30, 31 and 32). These increases in sleeping, grooming and time spent on the shelf were maintained during the following months in quarantine. Rolling and stretching behaviour was significantly increased ($p<0.05$) on day 8, and showed a tendency to increase ($p<0.1$) on days 10, 30, 31, 32, 60, 90 and 150. Locomotion was significantly increased ($p<0.05$) on days 8, 32, 90 and 150, and showed a tendency to increase ($p<0.1$) on days 30, 31, 60 and 120.

Urinary cortisol concentration was significantly lower ($p<0.05$) on day 32 and on subsequent days, compared with the first day in quarantine. A person was present either in or near the cats cage for between 1 and 8 percent of the time observed; this did not change significantly during the days of observation.

Conclusions

These results show that it takes between two and five weeks for cats to show evidence of adaptation to their new environment in quarantine. During the first month, hiding in a concealed place was an important behaviour for dealing with a new environment. By the fifth week, cats spent less time hiding in their cat house, and more time in an elevated and exposed location, such as the shelf. From day 31, cats groomed and slept more while not concealed, suggesting that the animal was more confident in its environment. This conclusion is supported by the increase in comfort (rolling and stretching) and locomotory behaviour in the second and fifth weeks, and by the decrease in urinary cortisol concentration from day 32. The cats had a limited amount of time in contact with humans.

This study will help in the development of sound scientific guidelines on how to ensure the optimal welfare of domestic cats kept in quarantine premises, and in other restricted environments such as boarding catteries and research laboratories.

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The behavioural assessment of dogs in animal shelters: Inter-observer reliability and data redundancy

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Introduction

A substantial proportion of dogs that pass through animal shelters have been given up for rehoming because of behaviour problems (Bailey 1991). Diagnosis of behavioural disorders while a dog is in a shelter would permit better matching of dogs to prospective owners, and more precisely targeted advice on how to cope with specific problems. There is therefore a need for a routine assessment procedure which can diagnose incipient behaviour problems. The one such procedure that has been published (Van der Borg *et al.*, 1991), while it does provide prediction of subsequent behavioural disorders, takes an average 1.5 hours to test each individual dog, making it unsuitable as a routine instrument. Other less widely disseminated procedures (*e.g.* J. Rogerson, unpublished) have not been formally validated, and may rely upon a high degree of skill in the interpretation of behaviour on the part of the tester. To be reliable, any standardised test would require that the dog should react identically to whoever carried out the test, and yet anecdotal evidence, and a single published account (Lore & Eisenberg 1986) suggest that dogs react differently to male and female testers. We report here a preliminary investigation into the effect of the characteristics of the tester on various elements of existing temperament tests.

Methods

Subjects were 79 dogs (54 male, 25 female, the majority cross-breeds), which had been kennelled singly at the rehoming shelter for at least 48 hours prior to testing. Each was tested once by a female (IAB) and once by a male (SMW), on different days in the same week. The tester first approached the kennel where the dog was housed, then squatted down at the entrance to the kennel, first without making and then making eye contact with the dog, and then finally putting the fingers through the bars of the door. The dog's reactions were recorded, including its position in the kennel, movements of ears and tail, vocalisations, and specific reactions to the tester's hand. The dog was then walked out-of-doors, noting its reactions to being leashed, to a test room. The tester allowed the dog to investigate the room for five minutes, then called it by name, commanded it to sit, offered it an item of food, and attempted to groom it. After being offered a further item of food, the dog was then left alone in the room for five minutes, and its reactions noted during separation and on the return of the tester. The dog was then returned to its kennel, pausing 15 seconds in an area of the shelter where all kennels were occupied to test the dog's reactions to unfamiliar conspecifics. Having replaced the dog in its kennel, the tester first talked to the dog quietly for 10 seconds, then made direct eye contact, stood up abruptly and shouted at the dog. A total of 121 measurements was recorded for each dog. Inter-observer reliabilities were tested using kappa coefficients for presence/absence measures and Spearman rank correlations for scaled measures with three or more points (Martin and Bateson 1993).

Results

Eighteen of the measures were discarded because they were too infrequent to be tested statistically, and 59 due to low reliabilities (kappa < 0.3; Spearman $\rho < 0.4$). Three infrequent measures, bite (tester) and growl (at tester, at dog), were summed across all stages of the test and retained for further analysis, because of their potential value in predicting problems of aggression. Average scores for the remaining 44 measures were combined by factor analysis. The measures loaded on each factor (Table 1) were then combined together for each observer separately. Inter-observer reliabilities for these eight composite measures were all greater than 0.55 (Spearman ρ), except measure 8, (ρ=0.39) which was only scored for 22 dogs by either observer. Median values for each composite were similar, except for measure 2, in which the male tester scored slightly higher than the female.

Table 1. Behavioural measures loaded positively on each of eight varimax-rotated principal factors, with descriptive names. Descriptors of measures loaded negatively have been reversed.

Number/Name	Measures
1. Tail Positions	Tail up to tester (at 4 stages), tail not moving (1 stage)
2. **Reactions to Eye Contact**	Tail moving, pawing, ears back.
3. Reactions to Dogs	Lunge, bark, growl, tail moving.
4. Reaction to Separation	Vocalisations, jumping at door in room test; pawing and whining in kennel
5. Contact-Seeking	Barking (5 stages); jumping, pawing (both 2 stages)
6. Shivering	Shivering (2 stages)
7. Scent-Marking	Frequency of urination (2 stages)
8. Aggression to Person	Bite finger, growl, mouth brush during grooming.

Conclusions

This study has highlighted the difficulties intrinsic in a test of dog behaviour that relies on interaction with a human handler. Even though the two testers were able to discuss the standardisation of each test element prior to starting the assessment of the dogs, they obtained different results, both qualitatively and quantitatively, on many elements of the test. Further studies of the effect of the characteristics of the tester on dog behaviour are needed; no firm conclusions can yet be drawn even on the effect of the gender of the tester, since in both this study and that of Lore and Eisenberg (1986) only one male and one female were used.

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Free Papers

Do Abnormal Behaviours of Captive Birds Reflect Specific Deficits in Foraging?

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Foraging in any species consists of a series of appetitive and consummatory processes, and Hogan (1971) showed that integration of these in young chicks depends on experience of post-ingestional consequences. In other work with chicks, Sterritt and Smith (1965) concluded that feedback from pecking and from delivery of food into the crop are both reinforcing, but only in interaction with each other. It seems possible that all components of foraging, including walking, ground scratching and oro-pharyngeal stimulation, may represent separate potential sources of reinforcement. In natural environments, where foraging may take up much time, levels at which different components are expressed presumably depend on factors such as diet, food availability and nutrient density. However, in captivity some components are likely to be suppressed relative to these levels, because of confinement, free access to concentrated food, or chronic food restriction. It is suggested that under these conditions, components of foraging that are suppressed are likely to be expressed in apparently inappropriate ways, but in appropriate contexts, in response to specific deficits in reinforcement. This assumes a homeostatic basis to reinforcing processes. This hypothesis is considered here in relation to abnormal behaviours shown by ad libitum-fed and restricted-fed captive birds.

Ad libitum-fed birds

Contra-freeloading

When given a choice between working for food and freely available food, pigeons and domestic fowls have been found to work for at least part of their daily food consumption. New evidence shows how food particle size and nutrient density are related to levels of feeding activity, contra-freeloading, and other forms of oral behaviour.

Variation in feeding efficiency

Typically, feeding efficiency (g food eaten/min feeding) is lower in laying strains of fowl than in broilers, and varies in relation to food form, time of day and environmental complexity. Times spent feeding by laying hens in different environments are negatively correlated with ground pecking and scratching behaviour.

Object pecking

Object pecking (and "exploratory" pecking at food) in cages substitute for ground pecking in pens. Caged hens with access to food for only part of the day showed stereotyped spot-pecking after the feeding period. It may reflect continued expression of foraging.

Feather pecking

Hens in pens with intermittent access to food showed ground pecking after feeding periods when litter was present, and feather pecking after feeding when it was not. This supports the proposal that feather pecking represents redirected ground pecking.

Route-tracing

Stereotyped pacing in hens is specific to the pre-laying context, but that seen in other caged birds may reflect a more general effect of confinement.

Restricted-fed birds

The level of chronic food restriction imposed, and associated reduction in body weight, are correlated positively with feeding motivational state and with levels of both general activity and expression of abnormal behaviour.

Operant conditioning

Schedule-induced polydipsia, autoshaping, complex stereotyped sequences, and other forms of "misbehaviour" have all been described in restricted-fed birds with various forms of operant feeding. The types of behaviour seen appear to be context specific in relation to food presentations. Contra-freeloading has also been demonstrated in hungry pigeons, but only after they had eaten substantial amounts of free food in test sessions.

Simple feeding schedules

Restricted-fed broiler breeders show increasing anticipatory pacing before their single daily meal and declining oral behaviour afterwards, some of which is stereotyped, and which is presumed to reflect persistence of unfulfilled foraging. Drinking, pecking at any non-food object (including litter) and preening can all substitute with each other as dominant post-feeding activities (hence distinction of "stereotypies" in this context may be misleading). During a period of mild food restriction in a layer strain, object pecking substituted immediately and completely for time that would have been spent feeding.

Despite the characteristic changes in broiler breeder behaviour before and after feeding, described above, feeding motivational state appears to remain consistently high at all times of day, judging from results of operant feeding tests. This apparent discrepancy may be accounted for by a distinction between motivational state and arousal. A growing body of evidence is consistent with the notion of a primary role for homeostasis of arousal (Delius, 1970) underlying the changes in behaviour of restricted-fed animals before and after feeding time.

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Why do female mink with high stereotypy levels have slow-growing offspring?

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Introduction

Farmed female mink can spend several hours a day performing stereotypies, and during the breeding season, the offspring of those with the highest levels grow approximately 85% as fast as other young (Mason 1992). There are a number of possible reasons why the young of the most stereotypic females grow more slowly. The cause could be endogenous to the young (e.g. they expend energy that would otherwise go towards growth through being more active themselves); it could stem from the mother; or it could be a combination of effects.

Materials and methods

To tease apart these possibilities, four groups of 13 litters each were compared: litters of High Stereotypy (HS) mothers; litters of Low Stereotypy (LS) mothers; litters of HS mothers cross-fostered to LS females; and litters of LS females cross-fostered to HS females. The four sets of litters were in 'quartets' matched for birthdate, litter size, and primiparity vs. multiparity of the mother. The following data were collected for all subjects:

1) average male and average female kit weights on the day of cross-fostering;
2) average male and average female kit weights at 14, 21 and 28 days of age;
3) the type of straw nest maintained by each female - 'Bare', 'Spherical' or 'Intermediate'.
4) the readiness with which each female left her litter to investigate a noise in the cage; each female was tested once a day for 10 days and scored as 'Easily lured' or 'Reluctant to leave' according to her most common response.
5) activity levels of the mothers. The nests were scanned every 15 minutes between 0900 and 1700 for two days a week, for the three weeks of the experiment. Females were recorded as to whether resting with the kits; resting apart from the kits; performing normal activity (e.g. grooming, eating); or performing stereotypies.

For a sub-set of the litters, the following data were also collected:

6) overnight nestbox temperature, for 36 litters (9 quartets);
7) mean weight of milk transferred in a suckling bout: 24 litters (6 quartets) were separated from the mother for two hours, weighed, replaced with the mother, and reweighed one hour later (c.f. Rushen & Fraser 1990).

Results

Kits from HS and LS families did not differ in weight at the start of the experiment, but over the next three weeks, male kits showed slower growth rates if housed with HS adult females (see Tables 1 and 2).

Table 1. Mean kit weight (g) at 21 days of age. * Paired t = 2.64

	HS Female (n = 26)	LS Female (n = 26)	Means
HS kit (n = 26)	122.5	130.7	126.4
LS kit (n = 26)	122.6	132.1	127.3
Means	122.6 *	131.4 *	

Table 2. Mean kit weight (g) at 28 days of age. * Paired t = 2.38

	HS Female (n = 26)	LS Female (n = 26)	Means
HS kit (n = 26)	180.3	192.1	185.9
LS kit (n = 26)	181.2	188.2	127.3
Means	180.7 *	190.1 *	

Thus kit growth was unaffected by their own family background, but was determined by the type of adult caring for them. How do females exert this effect? HS and LS females did not differ in the readiness with which they left their litters; the amount of milk they supplied to their litters after two hours' separation; the maximum, minimum and mean overnight nestbox temperatures; nor in the amount of time they spent with their young over the three weeks of the experiment. However, HS and LS did differ in the following ways. HS females spent more time performing stereotypic behaviour than LS females ($Z = 3.74$, $P < 0.001$); in Week 2, they spent less time with their kits (see Table 3); and they had a tendency to maintain poorer quality nests (see Table 4; chi-squared = 5.84, df = 2, $P < 0.10$).

Table 3. Time spent with kits by High and Low Stereotypy females** Z = 2.65

% time resting with kits in:	HS females (n = 26)	LS females (n = 26)
Week 1	86.9 (67.6 - 95.6)	88.3 (69.1 - 97.1)
Week 2	83.2 (72.1 - 95.5) **	88.3 (75.0 - 97.1) **
Week 3	71.6 (52.8 - 90.3)	71.7 (57.5 - 88.9)

Table 4: Numbers of High and Low Stereotypy females maintaining different types of nest

Female type	Bare nest	Spherical nest	Intermediate
HS (n = 26)	8	1	17
LS (n = 26)	3	6	17

Conclusions

High Stereotypy female mink exert a small but significant detrimental effect on the growth rates of their young. This is even though their levels of stereotypy are very low when lactating (HS females averaged approx. 3 hours/day performing stereotypies before the breeding season, but only 8 mins./day during the three weeks of the experiment). HS mothers reduce the amount of time they spend with their young at an earlier stage in the kits' development than LS mothers - although the difference in the amount of time spent with the young in Week 2 was small (6 hours, 40 mins./day, c.f. the 7 hours, 5 mins./day of LS females). Their tendency to make less insulating nests may also have depressed their litter's growth rates (c.f. Møller 1990). Performing stereotypies thus to some extent interferes with the normal parental behaviour of female mink.

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Behavioural and physiological consequences associated with prevention of crib-biting.

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Introduction

The debate surrounding stereotypies in captive and domestic animals has centred on the possible function of these behaviours in reducing stress. If stereotypies do function to reduce stress, an increase in cortisol might be expected to be associated with prevention. Kennes and deRycke (1988) found that prevention of jumping stereotypies in voles was associated with a rise in cortisol. However, during long and short-term deprivation in chain-manipulating pigs, no rise in cortisol was detected (Terlouw *et al.*, 1991).

Despite this debate, the prevention of crib-biting in horses is regularly attempted. In the short-term, prevention is possible with the use of projectionless stables or, more commonly, the application of a cribbing-collar. Attempts at longer-term prevention involve the excision of the nerves and/or muscles in the ventral neck or the fistulation of the buccal cavity. In the current study, twelve horses were transiently deprived of the opportunity to crib-bite, to feed and to do both. During these periods of deprivation, the horses' behaviour, heart-rate, and levels of plasma beta-endorphin (B-E) and cortisol were measured.

Materials and methods.

Six crib-biting and six normal thoroughbred geldings were kept in mixed groups of four in a paddock for five days prior to the start of the treatments and then habituated to projectionless loose-boxes. *Ad libitum* hay and two removable "cribbing bars" were available in these boxes. Subjects were turned out together in a paddock for an hour every day.

After two days of acclimatisation to roller-mounted heart-rate monitors and jugular catheters, horses spent six hours on alternate days deprived, in random order, of the opportunity to (i) crib-bite (CB) (ii) eat hay (H) and (iii) crib-bite and eat hay (**CB/H**). Each horse acted as its own control by being deprived of none of these resources (N). The first (baseline) blood samples were drawn as soon as the horses returned from the paddock. Sequential samples were taken every hour for the next six hours and behaviour was scanned continually for 50 minutes in each hour. Heart rates were recorded continuously for six hours. The cortisol and B-E were measured by radioimmunoassay.

Results

The mean baseline and response levels of plasma cortisol (Fig.1.) were significantly higher in the crib-biters than in the normal horses (ANOVA, $P<0.001$ and $P<0.0001$, respectively). Rises in plasma cortisol relative to the baseline during **CB/H** were significant in both stereotypic (paired t-test, $P<0.05$) and normal (paired t-test, $P<0.01$) horses. This treatment in stereotypic horses was associated with the highest mean cortisol response (253.0 ± 27.2 nmol/L). A significant fall (paired t-test, $P<0.05$) in plasma B-E (Fig.2.) relative to baseline levels occurred during treatment **CB/H** in normal horses. In stereotypic horses, this deprivation was associated with the highest mean plasma B-E response (345.15 ± 163.47 pg/ml). **CB** was not linked to a change in plasma B-E activity.

There were no significant differences between crib-biters and normal horses in the behavioural or the cardiac response to the three treatments compared to (N).

Conclusions

Plasma cortisol tended to rise relative to baseline (paddock) levels in response to stabling in all horses. An opposing trend was seen for B-E. Baseline levels reflect the horses' response to being at pasture where social, agonistic and kinetic behaviour are more easily expressed and the food source is more palatable than in the stable. Since more palatable foods are associated with rises in plasma B-E levels, the baseline concentrations may have been raised in response to eating grass. Further research into the differences between mean baseline levels of plasma cortisol levels in stereotypic and normal horses may determine to what extent these differences are genetic or experiential in origin.

There was no change in plasma B-E activity during treatment **CB** relative to **N**. This challenges the suggested link between cribbing and B-E indicated by the reported action of opioid antagonists (Dodman *et al*., 1987). Interestingly, **CB** was not associated with a rise in plasma cortisol, perhaps because stereotypic horses were able to satisfy their oral needs by eating. The highest mean cortisol response, seen in **CB/H** which imposed the greatest restrictions on the stereotypic horses indicates that these horses may have greater oral needs. This is supported by the fact that hay removal was associated with the next largest cortisol response in stereotypic horses while in normal horses, this treatment was associated with a response that was lower than the baseline level.

The results suggest that crib-biting may function to enhance oral stimulation in individuals with a seemingly greater baseline stress response. Furthermore, it has been suggested that the motivation to crib-bite rises during periods of deprivation (McGreevy, unpublished data). Therefore, while collars and surgery may have health benefits for horses that engulf air to the extent of the development of flatulent colic, for unaffected horses, their application could be associated with reduced welfare.

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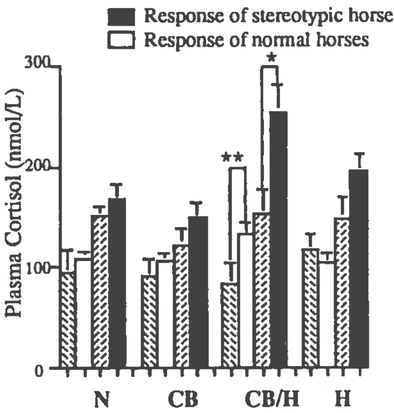

Fig. 1. Cortisol responses in four treatments

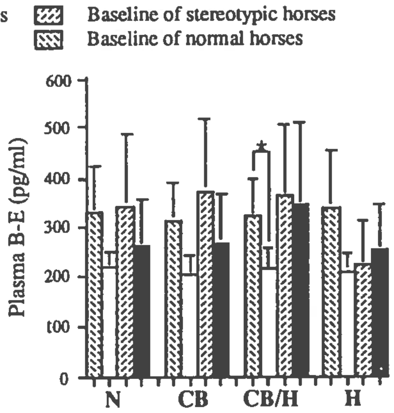

Fig.2. Beta-endorphin levels in four treatments

Behaviour of lactating dairy cows on pastures of varying sodium concentration

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Introduction

The acute appetite for sodium (Na) in ruminants is now firmly-established. In small animals in acute Na deficiency induced by bilateral adrenalectomy, removal of parotid saliva, injection of formalin, or peritoneal dialysis (e.g. Bell, 1995). An avid Na appetite has only recently been demonstrated for grazing livestock under practical field conditions (*see recent review* by Chiy and Phillips, 1995) and is believed to strongly influence livestock feeding behaviour. An experiment was designed to investigate this and in particular explore the strategy that cattle adopt when manipulating their ingestive behaviour.

Materials and Methods

Thirty-two British Friesian dairy cows were grazed for 20 weeks on perennial ryegrass (*Lolium perenne*) pastures receiving 0 (Nil) or 32 (Na) kg Na/ha/year in six split applications over the grazing season and the behaviour of the cows was monitored over one 24 hour period per month. All data was subjected to ANOVA.

Results

Treatment means of herbage Na content and cow behaviour are presented in Table 1. Herbage Na content was 36 % greater in the Na-fertilized pastures. Cows spent and extra half-hour each day grazing on the Na-treated, compared to the untreated, pasture. This represented an increase in number of meals, but a decrease in meal length. The Na treatment increased the times cows spent ruminating each day. Both total and time actually engaged in the drinking activity was increased when cows were grazing the high-Na pasture, but there was no difference in the number of visits to the drinking trough which was situated in the middle of each pasture block. The number of ruminating bouts was not affected by applying Na to pasture, but the rumination time was lengthened. Cow rumination time while standing was more than doubled, while lying and rumination time was increase by 13 % when pasture was fertilized with Na. Less time was spent idling, standing or lying on pasture that had received Na fertilizer. Cows grazing the Na-treated pasture had 8.4 extra bites of herbage in each minute that was spent grazing (over 600o extra bites per grazing day). Ruminating biting rate was also increased by Na fertilization, but the interval between regurgitated boluses was not affected. Cows walked over half a meter faster in every minute spent walking.

Conclusion

Energy conservation may explain why cows on pasture with Na increase drinking by increasing bout length, since energy is required for each drinking bout. Also each bout requires separation from the rest of the herd. Stable rumen conditions are likely to be favoured by an increase in grazing time through more, short bouts, and little extra energy is required to initiate a bout. In conclusion, the mechanisms that cows use to manipulate their ingestive behaviour may depend on the effects on energy requirements, rumen stability and their ability to synchronise their activities to those of the rest of the herd.

Table 1. Effect of Na fertilization on herbage Na content and cow behaviour.

	Nil	Na	SED	Signif.
Herbage Na content (g/kg DM)	3.96	5.41	0.294	***
Duration of cow behaviour (min/day)				
Grazing	508	537	9.32	**
Rumination	421	505	9.93	***
Standing	30	63	15.1	*
Lying	391	442	22.9	*
Total drinking time (including pauses)	6.72	1.07	1.068	***
Actual drinking time (excluding pauses)	0.706	1.063	0.095	**
Number of daily grazing meals	14.9	17.6	0.59	**
Number of daily ruminating bouts	22.3	22.1	0.73	NS
Duration of grazing meal (min)	31	34	1.1	*
Duration of ruminating bout (min)	28	38	0.60	***
Grazing biting rate (bites/min)	53	61	2.7	**
Rumination biting rate (bites/min)	60	63	1.0	**
Walking rate (m/min)	2.06	2.57	0.12	***
Interval between boluses (seconds)	51	52	2.10	NS

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The influence of interval duration between nursings on piglet milk intake, weight gain and udder massage.

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Introduction

Domestic sows nurse at regular intervals, with the typical inter-nursing interval varying from 30 to 70 min for individual sows during the first week of lactation (Bøe, 1991; Jensen et al., 1991; Gertken et al., 1993). Some sows change the frequency of nursing abruptly, and sometimes profoundly, during the first days after birth (Illmann and Madlafousek, in press). The aim of this study was to investigate how prolonging or shortening of internursing intervals affects milk intake, body weight gain and udder massage after milk let down in early lactation.

Materials and Methods

Seven days post partum, 8 sows were forced to nurse every 35 minutes for a period of 24 hours (group MIN35) and 10 sows were manipulated into a 70-min nursing interval (group MIN70). The time of milk ejection and udder massaging behaviour were recorded at each nursing. As to the duration of udder massage, the nursings were classified as follows: a. terminated by the sow - if the sow stood up or rolled over during 10 minutes after milk ejection; b. terminated by the piglets - if, in spite of the udder being accessible, the piglets left the udder within 10 minutes after milk ejection; c. terminated by the observer - if the massage lasted 10 minutes after milk ejection.

Milk intake was estimated by the weigh-suckle-weigh method. Urinations of the piglets between the weighings were noted, and these data were excluded from the analysis. Litters were also weighed 24 hours before the start of the manipulation in order to assess undisturbed weight gain.

Mann-Whitney U-test and Spearman rank correlation were used for statistical tests of the differences and relationships.

Results

The MIN70 sows started nursing after each of the 175 reunions with their litters. In the MIN35 group, the nursing interaction did not start at all in 28 reunions out of 428 (6.5%), mostly because the sow did not assume the lateral nursing posture. The MIN35 sows failed to release milk during 10.7% of the nursings, whereas the MIN70 sows did so only during 1.1% of the nursings ($p=0.02$). The effective number of nursings with milk ejection per 24 hours was thus 20.2 for the MIN70 group and 33.9 for the MIN35 group.

During the experimental 24-hour-period, MIN35 piglets gained 44% more weight than the MIN70 pigs (201 g vs. 140 g, $p=0.0149$). On the experimental day, the MIN35 piglets gained 31 g more body weight than during the preceding undisturbed 24 hours, whereas the MIN70 piglets acquired 88 g less during the experimental day than during the day before ($p=0.0043$ for the difference between the groups).

The first analysis of the milk intake data indicates that the MIN35 piglets ingested less milk per nursing than the MIN70 pigs. At the same time, their total milk intake during the experimental 24 hours was higher. However, the analysis also revealed that some urinations during the nursings escaped the attention of the observers. Careful analysis will be needed to establish how this could be corrected and whether firm quantitative conclusions about the milk intake could be drawn.

In both groups, some sows consistently interrupted the nursing early after milk ejection while others allowed a long udder massage for most of the nursings. The average proportion of nursings terminated by the sow was not different in group MIN70 (45.2%) and in group MIN35 (29.4%). MIN70 litters massaged the udder for at least 10 minutes in 85% of all nursings which were not interrupted by the mother, whereas the MIN35 litters used this opportunity in only 36% of nursings (p=0.007).

Conclusions

Artificial shortening of intervals between nursings induces a higher proportion of nursings without milk ejection and suppresses udder massage by the piglets. In spite of this, it increases weight gain of the young. Artificial prolonging has the opposite effects. These results indicate that spontaneous changes in the nursing rhythm which often occur in early lactation may also significantly affect milk intake, weight gain and suckling behaviour. Research of individual variability and development of nursing rhythms in different housing systems is warranted.

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Modifying stockperson attitudes and behaviour at a large commercial farm

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Introduction

The role of the stockperson in the welfare and productivity of farm animals has received increasing attention over recent years (Hemsworth *et al.*, 1989, 1991, 1994; Seabrook, 1991, English, 1991). While some of the emphasis in this research has been placed on stockperson personality variables such as introversion/extroversion and aggression (Seabrook 1991), the strongest predictors of stockperson behaviour have been found to be stockperson attitudes. It has also been proposed that empathy of the stockperson may be related to the welfare and productivity of animals under the stockperson's care (English, 1991). In general there are no strong empirical data showing sequential relationships between stockperson personality variables, empathy and animal behaviour and productivity.

Considerable research into the role of the stockperson's attitude and behaviour on the behaviour, productivity and welfare of commercial pigs has been conducted (Gonyou *et al.*, 1986; Hemsworth et al., 1981a, 1981b, 1986, 1987, 1989, 1991). This research has clearly demonstrated that the human-animal relationship has important implications for commercial pigs. Because a stockperson's behaviour towards animals is largely under his/her control, this behaviour is strongly influenced by the attitudes the stockperson holds about the animals. These attitudes and consequent behaviours predominantly affect the animal's fear of humans which, in turn, affects the animal's performance and welfare.

The objectives of the study reported here were to examine whether it was possible to improve the attitudinal and behavioural profiles towards pigs of stockpersons working in a large commercial piggery and to examine the consequences of these attitudinal and behavioural changes on the behaviour of commercial breeding pigs.

Materials and Methods

A total of 43 stockpersons from a large commercial piggery participated in this 3-month study. They were assigned to one of two groups. The first group received a procedure to modify attitudes and behaviour towards pigs, and the second group received no intervention. Stockperson attitudes were assessed by a computerised questionnaire. Stockperson interactions with pigs were recorded using experimenters different from those who administered the questionnaire. A team of four trained observers recorded the nature of the behaviour of these stockpersons during handling activities with breeding female pigs in the mating sheds of five units. These observations concentrated on the number and proportion of negative or aversive behaviours utilised by stockpersons in moving breeding pigs. A simple test, which has been shown to be predictive of fear responses in a commercial setting (Hemsworth *et al.*, 1981), was used in this study and basically involved measuring the withdrawal response of feeding gilts and sows to an experimenter approaching in a standard manner.

Results

Negative beliefs about pigs as animals correlated significantly ($\alpha<0.05$) with the observed number of negative interactions by stockpersons ($r=0.31$) as did beliefs about positive interactions with pigs ($r=-0.27$).

There was a significant improvement in stockperson attitude towards working with pigs in the modification group compared to the control group ($F_{1,34}=4.19$, $P=.05$). A similar improvement occurred in attitude towards handling oestrus pigs ($F_{1,34}$=9.11, $P<.01$) and a trend in the same direction for beliefs about positive interactions with pigs ($F_{1,34}$=2.74, P=.11).

A significant decrease was observed in the proportion of negative interactions with pigs by the modification group compared to the control group ($F_{1,35}$=4.25, P=.05).

There was a trend ($F_{1,33}$=2.78, P=0.11), consistent with this improvement in stockperson behaviour, for pigs supervised and assisted to mate by stockpersons in the modification group to show less withdrawal to an approaching experimenter.

Discussion

Although significant, the magnitude of the correlations between stockperson attitudes and behaviour was smaller than that reported in our earlier research (Hemsworth *et al.*, 1989). However, this study was carried out in a large commercial farm where stockpersons worked together in units and there were 5 units in all. This would have the effect of reducing the opportunity for stockpersons to behave in a totally independent way as would have occurred in farms operated by individuals. As a result, there would tend to be a reduction in the heterogeneity of attitudes and behaviour in a unit. Nevertheless, despite this limitation, the attitude-behaviour relationships identified in our earlier research remain.

There was a significant improvement in stockperson attitude towards interacting with pigs in the modification group compared to the control group. There was a significant decrease in the proportion of negative interactions with pigs by the modification group compared to the control group and a reduction in time for pigs to withdraw from an approaching stockperson.

The results of this study confirm that stockperson attitudes and behaviour can be improved in a large commercial farm in a way similar to that observed in small individual farms (Hemsworth *et al.*, 1994) and that short-term effects on pig behaviour can be observed. Taken conjunction with our earlier research, there is a strong case for introducing stockperson training courses in the pig industry which target the attitudes and behaviour of the stockperson.

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The effect of supplementary light on the behaviour of housed female cattle

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Introduction

Supplementary light generally increases the milk production of dairy cows exposed to a natural day length of 8-12h (Tucker, 1985; Phillips, 1988) and sometimes increases the rate of gain in growing cattle (Forbes, 1982). It has also recently been shown that supplementary light reduces daily activity levels and increases lying time (Phillips and Schofield, 1989; Weiguo and Phillips, 1990). The objectives of these studies were to investigate the effects of supplementary light on the behavioural changes in housed female cattle.

Materials and Methods

Experiment 1. Forty-eight Charolais x Freisian heifers of approximately 12 month old were used in this experiment, were housed in a straw yard, and were either kept in natural day length over winter (mean 10L 14D) (treatment N) or a constant 16L 8D (treatment L). Heifers were kept in three blocks for each treatment. Supplementary light was of mean intensity 463 lux. Behaviour was observed for one 24 h period/treatment in autumn, winter and spring. At 15 minute intervals, the main activity of each animal was classified as feeding, standing, standing ruminating, lying, lying ruminating and sleeping. In the second experiment, sixty-four dairy cows were subjected either to 18L 6D (treatment L) or natural day length (treatment N). Cows were housed in a cubicle building. The intensity of the artificial light was approximately 350 lux. Behaviour was observed for one 24 h period/treatment in winter and spring. At 4 minute intervals, the activity of each animal was recorded. Statistical analysis was performed using the computer package Genstat 5.

Results

Experiment l: The results of the main behaviours are presented in Table 1. There were no significant treatment effects but the time spent standing ruminating increased (68, 66, 108 min/d, SED 14.16) and lying ruminating decreased in spring (520, 474, 462, SED 13.62). Lying sleeping increased with time (42, 48, 62 min/d SED 9.69), as did standing time (228, 262, 287 min/d SED 6.34). Supplementaty light had no significant effects (Table 1.2) on any of the activities ($P>0.05$).

Experiment.2: The results of the behavioural studies are given in Table 2. Cows exposed to supplementary light (L) lay down for less time (L 162, N 217 min/d SED 12.0), ruminated for longer (L 584, N, 560 min/d SED 12.9) and spent less time sleeping (L 24, N 32 min/d SED 3.8).

Conclusion

The response to the daily supplementary light of 10 h was a reduction in the time spent lying down. This suggests that the resting behaviour of dairy cows intensively housed with cubicles can be decreased by a long photoperiod. For growing heifers in a straw yard, changes in age dominate behaviour and photoperiod did not affect behaviour.

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Table 1 EFFECT OF PHOTOPERIOD ON THE BEHAVIOUR OF HEIFERS

	AUTUMN		WINTER		SPRING		PERIOD		TREATMENT		PERIOD X TREATMENT	
SUPPL. LIGHT	L	N	L	N	L	N	SED	SIG.	SED	SIG	SED	SIG
Total rum	580	597	556	523	587	554	12	**	11.55	NS	20.02	NS
Total lying	774	732	753	726	714	680	17.55	**	22.12	NS	30.00	NS
Total standing	276	316	324	333	399	391	18.82	***	15.37	NS	26.62	NS
Lying rum.	520	520	493	456	477	447	14.20	***	12	NS	20.09	NS
Standing. rum.	60	77	63	68	110	107	9.804	***	8.004	NS	13.86	NS
Total idling	859	844	878	928	852	887	23.75	NS	43.30	NS	18.02	NS
Standing	216	240	261	264	289	285	14.13	***	11.54	NS	20.00	NS
Lying	253	212	260	283	237	233	11.74	**	11.60	NS	17.85	NS
Sleeping	38	46	45	51	53	72	5.74	**	7.33	NS	9.88	NS
Feeding	352	346	312	330	273	297	11.31	***	9.24	NS	16.01	NS

Total idling time = standing time + lying time + sleeping time + feeding time

Table 1.2 The effects of supplementary light on behavioural incidences of heifers (No./day)

	AUTUMN		WINTER		SPRING		PERIOD		TREATMENT		PERIOD X TREATMENT	
SUPPL. LIGHT	L	N	L	N	L	N	SED	SIG.	SED	SIG.	SED	SIG.
Grooming (self))	3.71	3.18	2.44	2.08	2.24	3.13	0.95	NS	0.08	NS	0.03	NS
Grooming (other)	1.87	2.19	1.18	1.17	1.11	1.25	0.8	***	0.14	NS	0.11	NS
Biting (object)	3.38	3.05	1.83	1.54	1.17	1.25	1.51	***	0.30	NS	0.11	NS
Drinking	3.70	3.74	1.58	2.26	3.09	3.26	1.7	***	0.46	NS	0.40	NS
Aggression	11.0	7.29	7.08	6.87	7.04	8.58	1.23	NS	5.84	NS	1.95	NS
Mounting	0.54	0.17	1.46	0.08	0.71	1.17	0.6	NS	0.74	NS	0.92	*
Mounted	0.58	0.21	1.45	0.08	0.71	1.12	0.53	NS	0.77	NS	0.89	*

Table 2 EFFECT OF PHOTOPERIOD ON THE BEHAVIOUR OF WINTER HOUSED DAIRY COWS

	WINTER		SPRING		PERIOD		TREATMENT		PERIOD X TREATMENT	
SUPPL. LIGHT	L	N	L	N	SED	SIG.	SED	SIG.	SED	SIG.
RUMINATION										
Total ruminating	608	572	559	548	12.9	**	12.87	NS	18.2	NS
Total lying	438	493	476	513	25.8	NS	25.8	NS	36.5	NS
Total standing	544	507	495	474	30.3	NS	30.3	NS	42.75	NS
Lying rum.	308	285	282	277	19.96	NS	19.96	NS	28.23	NS
Standing. rum.	300	286	277	271	23.05	NS	23.05	NS	32.61	NS
Total idling	827	869	876	892	12.7	**	12.7	*	17.79	NS
Standing	245	220	217	203	12.6	NS	12.6	NS	17.82	NS
Lying	130	207	194	236	12	***	12	***	16.98	NS
Sleeping	27	31	23	32	3.78	NS	3.78	NS	5.35	NS
Feeding	425	410	441	420	17.22	NS	17.22	NS	24.34	NS

Total idling time = standing time + lying time + sleeping time + feeding time

* P<0.05 ** P<0.01 *** P<0.001
NS P>0.05

Effects of straw and unfamiliarity on fighting between newly mixed growing pigs.

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Introduction

Mixing unfamiliar animals is common procedure in pig production. It leads to fighting, which helps to determine the establishment a social hierarchy. Fighting at mixing can lead to lower growth rates and poor welfare and should therefore be reduced where possible.

It is suggested that pigs should be mixed in deep straw. Straw has been shown to reduce aggressive behaviour between unfamiliar, food-restricted pigs (Kelley et al, 1980) and pigs fed *ad libitum* (Meyer et al, 1984). Fighting might also be reduced by limiting the number of unfamiliar pigs mixed together. However, there is evidence that this is not always the case (Friend et al, 1983; Rundgren and Löfquist, 1989). Commercial experience has often suggested that aggression is lower between sows when mixing occurs in larger groups.

The aim of this study was to determine the effects of straw and the effects of increasing the proportion of unfamiliar individuals on fighting between newly mixed growing pigs.

Methods

Twelve pens of 15 Large-White x Landrace pigs of mixed sex (approx. 50:50), weighing 25-30 kg, were formed by mixing 2,3 or 4 groups of unfamiliar pigs. These corresponded to mixing patterns G2, G3 and G4 which comprised 7 and 8; 5, 5 and 5; and 3, 4, 4 and 4 pigs so that each pig had an average of 7.5, 10.0 and 11.2 pigs in the same pen with which it was unfamiliar respectively. For each mixing pattern, 2 pens were provided with straw (2 kg straw per day) and 2 were not. The pens measured 2.7 x 4.0 m and food and water were provided *ad libitum*.

The pigs were mixed into the experimental pens between 1300 and 1400 h. Video cameras attached to 24 h time-lapse recorders were used to record all fighting and each hour, the number of pigs active, feeding or drinking, for 5 days after mixing. Fights were defined as any encounter between two or more pigs in which, for a period of over 10 s, repeated attempts were made to bite each other. This included the time intervals between vigorous biting while the pigs remained in contact. Each fight was deemed to have ended when one or more pigs retreated and biting ceased.

Results

Observation of the 12 pens showed a total of 360 fights over the 5 day period. The number of fights was not significantly affected by whether or not the pens were provided with straw (P>0.05), but was significantly affected by the number of pigs unfamiliar to each other (P<0.05). The average number of observed fights per pig were 2.7, 4.3 and 5.1 which expressed as percentages of the potential numbers of fights were 35.7, 43.1 and 45.0% for patterns G2,G3 and G4 respectively. These percentages did not differ significantly (P>0.05).

Nearly 40% of fights occurred within the first three hours after mixing. On days 2 to 5, fighting was significantly affected by time of day (P<**). Most fighting occurred between 0800 and 1600 h peaking at 1500 h. The number of fights fell significantly on the days after the pigs were first mixed (P<**). The distribution of fights on days 1 through to 5 was 63.6; 22.2; 8.6; 4.4 and 1.1% respectively of the total. It was unaffected by either straw or mixing pattern.

The average durations of fights were not significantly affected by either the straw or the mixing pattern (NS). The geometric mean for fight duration was 48 s (s.e. 3.9), the arithmetic mean was 98 s. Fights on days 1 and 2 tended to be about 35% longer than those on days 3-5.

Pigs in G3 showed more activity and less feeding and drinking than those in G2 or G4 (P<*). Pigs with straw showed more activity and less lying on days 1 to 5 than those without (P<*). The amount of feeding and drinking did not differ significantly between days 1 to 5 (NS) but over the same days, lying increased and activity decreased (P<*).

Conclusion

Straw had no effect on either the number or length of fights between unfamiliar growing pigs. Similarly, Waran and Broom (1993) found that straw did not affect the level of aggression between newly mixed weaned pigs. Straw may be of benefit when food is restricted but not when pigs are fed *ad libitum.*

The number of fights increased with the number of unfamiliar individuals in the group. In other words, the ratio of fights to the number of unfamiliar pigs was roughly constant. Over the first 5 days after mixing, pigs fought, on average, with about 40% of those with which they were unfamiliar and this proportion was unaffected by the total number of unfamiliar pigs with which they were mixed. Fighting was not observed between familiar pigs.

Fight length (mean 98 s) was similar to that recorded previously (118 s) (McGlone, 1985) and was unaffected by the number of unfamiliar pigs in the pen. The data suggested that later fights were less strongly contested. Time of day had a significant affect on fighting. The pigs were mixed at 1400 h which probably accounts for the high number of fights during the first 3 hours. Activity levels were not related to the amount of fighting. Lying increased and activity decreased during the five days after mixing in all groups. Pigs with straw were more active and spent less time lying than those without straw.

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Electronic feeders and feeding behaviour in growing-finishing pigs

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Introduction

Electronic feeding systems have been mainly developed for pig progeny testing (Webb *et al.*, 1990; De Haer *et al.*, 1992) but can also be used for feeding behaviour research (Young and Lawrence, 1994). Computerized feeders using transponder technology, are also coming into use in commercial farming (Gebbe, 1994). The aim of this paper is to evaluate the use of a simplified computerized feeder by recording the feeding behaviour in growing-finishing pigs housed in a group and fed in different ways.

Materials and Methods

For 90 days eight 20 week-old pigs (LW x L) weighing 54.2±7.4 kg were individually identified by eartag transponder (Lambooy and Merks, 1989) and housed in a slatted floor pen (4x2m) equipped with modified monoplace computerized feeder (PM70Pig - Proseat). The entrance of modified PM70Pig feeder is open on the back and only its sides are protected to avoid unintentional feed delivery due to the pigs getting too close to the station. In order to evaluate the learning ability of pigs in using the feeding system, feeding behaviour was immediately recorded.

Pigs were fed with a wet-dry standard meal grower diet containing 13.3 MJ digestible energy and 150 g crude protein per kg. Feed was restricted and offered on a live weight basis (3%) in different ways following the scheme reported in table 1. In order to adjust the feeding rate pigs were individually weighed every fortnight. After November 18th one pig was eliminated due to legs failure.

Table 1. Experimental scheme.

Period: Date	Feed delivery per time (g)	Pigs (no.)
A: 3-11 Oct.	100	8
B: 12-16 Oct	200	8
C: 17-27 Oct.	200, 200*, at request**	3, 2, 3
D: 28 Oct. - 1 Nov.	400, 400*	6, 2
E: 2 Nov. - 19 Dec.	300, 300*	6, 2
F: 20 Dec. - 2 Jan.	200, 200*	5, 2

* receiving 500g/d in addition to daily requirement.

** receiving the diet at request until a maximum 3% of live weight.

At least 10 min elapsed between 2 meals for the animals receiving the diet in a fractionated way. Diet was available for each pig from midnight on. Feeder allows access to only one pig at a time and the eartag transponder allows its identification; the amount of feed consumed and time were recorded by personal computer.

For each pig the variables recorded were: percentage of feed intake till 10.00 a.m. as regards to the fixed amount per day (%FI); direct observations between 8.00 and 12.30 a.m. estimated the times of feed intake combined to a disturbance action of pigmates calculated as percentage on the total feed intake activity (DFI).

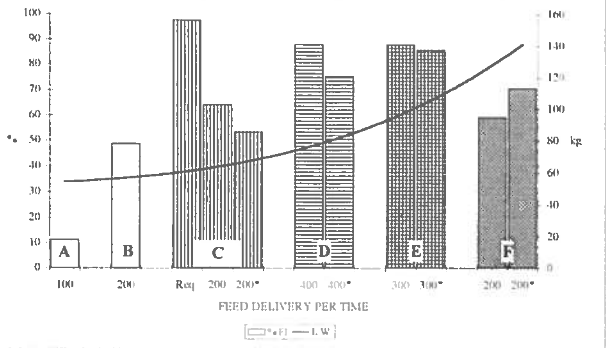
The percentage of feed intake was analysed by GLM. The factors used were period and feed delivery per time (see table 1). The variables considered in the analysis were means for period and feed delivery per time intra-period.

Results

As regards to the percentage of feed intake till 10.00 a.m. results are reported in figure 1. After a first period of acclimatization (A) and during period B pigs intook a different %FI (A=11±4.3, B=49±4.0) and minimum feeding competition was observed (DFI: A=0, B=4).

When 3 pigs (period C) were fed at request, the whole group feeding behaviour changed. For these pigs fed at request %FI was 98±4.7 whereas for 200 and 200* pigs %FI was 64±4.6 and 53±5.6 respectively and feeding competition increased (DFI=16). Disturbed meals were differently distributed among the groups (DFI: req.=0, 200=7, 200*=9). Besides, it is interesting to observe that at the end of C period %FI ranged between 88 and 100 thus showing an adjusted feeding behaviour. During period D the elimination of request feed delivery did not reduce immediately feeding competition (DFI: 400=14, 400*=0) with respect to period C, and %FI was not affected (%FI: 400=88±4.6, 400*=76±8.0). The reduction of feed amount delivered per time (period E) did not affect the %FI (300=88±1.2, 300*=86±3.0) but diminished the DFI (300=9, 300*=0). A further reduction (period F) decreased significantly the %FI (200=59±3.2, 200*=71±5.1) but the DFI increased (200=15, 200*=4).

FIGURE 1. Feed intake till 10 a.m. as regards to fixed amount per day



Conclusions

The use of the simplified electronic feeder system seems therefore to be useful in growing finishing pig farming. However, it is still necessary to detect the lowest feed delivery per time sufficient to assure temporary satiety to pigs, in order to equally share the daily feeding activity and to avoid long time starvation inducing stress and excessive feeding competition.

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Effect of past experience on later behaviour

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Early experience affects subsequent behaviour in many species (Appleby, 1984; Roff, 1974). For the growing pig behaviours influenced by the environment in early life are retained throughout life. For example high levels of social behaviour developed by piglets in barren farrowing pens have been shown to remain even if the environment has changed (Beattie, *et al*, 1993).

This study investigated the effect of housing environment in the first six weeks of life when piglets were suckling their dams, on subsequent behaviour in the post-weaning stages of growth.

Material and Methods

The effect of change of environment at weaning was examined in a 2 x 2 cross-over study involving 174 piglets in 29 groups each of six littermates. There were two environments (barren and enriched) and two growth periods, birth to weaning at six weeks and weaning to slaughter at 20 weeks. At weaning half of the piglets were moved to housing similar to that of the pre-weaning period, enriched to enriched (EE) or barren to barren (BB). The other pigs experienced a change of environment at weaning either barren to enriched (BE) or enriched to barren (EB). This created four treatments, BB, EE, BE each with eight replicates and EB which had only five replicates because of missing plots.

Barren environments were similar to intensive husbandry conditions. These consisted in the pre-weaning period of a pen with a slatted floor with the dam restrained in a farrowing crate. The growing period was spent in fully slatted floored pens with no substrates or bedding. In the pre-weaning period the enriched environment consisted of a large straw bedded pen where the dam was unconfined. Enriched housing after weaning included access to the substrates peat and straw and greater floor space allowance per animal in comparison with the barren housing. In both environments pigs were offered feed and water *ad libitum*.

The behaviour of two focal animals (one boar and one gilt) in each group was observed weekly by direct observation. An ethogram of twenty-nine behaviours was used (between 13.00 and 18.00 hours for the twenty week duration of the study). Analysis of variance was performed on the data.

Results

The effects of early environmental experience were revealed through different behaviours in both early (7 to 13 weeks) and later (14 to 20 weeks) stages of the post-weaning growth period.

Behaviour from 7 to 13 weeks (Table 1)

Pigs in treatment EB spent less time involved in harmful social behaviour which can lead to injury of penmates and headthrusted less frequently than pigs which were always in barren environments (BB). In enriched housing pigs which came from enriched pre-weaning environments (EE) were involved in the locomotory behaviours frisking and scraping the ground more frequently than pigs which had spent their early life in barren environments (BE).

Table 1 Behaviours between 7 and 13 weeks of age significantly affected by the pre-weaning housing environment

Behaviour	BB	EB	BE	EE	s.e.m.	Sig.
Duration % time						
Harmful social	20.18^{c}	11.87^{b}	5.17^{a}	2.42^{a}	1.245	*
Frequency (min^{-1})						
headthrusting	0.44^{b}	0.24^{a}	0.16^{a}	0.10^{a}	0.065	*
scraping	0.00^{a}	0.00^{a}	0.08^{c}	0.04^{b}	0.010	*
frisking	0.07^{ab}	0.04^{a}	0.04^{a}	0.08^{b}	0.016	*

Means followed by different letters are significantly different

Behaviour from 14 to 20 weeks (Table 2)

Pigs which had always been in an enriched environment (EE) performed scraping behaviour more frequently between 14 and 20 weeks of age than pigs which were initially in a barren environment (BE). Pigs initially in barren housing (BE) spent less time feeding than pigs in the other three treatments (BB, EB and EE). BB gilts were more frequently the recipients of headthrusts than EB, BE or EE gilts.

Table 2 Behaviours between 14 and 20 weeks of age significantly affected by the pre-weaning housing environment

Behaviour	BB	EB	BE	EE	s.e.m.	Sig.
Duration % time						
scraping	0.00^{a}	0.00^{a}	0.00^{a}	0.02^{b}	0.004	*
feeding	12.10^{b}	10.63^{b}	4.97^{a}	10.45^{b}	1.650	*
Frequency (min^{-1})						
Receiving headthrusts~	0.33^{c}	0.17^{b}	0.11^{ab}	0.06^{a}	0.048	*

~ gilts only

Means followed by different letters are significantly different

Conclusions

Only a few behaviours in later life were influenced by the early experience of the pig. This demonstrates the ability of the pig to adapt its behaviour to its environment. However the behaviours which are regarded as abnormal, such as harmful social and persistent aggressive behaviour can be reduced in barren environments in later life by environmental enrichment in early life. The reverse situation of a barren environment followed by enrichment, further reduces harmful social behaviour. Although the carryover effect is of academic interest the best welfare practice in commercial pig units would be to provide enrichment throughout life.

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Long term effects of rearing management before weaning on the behavioural and physiological responses of cattle to human handling

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Introduction

Studies of long-term establishment of the human-cattle relationships are of interest especially for husbandry systems where there is little contact between farmers and the animals. Previous experiments (Boivin *et al.*, 1994) showed that age is very important for the establishment of the human-cattle relationship. This experiment compared two rearing treatments for French Salers and Limousine calves during the first three months:

1-traditionally reared calves: separated from the mother and led by a human to their mother to suckle twice a day;

2- free range calves reared permanently outside with the mother with little human contact.

Traditionally reared calves were much easier to handle in a standard test (more quickly restrained in a corner of the testing pen) than free range ones. This difference persisted until at least 8 months of age even if they were put together during the last five months on pasture. Both breeds were equally easy to handle during the test. This new paper describes the reactivity to handling after 8 months of age of calves reared traditionally or in range conditions during the first three months. Do differences in reactivity to handling last until 20 months of age? Secondly, do handling procedures such as tying the animals (popular among French farmers) or putting them in free-range conditions change their behaviour towards humans?

Materials and Methods

Forty heifers, half of them from Salers and half of them from Limousine breeds were used. Half of them were reared traditionally and half in range conditions during their first three months. The half of each breed group was kept in free-stall at 8 months of age following complete separation from the mothers (weaning). They were subsequently tied between 9 and 15 months of age. The remaining animals were put together in range conditions with little human contact. Three restraint tests were performed at 16 and 20 months of age. A cage test was also performed at 20 months of age on 16 Salers and 19 Limousine animals equally balanced for their rearing conditions. The test included social isolation in a cage for 5 minutes. Subsequently an unfamiliar human came within one meter at the head of the animal, waited motionless for 30 seconds, touched the animal for 30 seconds, left for one minute, came back and approached the animal at one meter for 30 seconds and finally touched the animal again for 30 seconds. Heart rate was recorded continously with electrodes put on the back of the animal. Basal heart rate frequency was estimated at the end of the 5 minutes of social isolation. Variations in heart rate were obtained by comparison to this basal level.

Results

Traditionally reared animals during the first three months were more quickly restrained in the corner at both ages (ANOVA, $P<0.01$) than range reared calves (Table 1). No significant difference was apparent in average duration necessary to restrain the animals either between breeds or between rearing conditions after weaning. These results were confirmed in the cage test at 20 months of age. When the human touched the calves, the increase in heart rate was much lower for the traditionally reared animals before weaning (ANOVA, $P<0.01$) than for the range reared animals (Table 1). Rearing conditions after weaning or breed have no significant effect on the animal reaction to human presence (Table 1).

Conclusions

The results show a very long term effect of the rearing management during the first three months on the later response of calves to human handling. The absence of significant effect of tying the animals on their ease of handling is surprising. Many French farmers believe strongly in such method to quiet the animals. In contrast to our experiment, they performed this method usually just after weaning. It is possible that close contacts especially just after weaning could be a more important factors in "taming" the animals. Previous experiment has shown that a durable taming effect could be obtained with free range heifers by close human contacts given during the two weeks following weaning (Boivin *et al.*, 1992).

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Table 1: Effects of breed and rearing management on the time necessary to restrain the calves in a corner of the testing pen at 16 and 20 months of age and the heart rate (beats/min) in the cage test at 20 months of age (** : $P<0.01$).

	breed		rearing conditions before weaning		rearing conditions after weaning		SD
	Salers	Limousine	traditional	range	tied	range	
restraint test							
number of calves	20	20	20	20	20	20	
16 months of age							
restraint time (s)	108.9	107.2	124.5 **	91.6	108.4	107.7	35.4
20 months of age							
restraint time (s)	125.7	118.9	139.5 **	106.1	126.6	118.4	35.1
cage tests							
number of calves	16	19	18	17	18	17	
basal heart rate	79.9 **	67.6	75.5	71.9	73.6	73.8	12.7
increases of the heart rate when							
human entrance 1	19.4	37.4	19.07	37.7	25.6	31.2	27.4
human touch 1	31.9	44.9	23.2 **	53.5	34.8	41.9	26.1
human entrance 2	17.9	30.0	12.1 **	35.8	22.8	25.1	31.6
human touch 2	21.6	30.9	13.6 **	39.0	24.5	28.1	26.5

Behaviour of dairy cows in cold or warm housing during winter

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Materials and Methods

Thirty Holstein cows paired by age and current milk production were randomly assigned to two housing treatment groups. One group (outside) was housed in an open free-stall facility, the other group (inside) in a warm, enclosed tie-stall barn. The study was carried out between 9 December 1992 and 2 March 1993 (12 wks). Feed for each day was mixed, stored in a mobile mixer, and distributed by a Calan scale feeder into individual feeders controlled by Calan gates outside or into separated manger compartments inside. The average age of the cows in the open housing group was 1419 days and was 1713 days in the warm housing group. The stage and order of lactation were 150 days and 2.4 in the open group and 173 days and 2.8 in the inside group. Cows were milked twice daily in a herring-bone parlour.

Results and Discussion

Observations were made during three 24 hr periods: in January (wk 5), February (wk 9) and March (wk 12). The outside lowest minimum 24,h temperature (-17.9°C) occurred during wk 5. Additional cold minimums (-13.6°C, -12.9°C) were recorded in wk 9 and wk 12 respectively. Corresponding average daily temperatures were -14.5°C, -8°C, and -8.3°C. Inside minimum temperatures were 1.5°C, 2.3°C and 5.9°C for wks 5, 9, and 12 respectively. Inside average temperatures for these observation periods were 4.6°C, 7.8°C, and 9.8°C respectively. The body weight of the cows from the open housing increased from the first observation (623.3 kg) to the third observation (663.3 kg). The lowest body weight was also recorded in the animals from the inside housing during the first observation (671.4 kg). The highest body weight was observed in February (686.2 kg). A significant difference between the groups was found in January ($P<0.05$). There were no statistically significant differences in milk yield during observation days between the groups. Milk production steadily decreased from January to March as the lactation progressed. There was significant difference in the milk yield ($P<0.05$) of the first and third observations in the trial group (33.4 kg vs. 27.6 kg). Feed intake of the cows kept in the open barn was significantly increased during all observations. The largest differences between the groups ($P<0.001$) were recorded during the first observation (37.3 kg vs. 27.3 kg).

During the three 24 h observation periods, cows from both groups spent longer lying on their left (as opposed to right) side. This difference in laterality was more apparent in the cows in the outside group, although significant differences were only found in February and March (42.9% vs. 22.7% and 34.4% vs. 19.6%). With the exception of the February observation period, cows in the tie stall barn group always spent longer times lying on the left side. During the first observation period (when the coldest temperature was recorded), outside cows significantly more time eating than inside cows (15.5% vs. 8.5% of total time). During the last observation period, the cows from the warm barn spent more time eating. In this group, the time spent eating steadily increased from the first observation period onwards. Outside cows were observed ruminating slightly longer than inside cows. In an average of the three observation periods, the cows in the open group spent 32.6% of the time ruminating (compared with 30.6% of the time in the warm group). The largest differences in ruminating while lying between the groups were found in the second observation (30.7% in open free-stall housing versus 22.0% in tie housing). However, the differences were not significant. During the last observation period, time spent ruminating while lying was higher in the cows from the inside group (23.3% versus 18.8% in outside group), the difference was highly significantly ($P<0.01$).

In both groups there were more bouts of the lying on the left side than on the right side. Greater differences between left and right laterality were recorded in the trial group. The frequency of meals was greater for both groups during the third observation period (March). Time standing as well as lying did not differ between groups. Feeding behaviour appeared to be most affected by type of housing.

Conclusion

Based on this experiment and on the available literature, it is concluded that open conditions in free-stall housing at temperatures approaching -18°C are not stressful to cows and do not affect the welfare of dairy cows.

The effects of climate, reproductive state and season on the use of shelter by outdoor sows

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Introduction

Outdoor sows are exposed to a wide variety of weather conditions which greatly affect their heat loss. The effect of climate can be modified by the sow by the use of shelter. It is necessary, therefore, to be able to predict the use of shelter by outdoor sows throughout the year in order to model their energy requirements (Buckner *et al.* 1994).

Materials and Methods

An experiment was carried out at an outdoor pig unit in North East Scotland in order to predict the use of shelter by pregnant and lactating sows. Five dry sow paddocks and five lactating sow paddocks were observed during daylight hours for one complete day each fortnight for a year. The numbers of sows inside and outside the conventional corrugated metal sow arcs provided were recorded at five minute intervals. The behaviour of the sows outside was classified into one of nine mutually exclusive behaviour categories: standing, walking, foraging, sitting, lying on side, lying sternally, feeding, drinking and wallowing. A weather station on the unit measured hourly rainfall, average hourly humidity, ambient temperature, net radiation, wind speed and wind direction. The stage of pregnancy or lactation of the sows in each paddock was recorded, with sows in the same paddock being approximately in the same reproductive state.

Results

A logistic regression model was developed relating the number of sows outside to climatic conditions, reproductive state and season. The response variable was measured on a binary scale, IN or OUT. Reproductive state was divided into four categories: sows up to day 111 of pregnancy, 112 days gestation to farrowing, farrowing to 5 days post farrowing and sows greater than 5 days post farrowing. These values were based on the observed variation between sows in different reproductive states. Newly farrowed sows spent a considerable proportion of their time inside, up to a maximum of 91%, whereas sows immediately prior to farrowing spent a large proportion of their time outside, up to a maximum of 90%. Seasonal variations were incorporated into the model by using trigonometrically transformed Julian day number.

When factors were initially fitted individually it was found that reproductive state, precipitation, windspeed and season had the greatest effect on the proportion of the day that sows spent outside. Wind direction was excluded from the model since it had no significant effect on sow behaviour. Humidity was highly correlated with precipitation and was therefore also excluded.

Fitting the model to the data gave:

$$\ln\left(\frac{p_i}{1-p_i}\right)=\beta_0+\beta_1\Gamma+\beta_2V+\beta_3\cos\theta+\beta_4\sin\theta+\beta_5T+\beta_6R+\beta_7C_1+\beta_8C_2+\beta_9C_3$$

where p_i is the daily proportion of observations of sows outside for observation i, Γ is daily precipitation (mm), V is average daily windspeed (ms^{-1}), $\theta=2\pi$(Julian Day Number-1)/365, T is average daily temperature (°C), R is average daily radiation (Wm^{-2}) and $C_1 = 1$ if reproductive state is between 111 days and farrowing and 0 otherwise, $C_2 = 1$ if reproductive state is between farrowing and 5 days post farrowing and 0 otherwise, $C_3 = 1$ if reproductive state is after 5 days post farrowing and 0 otherwise and β_0 to β_9 are the regression coefficients presented in Table 1.

Table 1. Regression coefficients

	Coefficient	Standard Error
β_0	-0.434	0.182
β_1	-0.0167	0.00567
β_2	-0.125	0.0315
β_3	0.599	0.115
β_4	0.0445	0.0517
β_5	0.0710	0.0205
β_6	0.00223	0.000792
β_7	0.301	0.166
β_8	-0.843	0.121
β_9	-0.196	0.0766

This logistic regression model accounted for 33% of the variation in shelter use. When factors were fitted singly, reproductive state explained 20% of the variation and no other single factor accounted for more than 5%.

Conclusions

The logistic regression model indicated that combinations of weather parameters had the greatest effect on the use of shelter with cold, wet, windy weather greatly increasing the proportion of time spent inside. Season represented by trigonometrically transformed Julian day number, affected the proportion of time spent outside, with sows spending a greater proportion of their time outside in the winter than in the summer. However due to seasonal variation in the number of daylight hours, considerably more time was spent outside in the summer, up to a maximum of 12.3 hours than in the winter, up to a maximum of 6.1, for dry sows .

Acknowledgements

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Offspring recognition and adoption in the Indian peahen

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Introduction

The Indian peahen *Pavo cristatus* is a large, ground-nesting pheasant, in which the female alone cares for the precocial, synchronously hatching chicks. A large feral population of about 200 peafowl was studied at Whipsnade Wild Animal Park, Bedfordshire. Although females were frequently observed attacking alien chicks that approached too closely, the frequency of adoption within this population was estimated to be approximately 20% of all broods. This paper examines the question of why peahens should accept an alien young, and under what circumstances they would be responsive to the calls of an unfamiliar chick.

Several functional explanations of the apparently maladaptive phenomenon of adoption have been proposed (e.g. Riedman 1982; Eadie *et al.* 1988). At Whipsnade, evidence suggests that acquisition of parental experience is not the primary mechanism, since both old and young hens adopt, and most alloparents already have their own brood. Hens do not appear to be exploiting or kidnapping adopted chicks; there is no evidence that adoption increases the alloparent's status, and there are certain behavioural costs of increasing brood size (Budgey 1994). Reciprocal altruism is unlikely, since no exchanges of chicks have been observed, and adopted chicks remain with their foster brood for the entire season. Resources are not limited, and communal breeding is not essential for chick survival. Kin selection is a possible explanation for some cases, but in others the hens involved are known to be unrelated.

An alternative hypothesis is that adoption occurs as a result of 'recognition error', which is dependent upon the ability of peahens to recognise individual chicks, and their motivation to discriminate against unrelated ones. There are certain costs of parental discrimination, not least the risk of mistakenly rejecting one's own offspring, and it is predicted that females should accept an alien chick when the potential benefits of doing so outweigh the potential costs. A model is presented in Figure 1 to show how manipulation of the cost and benefit functions can produce variation in the optimum threshold at which a hen should accept an alien young.

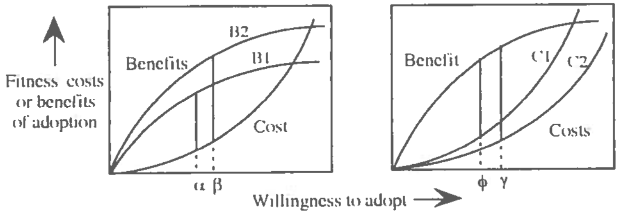

Figure 1. Simple cost/benefit trade-off model for adoption. As either the benefit of adoption increases (from B1 to B2), or the cost decreases (from C1 to C2), a peahen's motivation to accept an unfamiliar chick is predicted to increase (from α to β and φ to γ respectively).

It is proposed that costs and benefits will change over the course of breeding, being related to the perceived probability that the chick is the peahen's own. The following experiment tests the hypothesis that a female's susceptibility to adoption depends upon her motivation to discriminate against alien chicks, which depends in turn upon her breeding state. Recognition in birds usually occurs through calls (Falls 1982), and recordings of the distress calls of 3-day old peachicks were used to investigate the responsiveness of females over the breeding season.

Methods

Calls were played in the field to 83 unrestrained hens in six breeding categories: non-breeding females, used as control (NB); hens in early incubation, days 1-15 (EI); hens near hatching, days 25-28 (NH); hens with a brood younger than seven days (YB); hens with a brood older than three weeks (OB); and hens that had lost chicks within 5 days prior to testing (LC). The response of each female to the playback was assigned to one of the following four categories: 'positive' (++) (alert, broody, approaches loudspeaker); 'interested' (+) (alert, but does not approach loudspeaker); 'neutral' (0) (no observed change in behaviour during testing); or 'negative' (–) (appears distressed, retreats from loudspeaker).

Results

Figure 2 shows that peahens in late incubation, those with young broods and those which have lost chicks are significantly more likely to approach an unrelated chick than non-breeding hens. In contrast, females with older broods are significantly more likely to avoid alien chicks.

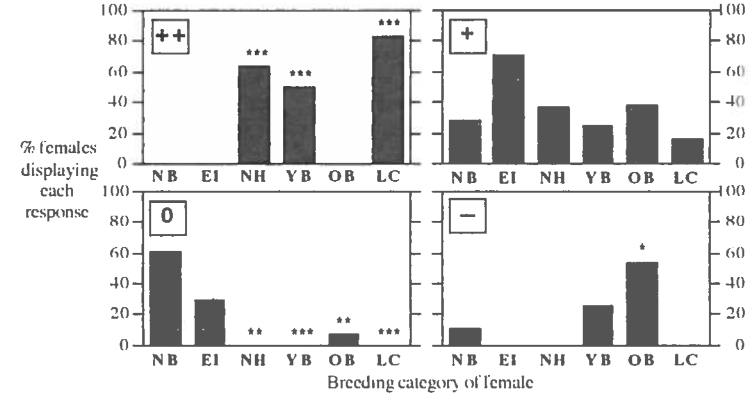

Figure 2. Responses of females in six breeding categories to an unfamiliar chick call. (See Methods for definitions of categories.) Asterisks denote differences in response between non-breeding (NB) females ('controls') and other breeding categories (Mann-Whitney U test).

Discussion and conclusions

There appear to be particular windows within a peahen's reproductive cycle when she is more responsive to an alien chick, and it is suggested that these windows occur when the costs of rejecting an unfamiliar chick outweigh the costs of accepting it into her brood. The benefits of adoption will be higher when there is increased likelihood that the chick is one of the female's own, such as when the parent-offspring recognition system is not fully developed (categories NH and YB), or when a female has lost her own chicks (LC). As recognition develops, this probability will decline, and the expected benefits will therefore decrease with chick age. Further experiments, using calls of older chicks, would determine whether peahens do learn to recognise individual chicks, or merely discriminate against an age difference.

Adoption can thus be an adaptive response to constraints of recognition. Since peahens frequently amalgamate their chicks into temporary 'gang-broods' (Budgey 1994), the proximate causal mechanism may be accidental mixing, and the observation that hens isolate their broods for the first few days post hatching lends support to this hypothesis.

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Influence of lamb presence on the behaviour at pasture of "Altamurana" breeding ewes

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Introduction

The productivity of free-ranging ruminants mostly depends on grazing activity (Arnold and Dudzinksi, 1978), and knowledge of the main behavioural traits of sheep during their time at pasture is essential. This paper reports a study on the influence of lamb "presence/absence" on the behaviour at pasture of "Altamurana" breeding ewes.

Material and methods

3 groups of ewes were formed: A, 5 ewes with their single lamb at pasture; B, 5 ewes without their single lambs at pasture; and C, 5 ewes with their twin lambs at pasture. The time at pasture was subdivided in 4 daily periods: I, from 08:30-10:30; II, 10:30-12:30; III 12:30-14:30; and IV, 14:30-16:30.

The trial, 31 days long, began on average 9 days after delivery. The ewes were kept on the pasture in special pens large enough to guarantee their daily intake requirements. The behavioural observations on the ewes started after day 10, and lasted about 20 min for each period. They were carried out using video-recorders for 2 observations a week. The behavioural data collected were submitted to repeated measures analysis of variance by a mean squares method regarding the group, the period and the weekly observations. The means were assessed and their differences tested using a t-test. Behavioural traits referred to were: time spent eating and standing, prehensions (number) and mobility (steps.min^{-1}).

The weight of the ewes (at the start and at the end of the trial) and of the lambs (at birth; at the start and at the end of the trial) were also taken.

Results

Table 1 shows that the ewes spent almost all of the time at pasture eating and standing. The number of prehensions was significantly higher in groups A and B in comparison with group C, and in the 1st period in comparison with the other periods. The mobility of ewes also decreased significantly during daily periods at pasture. Lamb presence at pasture did not influence the weight change of ewes and lambs (Table 2). In fact, similar weights were found in groups A and B. The significantly lower weight of group C was probably due to the type of birth (i.e. single or twin).

Conclusions

The weight change of sheep during the trial did not show differences due to the "presence/absence" of lambs at pasture, although this did influence some of the behavioural traits of the ewes. In particular, group A showed relatively active behaviour at pasture.

Reference

Arnold, G.W., Dudzinksi, M.L., 1978. Ethology of Free-Ranging Domestic Animal. Elsevier, Amsterdam 198pp.

Table 1 - Behavioural traits of ewes at pasture.

	Group A		Group B		Group C	
	n.	mean ± SE	n.	mean ± SE	n.	mean ± SE
TE	94	98.34 ± 1.00	105	98.35 ± 0.95	105	96.48 ± 0.95
Pr	89	20.04 ± 0.46 A	100	19.64 ± 0.45 a	105	18.15 ± 0.42 Bb
TP	95	100.0 ± 0.62	105	99.66 ± 0.59	105	97.47 ± 0.59
S	100	4.73 ± 0.14 A	105	4.15 ± 0.24 B	105	4.10 ± 0.14 B

	I period		II period		III period		IVperiod	
	n.	mean±SE	n.	mean±SE	n.	mean±SE	n.	mean±SE
TE	60	97.58 ± 1.30	84	99.87 ± 1.06	85	97.20 ± 1.05	75	96.25 ± 1.13
Pr	60	21.37 ± .57 Aa	84	19.16 ± 0.47 b	81	18.18 ± 0.48 B	69	18.39 ± 0.53 B
TP	60	99.03 ± 0.80	85	99.86 ± 0.65	85	97.68 ± 0.65	75	99.59 ± 0.69
S	60	5.00 ± 0.19 A	85	4.76 ± 0.1aAB	90	4.25 ± 0.15Bb	75	3.29 ± 0.16 C

⇒ A,B,C=P≤0.01; a,b,c=P≤0.05.
TE = Time spent in eating (%);
Pr = Prehensions in 1min (n.);
TP = Time spent in erect position (%);
S = Steps in 1 min (n.).

Table 2 - Weight change of ewes and lambs (kg).

	Group A	Group B	Group C
	mean ± SE	mean ± SE	mean ± SE
Esw	50.0 ± 2.2	47.8± ± 2.2	47.6± ± 2.2
Ese	40.9 ± 1.9	39.7± ± 2.0	37.8± ± 1.9
Lwb	3.807 ± 0.17	4.082 ± 0.17 a	3.476 ± 0.13 b
Lws	5.854 ± 0.15 A	5.887 ± 0.15 A	4.551 ± 0.12 B
Lwe	11.875 ± 0.46 A	11.912 ± 0.51 A	8.479 ± 0.35 B

⇒ A,B,C=P≤0.01; a,b,c=P≤0.05.
Esw = weight of ewes at start of the trial (kg);
Ese = weight of ewes at the end of the trial (kg);
Lwb = weight of lambs at birth (kg);
Lws = weight of lambs at the start of the trial (kg);
Lwe = weight of lambs at the end of the trial (kg).

Preliminary results on the maternal and neonatal behaviour of the "Altamurana" thoroughbred sheep

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Introduction

Study of the Altamurana breed (now completely replaced in South Italian sheep-rearing) is important as it may be possible to recover some of their more valuable and distinctive features. The aim of this study was to investigate of the maternal and neonatal behaviour of the Altamurana sheep (Arnold and Morgan, 1975).

Materials and methods

The investigation was carried out on the only experimental farm where this breed is preserved. It studied the behaviour at lambing of 50 family groups of ewes and their single or twin lambs. The behavioural observations were carried out by video-recording in the same place where the ewes naturally lambed (at pasture or at fold). Filming started when the hooves of the lamb appeared on the ewe's *rima vulvae* and ended 90 min after the last lambing. In this preliminary report, only the behavioural data supplying the most interesting results were considered: TG=time spent grooming in 90min period; UM=time under mother in 90min period; LS=length of first suckling; LD=interval birth-first lying down. The weight of lambs at 5h (BW) and day 10 (W10) after birth was also noted (Table 2). The data were submitted to analysis of variance by a mean squares method (factorial model); the means were assessed and their differences were evaluated by t-test. Total correlations were also considered.

Results

During delivery only 4 ewes needed human assistance. In general, the grooming started from the head region (59%), and it was significantly longer in the primiparous ewes than in the multiparous ones and in the single births than in the twin ones (Table 1). Twin lambs spent more time in close contact with the mother's abdomen than the single and had a shorter length of first suckling (Table 1). Total correlations show how the birth weight of lambs is, to a certain extent, directly related to the time receiving grooming and the length of first suckling. There was an inverse relationship between the time under the mother and the time interval between birth and first lying down. The same relationship was found for weight at day 10 (Table 3).

Conclusions

The heavier lambs at birth seem to have a better behavioural equilibrium and in particular earlier first voluntary lying. This is believed to be due to the need to rest after an easier acquisition of the typical neonatal behaviour than that of the lighter lambs. From an ethological point of view, the excellent maternal and neonatal behaviour of the Altamurana thoroughbred sheep undoubtedly justify the preservation of this breed.

Table 1 - Main behavioural traits of lambs.

	1st delivery		2nd delivery		≥3rd delivery	
TG(%)	n.	mean±SE	n.	mean±SE	n.	mean±SE
Single	13	64.5±5.6 a	11	45.4±6.3 bM	10	52.8±8.0 M
Twin	-	-	8	19.4±7.3 N	18	15.1±4.9 N
Male	6	63.1±8.2 A	10	26.9±6.9 B	15	36.1±5.2 B
Female	7	65.8±7.6 A	9	37.9±6.7 B	13	31.9±7.7 B
UM(min)	n.	mean±SE	n.	mean±SE	n.	mean±SE
Single	13	19.9±2.6	12	14.8±2.7 M	10	19.0±3.7
Twin	-	-	8	34.8±3.4 aN	18	26.1±2.3 b
Male	6	20.8±3.8	10	24.1±3.2	15	19.1±2.4
Female	7	19.0±3.5	10	25.5±3.0	13	26.0±3.5
LS (min)	n.	mean±SE	n.	mean±SE	n.	mean±SE
Single	13	65.8±11.3	12	92.5±11.8 M	10	67.2±16.0 m
Twin	-	-	8	19.5±14.8 N	18	26.3± 9.8 n
Male	6	66.7±16.5	10	62.5±14.0	15	55.7±10.5
Female	7	65.0±15.3	10	49.5±12.8	13	37.7±15.6
L D(min)	n.	mean±SE	n.	mean±SE	n.	mean±SE
Single	7	62.5±6.5	9	53.5±6.8	7	48.7±9.2
Twin	-	-	4	71.2±8.5	6	71.6±7.3
Male	3	55.7±9.8	9	67.5±6.8	10	62.8±5.5
Female	4	69.2±8.5	4	57.2±8.5	3	57.5±10.4

Table 2 - Weights of lambs.

BW(g)	n.	mean±SE	n.	mean±SE	n.	mean±SE
Single	14	4086±136	12	4098±149 M	11	4042±173 M
Twin	-	-	8	3477±186 N	18	3447±123 N
Male	7	4228±193	10	3845±176	15	3968±132 m
Female	7	3943±193	10	3730±161	14	3521±166 n
W10(g)	n.	mean±SE	n.	mean±SE	n.	mean±SE
Single	14	5335±146 a	12	5798±160bM	11	5805±184bM
Twin	-	-	8	4760±199 N	18	4679±132 N
Male	7	5551±206	10	5293±188	15	5617±141 M
Female	7	5120±206	10	5265±172	14	4866±177 N

⇒ A,B,C=P≤0.01; a,b,c=P≤0.05 (in lines); M,N=P≤0.01; m,n =P≤0.05 (in columns).

Table 3 - Total correlations

	TG	UM	LS	LD
BW	+**	-**	+**	-*
W 10	+**	-**	+**	-**

⇒ *= P<0.05, **= P<0.01

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Effect of flavours on dairy cow feeding behaviour

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Introduction

Feed changes often result in an initial depression in feed acceptance by farm livestock, particularly in pregnant livestock where the motivation to feed may be impeded by an intake restriction caused by the physical presence of the foetus. Flavour provides the primary test for feed preference, tolerance or rejection, while visual and/or olfactory messages function as secondary reinforcers. he development of effective feed masking flavours could not only assist cattle to eat unpalatable feeds, especially by-products, but also allow the farmers to change feeds suddenly without risk of reduced intake by their cattle and the feed millers to take advantage of short-term fluctuations in raw material price and availability. Concentrates with bitter or salty tastes may have low acceptability, but this could be masked by sweeteners.

Materials and Methods

Twelve non-lactating, pregnant, autumn-calving British Friesian cattle were paired according to preceding and expected calving dates, rate of eating a pre-experimental diet, lactation number, live weight and milk yield immediately prior to drying-off. They were then allocated at random to one of two blocks of a Latin square changeover design consisting of six periods of seventy-two hours each. Within blocks cows were allocated at random to one of six treatment sequences, arranged in a 3 (salty, bitter, sweet flavours) x 2 (masked or unmasked) factorial design.

Two start-stop watches (Beta, minute - second -1/1000 second timers) were started simultaneously at commencement of each feeding. One was stopped when the cow was not ingesting feed (idling) and the other was left running. The former measured the actual feeding time and the latter, the total time. During the first two feeds, both watches were stopped after one minute of actual feeding time, feed was withdrawn immediately, weighed and again presented to the cows and idling time recorded. Both stop watches were again restarted instantaneously and stopped when all the feed has been consumed. Time spent idling in the first minute was also noted after initial feed withdrawal. All weighings were made using a rapid taring, self-indicating scale. All data was analysed by ANOVA.

Results

Intake during the first minute of feeding was the same for the salty and bitter flavours but was increased for the sweet (Table 1). However, masking enhanced first minute intake of the salty diet, had no effect on the bitter but tended to reduce intake of the sweet treatment. There was no difference in first minute intake between the salty and bitter diets but both were less than the sweet diet. Masking had no effect on first minute intake of second feed.

Cows spent less time feeding on the sweet than on the salty and bitter feeds (Table 2). Masking reduced the time spent eating the salty feed, increased that of the bitter, but had no effect on the sweet. In both the masked and the unmasked treatments, time spent idling tended to be lower when cows were fed the salty diet compared to the bitter and sweet where they spent similar times idling.

Table 1. First minute intake (g)

	Flavour			Standard errors of difference between means and significance		
Mask	Salty	Bitter	Sweet	Flavour		Flavour x Mask
First feed						
No mask	636	649	679	5.74(***)	4.69(NS)	8.12(*)
Mask	662	651	669			
Second feed						
No mask	659	658	688	5.24(***)	(5.28(NS)	7.41(NS)
Mask	675	672	689			

Table 2. Feeding and idling times (minutes)

	No Mask			Mask			Standard error of difference and signif.		
	Salty	Bitter	Sweet	Salty	Bitter	Sweet	Flavour	Mask	Flavour x Mask
Idling	0.02	0.14	0.11	0.06	0.16	0.14	0.019(***)	0.010(***)	0.011(NS)
Total feeding	2.69	2.83	2.61	2.65	2.89	2.63	0.114(***)	0.011(*)	0.019(***)

Conclusion

This study demonstrates that the most palatable feeds for cows are those with a sweet taste, or a salty flavour when masked with a sweetener, but not feeds with a bitter taste. Masking was effective in increasing the acceptability of salty and bitter feeds in the first minute of feeding, but over a longer period was only successful in increasing the acceptability of salty feeds.

Using Individual Behavioural Characteristics to Predict Aggression in Groups of Growing Pigs

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Introduction

Mixing unfamiliar pigs and the resulting aggression pose serious husbandry and welfare problems in pig farming. Pigs are social animals who form dominance hierarchies (Beilharz & Cox 1967). These hierarchies are established by assessing an opponent's fighting ability, usually through fighting (Rushen & Pajor 1987). These fights occur in established groups from time to time, but are particularly frequent and serious after regrouping. Many studies have attempted to reduce this aggression after mixing. One problem often encountered in these studies is the great variability in aggressiveness between pigs. Hessing et al (1993) found degrees of aggressiveness to be consistent across time. If the behaviour of pigs after regrouping could be predicted by a standard test done on individuals before, this information could be used in experiments on mixing aggression to either balance the design or as a covariate in the analysis.

Material and Methods

The animals tested were 95 crossbred pigs at 11 weeks of age, 33.5±0.6 kg body weight. They were kept in litter groups of 8 to 10. Attack latency tests (see below) were carried out on two consecutive days. Pigs were categorised according to their average attack latency into high-aggressive (H) and low-aggressive (L) pigs. They were observed in their home pens for 2 days (1 hr am, 1 hr pm), and then mixed (see below) into new groups of 8 pigs with 4 pigs from each of 2 litters. The mixing treatments were H/H (4H+4H; n=3), H/L (4H+4L; n=4) and L/L (4L+4L; n=2).

Attack latency test: The home pen, size 3x4 m^2, was divided in half by a solid partition. One pig of the group was isolated in one half of the pen, the remaining pigs were retained in the other half. An intruder pig was then introduced into the test area. The intruder pigs were 2-3 weeks younger than the residents in order to prevent them from attacking the residents. The time from when the resident first made snout contact to when it attacked the intruder was used as an indicator of aggressiveness. The test was terminated as soon as the resident attacked the intruder or, if that did not happen, after 3.5 minutes. This short time period was chosen to keep the stress imposed on the intruder pigs to a minimum. Two tests were carried out per pig with a different intruder on each day.

Mixing: At 0930 hrs on the day of mixing, 2 groups of 4 pigs were simultaneously moved into a new pen of the same size and design as their previous home pens and continuously observed for 2 hrs and again for 1 hour in the afternoon. They were again observed on days 1, 2, 6 and 7 for 1 hour in the morning and 1 hour in the afternoon. Behaviours recorded were number of fights and number of agonistic interactions. Skin lesions were counted after mixing and on day 2, for front and rear separately. 'Front' consisted of head, ears, neck and shoulders, 'rear' of flanks, back and hindlegs. The distinction between front and rear was made because different types of aggression result in wounds on different locations of the body. A lying preference score was also calculated. Whenever a pig lay down and at least one littermate and at least one unfamiliar pig were lying already, the choice it made was recorded. It could either AVOID the unfamiliar pig by lying down next to a littermate or on its own, or, alternatively, it could NOT AVOID the unfamiliar pig by lying down next to it. A preference score (LPS) was then calculated:

LPS = (AVOID - NOT AVOID) / NUMBER OF CHOICES MADE

This score ranges between -1 and +1: '-1' if unfamiliar pigs were never avoided, '+1' if they were always avoided and '0' if both choices were made equally often.

The analysis is based on group means, not on individuals, the sample size is therefore 3, 4 and 2 for H/H, H/L and L/L treatments, respectively.

Results

Significantly more fights occurred in H/H groups (21±2.03) than in H/L (7.3±3.20) or L/L groups (1.3±1.07; $F_{2,6}$=11.72, p<0.01) on the day of mixing. Two days after mixing, pigs in L/L groups tended to initiate fewer agonistic interactions (0.8±0.06) than those in H/L (3.6±0.79) and H/H groups (2.9±0.29; $F_{2,6}$=3.84, p=0.08). In all groups a clear winner and loser litter could be identified by the number of displacements. While there was no difference in scratch counts between losers of the different groups, the winner litters in H/H groups suffered more scratches (82.8±4.71) than winners in H/L groups (20.6±5.78) and L/L groups (40.2±17.15; $F_{2,6}$=17.94, p<0.01). All 3 treatments showed at least a tendency to avoid unfamiliar pigs on the day of mixing. L/L groups showed no preference on any other day. H/H and H/L groups still showed a preference for their own litter mates on day 2 (see Table 1).

Table 1: Lying Preference Score (means ±SE; t-test for LPS > 0)

	Treatment		
	H/H	H/L	L/L
Mixing	0.58 ± 0.21^{+}	0.77 ± 0.17**	0.23 ± 0.03*
Day 1	0.53 ± 0.25^{+}	0.55 ± 0.18*	-0.08 ± 0.19
Day 2	0.46 ± 0.08*	0.42 ± 0.09**	-0.13 ± 0.15
Day 6	0.00 ± 0.11	0.22 ± 0.16	-0.05 ± 0.24
Day 7	0.26 ± 0.23	0.20 ± 0.09^{+}	-0.08 ± 0.35

($^{+}$ = p<0.10, * = p<0.05, ** = p<0.01)

Conclusions

The amount of aggression observed in groups after mixing was, to a certain extent, predicted by the categories of pigs which were mixed together. This suggests that individual characteristics measured in one context (the attack latency test) have some cross-situational consistency. We therefore believe that the test described above can give useful information about an individual pig's aggressiveness.

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Influence of social experience on learning success in calves

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Introduction

Wemelsfelder (1993), Buchholtz (1994), Persch (1994) and others argue that animals, if given the opportunity, will voluntarily (spontaneously) interact with the environment. Social deprivation will therefore change orienting behaviour, exploration, play or learning ability. The aim of our investigations was to investigate this hypothesis.

Animals and methods

The learning abilities of young and mature cattle were tested in a 3 and 6 arm maze respectively, using a colour preference reward paradigm i.e. preference for green light being rewarded in contrast a yellow light (Figure 1).

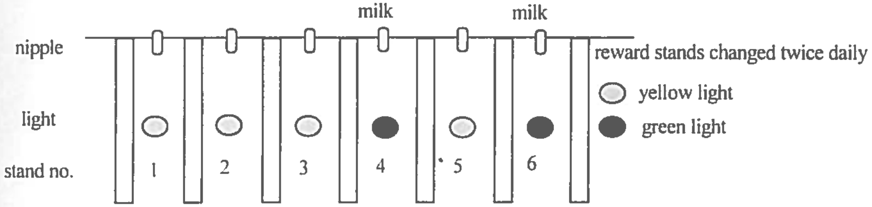

Figure 1. Six-arm maze test for calves.

The learning success was assessed by: (i) percent of correct stand choices during the test day (LT) (all stands were accessible) and (ii) cumulative value of stand choices (LK). Index points achieved during the test day were allocated as follows: correct stand choice +1, incorrect stand choice -1, choice when not all stands were accessible ±0. The following statistical models were used:

model 1 (fixed factorial): $LT_{ijklm} = \mu+K_i+S_j+(K*S)_{ij}+G_k+A_l+e_{ijklm}$
model 2 (mixed model): $LT_{ijklmno} = \mu+TT_i+K_i+S_j+(K*S)_{ij}+G_k+A_l+\underline{TN}_{jklmn}+e_{ijklmno}$
K = climatic stimulus: weak, strong, S = social contact: strong (cows and calves grouped), medium (calves grouped), weak (calves isolated), G = sex, A = age at test start,
TT = test day, TN = animal no.

Results

We determined the influence of social deprivation on learning success in calves socially deprived before testing. Results are shown in Figure 2.

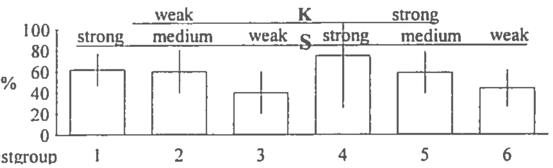

Figure 2. Influence of social experience on % of correct stand choices during the testday (LT)

Calves reared in isolation (test groups [VG] 3 and 6) performed worse on day 1 of testing. However, during the subsequent tests in groups, socially deprived subjects gradually reached success rates similar to those in animals reared in social groups (see Figure 3). Acquisition of preferences differed between socially deprived and non-deprived subjects.

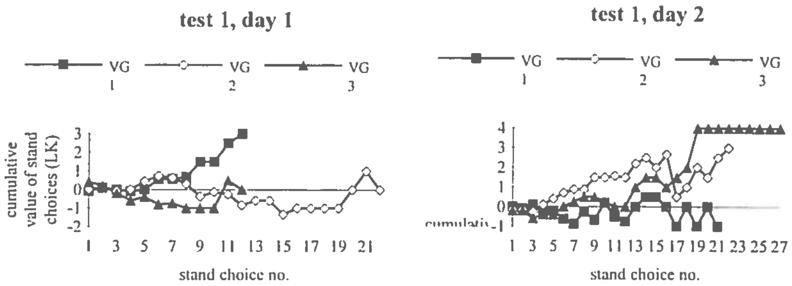

Figure 3. Learning success (LK) of test groups (VG).

On the average, individuals tested in groups performed better than calves tested in isolation (Figure 4).

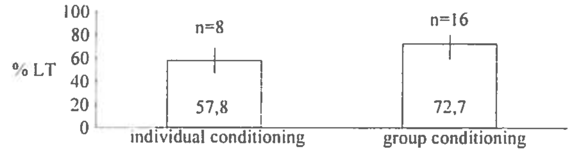

Figure 4. Percent of correct stand choices (LT).

After 3 or 4 days, learning success reached at least 80% correct choices, compared with a random expectation of 33%. Significant individual variation became apparent after day 3 of testing, with differences of up to 40% between individuals. The standard deviation for LT was 12% in test 1 and 7% in test 2 and 3. The rank correlation coefficients between test days within subjects were $R_S = 0.34\text{-}0.45$. No significant rank correlation coefficients were found between tests.

Conclusion

We suggest, that social conditions have an influence on learning success in calves. Further experiments will follow.

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Individual responses of pigs to social and non-social challenges in the slaughterhouse

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Introduction

Individual differences in behavioural responses to stress in pigs have been well documented. Several recent studies have shown that different behavioural and physiological strategies are consistent within individual pigs (e.g. Hessing et al., 1994), although some authors doubt these studies support the existence of discrete 'categories' of individuals (Jensen, 1994). Individual differences between pigs can result in considerable variation in their ability to cope with stressful situations. Slaughterhouse conditions involve exposure to social stress (mixing with unfamiliar pigs) and non-social stress (rough handling). In this experiment, we studied whether individual differences in behaviour and physiology in home pen conditions (and during a mild challenge test) are related to subsequent reactions during periods of transport, driving and mixing.

Materials and Methods

Five groups of six pigs and five groups of seven pigs were studied. All animals were 16 weeks old at the start of the study. A total of four hours of data on agonistic interactions were focally sampled in the home pen and social status of individuals within each group was determined (Lee et al., 1982). At 18 weeks old all groups of pigs were individually subjected to an 'open-door' test whereby the door of the pen was opened and pigs could enter a passageway divided into six equal sections. The number of sections entered by each pig was recorded.

At the age of 20 weeks all groups of pigs were first transported for 0.5 hours on a lorry. Immediately following this period groups were subjected to one of the following treatments: two groups were driven through a passageway (thus simulating 'driving' in lairage); four groups were mixed (i.e. two groups were mixed and another two groups were mixed separately), and four groups received both driving and mixing treatments (combined treatment). Data recorded during driving consisted of the order individual pigs proceeded along the passageway and the number of times individuals were pushed by the driver. Agonistic interactions were recorded during mixing. Saliva samples for analysis of cortisol were taken and skin damage scored for each pig before transport, after transport and following each treatment.

The Wilcoxon matched-pairs test was used to analyse changes in levels of cortisol. Overall rank correlations were obtained by averaging over separate Spearman correlations calculated within groups. A split-plot analysis of variance model was used to study differences in cortisol levels and behavioural parameters in relation to treatment and skin damage.

Results

Transport. Mean levels of cortisol increased significantly during transport ($P<0.01$) although there were large individual differences in levels of cortisol and five pigs even showed a decline. The level before transport did not correlate with the level afterwards (r_s=-0.16, ns).

Driving. The order of individual pigs during driving in the passageway did not correlate with social status (r_s=-0.25, ns) and neither order nor frequency of being pushed by the driver correlated with change in levels of cortisol (r_s=0.25; r_s=0.10, ns).

Mixing. Fighting was significantly positively correlated with frequency of aggressive behaviour in the home pen (r_s=0.46, $P<0.05$) and rise in cortisol (r_s=0.42, $P<0.05$). Fighting was also significantly negatively correlated with the number of sections entered during the 'open-door' test (r_s=-0.40, $P<0.05$). Pigs with high skin damage scores after mixing were those which had fought for longer during mixing ($P<0.001$) and they showed a smaller decrease in cortisol ($P<0.05$) than pigs with low skin damage scores. Skin damage after mixing was significantly higher than after either driving or the combined treatment ($P<0.05$). Pigs showed a significant decline in cortisol during mixing relative to control ($P<0.05$).

Combined treatment (driving and mixing). None of the above findings were significant but cortisol levels rose significantly in response to mixing ($P<0.01$). Frequency, duration and distribution of agonistic encounters during mixing did not differ between the mixing and the combined treatment.

Conclusions

Social status did not predict order during driving. In the mixing treatment the correlation between frequency of aggressive behaviour in the home pen and duration of fighting during mixing suggests a consistent response when presented with similar situations. However the correlation between the number of sections entered during the 'open-door' test and duration of fighting during mixing suggests a consistent response also exists between quite different situations. In the case of the combined treatment these relationships are absent. Furthermore the observation that the mixing treatment caused more skin damage than the combined treatment and fighting was not correlated with skin damage in the combined treatment, suggests that fighting was less intense when pigs were driven before mixing. Cortisol rise was higher after the combined treatment compared with either of the other two treatments suggesting that pigs were more stressed under this condition. It is concluded that a combination of driving and mixing is very stressful to pigs and fatigues them which leads to a reduction in their predictability of reaction.

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Choice between floor type and floor level in farmed silver foxes

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Introduction

The debate about whether or not wire mesh floor is aversive for animals is as old as the history of fur farming. Due to a lack of scientific evidence, argument is mainly based on emotions; wire mesh floor is not natural. The available scientific evidence is scarce and does not give a clear evidence for or against. Some experiments have shown that, when given a choice, adult silver foxes distributed their time about equally between a solid bottom and wire bottom (c.f., Bakken et al., 1994), whereas some expreriments showed that, unexpectedly, silver and blue foxes spent even more time in a high-mounted wire-mesh cage than in a 4-times larger earth-floor pen (Korhonen and Niemelä, 1994). This and many other results (c.f., Bakken et al., 1994) support the hypothesis that silver foxes prefer to stay on a higher level. However, in addition to floor type, also other key features of the cage environment influence their choices. The present paper is a part of the experimental series in which those key features have been examined. This time silver foxes had to weigh the importance of the floor level against the importance of the floor type.

Materials and methods

Two standard cages (120 x 105 x 70 cm, length, width, height) were connected with an opening (20 x 20 cm) allowing the animal a free access from one cage to the another. Food and water was offered to both cages. One cage had a traditional wire bottom while the bottom of the other cage was covered with a box containig a 5-10 cm layer of sand-peat mixture. The floor level of the cages was changed after 2 weeks as follows: (1) both low, (2) wire floor high (=50 cm higher), (3) sand-peat floor high and (4) both high. The behaviour of nine adult silver foxes was video recorded for the total period of 8 weeks. The behaviour was then scan-sampled from the tapes at 5 min intervals for activity (sitting, standing, walking, eating etc) and rest (either sleeping or lying awake) in wire floor cage or sand-peat floor cage. Faeces were collected from and below each cage after each period.

Results

Percentages of time spent in active behaviour were: 46±4, 43±6, 33±5 and 34±7 % (mean ±SD) for the periods of 1 to 4, respectively (MANOVA, $P<0.001$). Percentages of active time on sand-peat floor were: 76±10, 69±14, 64±15 and 79±12% ($P<0.05$), respectively. Rest times on sand-peat floor were 84±22, 53±27, 48±36 and 71±24 % ($P<0.01$), respectively. The results support a higher preference for the sand-peat floor (Table 1). This preference was influenced by the floor level but not in a systematic way. During the first 2 weeks when both cages were on a low level the foxes spent significantly more time for rest and activity in the sand-peat floor cage. There was no day-to-day variation but there was a clear circadian rhythm: animals were most active during the working hours (800-1600 h). When the wire floor was raised higher the animals immediately rested more than earlier on it. This proportion further increased with time (% resting time on wire floor = 1.3 x days after lift +18, $r^2 = 0.63$, linear regression analysis) being greater than on sand-peat floor after the 8th day. On the third period when the sand-peat floor cage was lifted higher while the wire floor was returned to the lower level the animals still rested as much on the wire floor as on the sand-peat floor. During the fourth period they shifted their resting place from the wire floor to the sand-peat floor. During all periods more than 97 % of defecations took place on the wire floor.

Table 1. Effect of floor level on choice (% of 24 h) between wire floor and sand-peat floor.

Floor level	Sand-Peat floor Activity	 Rest	Wire floor Activity	 Rest
Both low	35	45	11	9
Wire floor high	30	30	13	27
Sand-peat floor high	21	33	12	34
Both high	28	47	7	19

Conclusions

In earlier studies silver foxes did not show any preference for solid floor (cf. Bakken et al., 1994; Korhonen and Niemelä, 1994), whereas in the present study some preference for sand-peat floor was found. However, this preference was not exclusive but was influenced by several intervening factors. The preference for wire mesh floor as a resting place at once increased as it was lifted higher and the preference further increased with time. These observations support the conclusion that a surface for active behaviour and rest are selected using different criteria. For resting place, level is important. Unexpectedly, the preference for wire floor as a resting place did not decrease during the third period although the wire floor was returned to its initial lower level. An exceptionally hot weather may explain this as well as a lower activity of the animals during the last two periods.

Furthermore, preference of active behaviours for sand floor is greatly influenced by experimental set-ups. Korhonen and Niemelä (1994) used a long tunnel to connect the cages, whereas in the present study a simple hole between the cage pairs served the purpose. As a result, what the foxes chose in the study of Korhonen and Niemelä (1994) may be going through the tunnel, rather than a quality of surface at the end of tunnel explaining the equal activity counts in the two cages connected with the tunnel. In this study going through the hole was perhaps not as attractive as an object of preference, maybe going through the hole even disturbed normal locomotory patterns to such an extent that the foxes distributed their activity more inside one and the same cage.

Selection of wire floor for defecation was, however, exclusive.

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Social dominance affects behavioural and immune responses to the change of housing system from tie-stall to free-stall barn in dairy cattle

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Introduction

Although the expansion of the Japanese dairy industry has resulted in an increase in free-stall barn housing, the majority of Japanese dairy cows are still housed in tie-stall barns. Dairy farmers who have changed from tie-stall to free-stall barns have experienced a decrease milk production and increase of infectious diseases such as mastitis. It is estimated that the abrupt change of housing, social circumstances and management may cause stress in cattle even if group housing is less stressful than tethering. In this experiment, the effects of a change of housing system from tie-stall to free-stall barn on the behaviour and immune function of dairy cattle. The influence of social dominance ranks were also evaluated.

Materials and Methods

30 milking dairy cows and heifers were moved from tie-stall to free-stall barn on Day 0 (at the Iwate Prefectural Animal Husbandry Experimental Station). Dominance values were evaluated before the animals were moved by a 5-day period of observation of aggressive behaviour during a 3 hour period each day in a paddock. 5 dominant (Dm), 5 middle (Md) and 5 subordinate (Sb) animals were selected. Their behaviour was observed during 24 hours and was recorded every 5 min on day -3, 1, 7, 15, 30, 58 and 88. Behavioural categories recorded were standing (S), lying (L), ingestion (Ing), rumination (Rum), resting (Res) and others (O). (S+L=24 hour or 100%, and I+Rum+Res+O=24 hour or 100%.) Blood samples were collected from 4 animals from Dm, Md and Sb on Day -1, 2, 6, 16 and 54 and the level of major lymphocyte subsets (by panning) and serum ACTH (by radioimmunoassay) were determined. The data were analyzed by analysis of variance using a SAS GLM procedure for experimental day (DAY) and dominance rank (DR). Duncan's multiple range test was used to compare the treatment means.

Results

Figure 1 shows behavioural changes of Ing, Rum, Res and Others after the housing system change. Figure 2 shows the change of lying behaviour and the difference associated with dominance rank. Ing and Rum time significantly increased from Day -1 to Day 1 (130 to 374 min, 452 min to 586 min, respectively) ($P<0.01$) and Res time decreased from 805 min to 360 min ($P<0.01$). On day 1, wide individual variation from 360 to 1026 min was observed in L time which was shortest in Md in spite of no difference in the which was shorter than Dm (839 min) ($P<0.05$).

Table 1 shows the immune and serum ACTH responses to the housing system change and the differences assocaited with dominance ranks. The mean number of white blood cells and lymphocytes were not different between experimental days but those of Dm were lower than those of Md and Sb ($P<0.01$). The mean levels of pan-T (CD2) and T-helper (CD4) lymphocytes increased on day 54 as compared with day -1 ($P=0.05$), and tended to increased in Dm after moving ($P<0.1$) but decreased in Sb on Day 16 (p=0.05). B cell level decreased on Day 1 but did not return to the basal level by Day 54 (p<0.001). The mean level of serum ACTH did not differ between experimental days, however it was lower in Dm (67.61 pg/0.1ml) than in Md (114.51 pg/0.1ml) and Sb (100.73 pg/0.1ml) ($P=0.05$) through the experimental period.

Conclusion

These results suggest that disturbance of behaviour and stress by change of housing system affect immune function, even in subordinate animals.

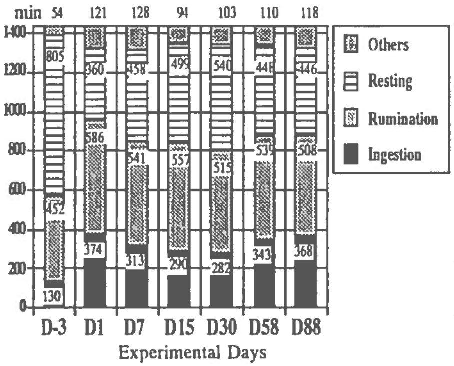

Figure 1. Change of 24 hour behaviour of dairy cattle after housing system change from tie-stall to free-stall barn. Ingestion + Rumination + Resting + Others = 1440 minutes or 24 hours.

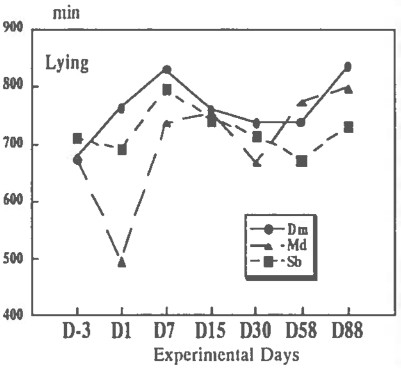

Figure 2. Change of lying behaviour of dairy cattle after housing system change from tie-stall to free-stall barn and the difference among dominance ranks. Lying + Standing = 1440 minutes or 24 hours. Dm = dominant, Md = middle and Sb = subordinate.

Table 1. The effect of housing system change from tie-stall to free-stall and social dominance on immune function and serum ACTH level in dairy cattle.

Item	Unit	Mean	Experimental Day					Dominance Rank			Probability	
			-1	2	6	16	54	Dm	Md	Sb	DAY	DR
WBC	No/μl	102.04	9825	.	93.55	10600	1096.7	8675^{n}	11231^{m}	10740^{m}	0.256	0.003
Lymphocyte	No/μl	5636	5342	.	48.09	6142	6183	4331^{n}	6319^{m}	6300^{m}	0.149	0.001
CD2	%	28.63	23.36^{b}	29.79^{ab}	28.99^{ab}	27.73^{ab}	33.29^{a}	30.77	26.80	28.34	0.054	0.284
CD4	%	22.02	17.49^{b}	22.63^{ab}	21.72^{b}	20.66^{b}	27.60^{a}	25.10^{m}	20.73^{n}	20.24^{n}	0.006	0.032
CD5	%	65.73	62.69	67.35	65.31	64.63	68.63	64.24^{n}	70.25^{m}	62.71^{n}	0.49	0.02
CD8	%	8.01	8.99	7.51	6.89	7.03	9.62	7.18	8.17	8.68	0.185	0.363
$\gamma\delta$T	%	35.70	36.21	37.20	36.66	37.00	31.42	31.95	41.35	33.80	0.844	0.129
B cell (CD5-/DR)	%	35.16	41.31^{a}	33.01^{b}	37.48^{ab}	37.73^{ab}	26.25^{c}	34.68	34.01	36.79	0.0003	0.503
ACTH	pg/0.1ml	94.28	97.13	91.38	110.08	92.33	80.49	67.61^{n}	114.51^{m}	100.73^{mn}	0.817	0.046

$^{abc, mn}$ Values in rows with different superscripts differ (p<0.05).

Behavioural response to humans and the productivity of commercial dairy cows

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Introduction

Studies on commercial pigs, broiler chickens and laying hens have found significant correlations, based on farm averages, between the behavioural response of animals to humans and animal productivity (Barnett *et al.*, 1992; Hemsworth *et al.*, 1981, 1989, 1994b). These significant relationships indicate that productivity is depressed in situations in which animals show marked avoidance of humans in a standard test. Recent studies, particularly on commercial pigs but also on poultry, indicate that the attitude and behaviour of stockpersons towards animals are major determinants of the behavioural response of farm animals to humans and that manipulation of these human characteristics, through training programmes, offer the opportunity to improve animal productivity (Coleman and Hemsworth, unpublished data; Cransberg *et al.*, 1995; Hemsworth *et al.*, 1989, 1994a). Seabrook (1972) also reported some significant associations between the personality of the stockperson and the milk production of dairy cattle. The major objective of the study reported here was to examine the relationship between the behavioural response of commercial dairy cows to humans and the productivity of these cows.

Material and Methods

This study was conducted in two time replicates (1993/94 and 1994/95) at a total of 29 commercial dairy farms in south-eastern Australia. The average herd size of the farms was 177 cows and cows were milked in herring-bone parlours. In addition to milk yield, the following observations and measurements were recorded:

i. Stockperson questionnaire. The questionnaire mainly contained questions concerned with attitudes towards interacting with cows.

ii. Stockperson behaviour. These observations focused on the nature of the behaviour of the stockpersons towards cows during handling and milking activities.

iii. Milking Behaviour. The behaviour of cows, such as the "flinch, step and kick" response, was recorded during milking and in the presence of the stockperson.

iv. Level of fear of humans by cows. The approach behaviour of approximately 50 cows at each farm to a stationary experimenter in a standard arena was be quantified in a standard 3-minute test.

Results

Only behavioural and productivity data for the first replicate (14 farms in 1993/94) are presented here since other data have only been provisionally collated and analyzed. However, the major relationships observed in the first replicate appear at least superficially to be generally apparent in the second.

There was a highly significant negative relationship, based on farm averages, between the level of fear of humans by cows and the milk yield of cows. A significant correlation between the average time that cows at the farm spent within 3 m of the experimenter in the standard test and milk yield of the farm ($r=0.70$, $P<0.01$) indicates that variation in fear levels between farms is accounting for a substantial proportion of between-farm variation in milk yield. Furthermore, there were some highly significant correlations, again based on farm averages, between the behaviour of the stockperson towards cows and both the behavioural response of cows to humans and their productivity. For example, there was a significant correlation between the average number of moderate to forceful negative physical interactions used by stockpersons in handling cows and the time that cows spent within 3 m of the experimenter in the standard test ($r=-0.55$, $P<0.05$).

Discussion

The fear-productivity relationship found in this study support similar relationships observed in other animal industries. The highly significant positive correlation, based on farm averages, between the approach behaviour of cows to a stationary experimenter in a standard test and the milk yield of cows indicates that the productivity of commercial dairy cows is depressed in situations in which the animals show marked avoidance of humans. One possible explanation for this apparent fear-productivity relationship is that highly fearful cows may experience a chronic stress response or a series of acute stress responses in the presence of the stockperson to the extent where the milk yield of these fearful animals is seriously limited. The existence of significant correlations between human behaviour and both the behaviour and productivity of cows indicates the opportunity to improve the productivity of commercial dairy cows by training and selecting stockpersons targeting the attitudinal and behavioural profiles of stockpersons.

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Injury status of group-housed sows

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Introduction

Individual and group housing systems for dry sows have traditionally alternated in their popularity with respect to animal welfare. However, in response to the latest legislation, intensive sow housing systems will be banned entirely in Great Britain from 1999 and in the rest of the EC from 2005 and the future of sow welfare depends upon the development of housing systems which accommodate the animals in groups whilst maintaining aggression at a minimum. Although various authors have cited the existence of a dominance hierarchy in pigs (eg Ewbank 1969) and its role in regulating aggression (Beilharz and Cox 1967), the major argument against group housing has been the associated high injury status as a consequence of frequent and intense aggressive interactions, especially in competitive situations (Rasmussen, Banks, Berry and Becker 1962).

This investigation assessed the injury status of sows housed in an electronic sow feeding (ESF) system in which the animals were housed as a group but fed as individuals. The aims were as follows:

- to investigate whether certain groups/types of individuals (eg. gilts) were especially susceptible to aggressive attacks
- to identify any relationship between injury status and pregnancy stage eg. at implantation (days 12-28); 1-2 weeks prior to farrowing
- to identify those areas of the body most susceptible to injury throughout pregnancy

Methodology

A dynamic commercial herd of sows (Camborough, PIC) was housed in straw yard separated into lying (120m^2), feeding (17m^2) and dunging (100m^2) areas. Two electronic sow feeders were situated side by side in the feeding area. The group contained between 55-70 animals ranging from gilts to sows in parity ten and above. Small sub-groups of sows were moved into the yard immediately following service and removed, again in sub-groups, approximately one week prior to farrowing. Injury status was assessed weekly for a period of eighteen months. Injuries were sustained whilst in the service and farrowing houses, from rough surfaces in the yard and from friction from the collars. The different sources were easily distinguishable and only injuries from aggressive interactions were recorded. A scale of 0-3, based on a simplification of the de Koning scale (de Koning 1985), was devised to record the number and severity of injuries arising from aggressive interactions. The surface of the body was divided into twelve areas and each area was given a score, giving a potential individual total score of 36. Records were also kept of weight and backfat measurement throughout pregnancy.

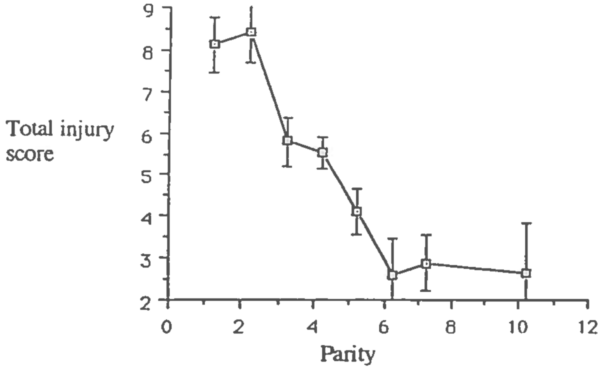
A stratified random sample was taken across the herd to ensure data independence and data were analysed using analysis of variance.

Results and Discussion

The paramount finding of this study was the low injury status throughout the herd, the maximum individual total score recorded being only 17. This suggested that some form of social organisation was having a regulatory effect on behaviour. Total injury score (sum of all area scores) was observed to decrease with increasing parity (P ***) suggesting that a learning process existed as well as the more obvious conclusion that higher parity sows were older and heavier and thus less susceptible to attack (see Figure 1). Total injury score decreased slightly throughout pregnancy as shown by the following regression equation:

Total injury score = 8.23 - 0.518parity - 0.0203pregnancy days ($F_{2,1415}$ = 255.23; P *).** Weight and backfat were also observed to be related to total injury score with lighter, thinner sows attaining the highest scores (P ***).

Figure 1. The relationship between injury status and parity



Van Putten and Van de Burgwal (1990) cited vulva biting as a potential problem in group-housing systems. However, there was little evidence of vulva damage throughout pregnancy in this study and no significant increase in the final weeks when the vulva becomes swollen and potentially more susceptible to attack (P *). This may be explained by the fact that the sows had access to straw which provided both a behavioural distraction and a feed buffer and also the design of the feeding system in which the sows were protected whilst feeding and provided with sufficient queuing space.

Conclusion

Group-housed sows, fed a conventional low energy ration in an ESF system, sustained a low injury status throughout pregnancy. This was thought to be due to the provision of straw, the design of the yard and the feeding system.

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Resting behaviour of group-housed sows

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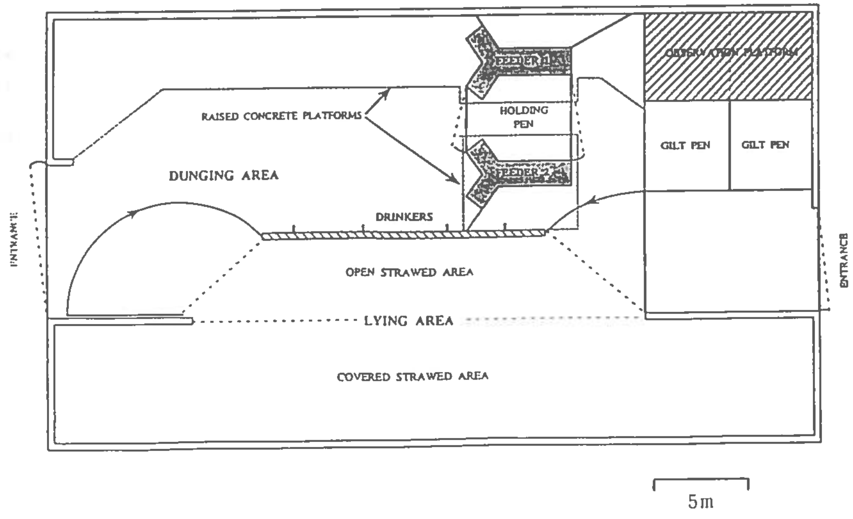
Introduction

Group-housing systems for sows are to be re-introduced as intensive stall and tether systems are phased out in response to welfare legislation (HMSO 1991; EC 1991). The social behaviour of group-housed sows needs to be investigated and the information used in the design of group-housing systems. This will help to ensure that one set of welfare problems are not simply replaced by another in the transition. One aspect of social behaviour that will have important implications on housing design is resting behaviour.

Methodology

A dynamic commercial herd of between 55-70 sows, ranging from gilts to sows of parity ten and above, was housed in a straw yard with access to an outside paddock in the summer months. The yard was separated into a lying area (120m^2), a dunging area (100m^2) and a feeding area (17m^2) containing two electronic sow feeders (Nedap Poeisz) as shown in figure 1. Gilts were introduced in groups of four to six after they had been trained to use the feeders. Small sub-groups of four to six sows were moved in to the yard immediately following service and removed approximately one week prior to farowing.

Figure 1. Plan of the dry sow yard



The daily feeding cycle started at 1630 hours and preliminary observations of the herd revealed that the majority of the sows rested during the latter period of the cycle after they had all fed. For a period of six months, the herd was regularly scanned at 1400 hours and the location of each individual sow recorded together with information on any surface or other sows with which she was in contact. Temperature was recorded in the different areas and records were kept of any management factors that may have affected the animals' behaviour. The aims were as follows:

- to collect information on resting locations and to investigate whether individuals prefer certain locations
- to investigate whether animals lie in regular sub-groups
- to observe the behaviour of newly introduced gilts

Results and Discussion

Chi square analysis revealed that sows regularly occupied certain resting positions (P ***) and that these positions were maintained over parities. Those locations adjacent to the walls and corners were considered to be most favourable (Wiegend, Gonyou and Curtis 1994) and were regularly occupied by the older sows. Gilts were found to rest in the dunging area when first introduced into the yard before gradually integrating with the main group. This process took approximately one to two weeks. These results support those of Beckett, Edwards, Simmins and Walker (1986) and Moore, Gonyou and Ghent (1993).

Sows consistently associated with certain other animals in the herd (P ***), forming sub-groups of up to four individuals. Further analysis will be carried out to investigate whether these sub-groups can be explained by either gilt or service management history. A further association existed between resting position and pregnancy stage (P ***). In the final week of pregnancy sows tended to lie away from the rest of the group and to occupy the area near the exit gate. This concurred with the findings of Hurnik (1985).

Conclusion

Results from this trial revealed that both the facility for sows to lie in sub-groups and the provision for gilts to integrate gradually with the herd should be incorporatd into yard design and herd management. Keeling and Duncan (1983) cited the importance of housing design in relation to the spacing behaviour of hens and these results suggest similar implications for pregnant sows.

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Piglet vocalization before and after milk ejection in early lactation

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Introduction

Piglets frequently initiate nose contacts with the mother before and after milk ejection. These contacts are often accompanied by typical vocalization (Nose Contact Vocalization, NCV). This behaviour was described both in wild and domestic pigs, but is still poorly understood (Gundlach, 1968; Jensen et al, 1991). The aim of this study was to investigate relationships between NCV, body weight increase, intervals between milk ejections and duration of udder massage.

Materials and Methods

Nursings of 19 sows were observed during 24 hours at days 7 or 8 post partum. The sows were either enforced a 35 min inter-nursing interval (group MIN35, n=7) or 70 min interval (group MIN70, n=7) or were left on a free nursing rhythm (group CONT, n=5). We recorded NCV and udder massage of individual piglets before and 10 minutes after milk ejection. As to the duration of udder massage after milk ejection, the nursings were classified as follows: a. terminated by the sow - if the sow stood up or rolled over during 10 minutes after milk ejection; b. terminated by the piglets - if, in spite of the udder being accessible, the piglets left the udder within 10 minutes after milk ejection; terminated by the observer - if the massage lasted 10 minutes after milk ejection. Milk intake was estimated by the weigh-suckle-weigh method.

Results

The first results show a great variability of NVC between and within litters. Some piglets vocalized once per nursing, other piglets vocalized never during 24 hours. Piglets in groups MIN70 and CONT had significantly more NCV after milk ejection than those in group MIN35 (Kruskal-Wallis analysis, p=0.03), but not before milk ejection (Kruskal-Wallis analysis, n.s.). The frequency of NCV shows a peak during the first minute after milk ejection in group MIN70 and CONT, but not in group MIN35 (Fig. 1). During the whole 24-hours-period, group MIN35 piglets gained more weight (200 g) than group MIN70 (140 g) and of group CONT (152 g). Litter weight gain during 24 hours correlated negatively across groups with number of vocalizations after milk ejection (n=19, r_s=-0.44, p=0.059). However, the NCV and the weight gain of individual piglets (relative to the average of each litter) was not correlated (n=154, r_s=0.05, n.s.). These results suggest that the frequency of NCV after milk ejection is higher in litters with lower weight gain, but within litters piglets with lower weight gain do not vocalize more. We are now analysing the milk intake during separate nursings in relation to NCV.

The relationship between NCV and duration of udder massage were calculated for all 19 sows across the groups. There was no correlation between the proportion of nursings terminated by the sow and the litter NCV (n=19, r_s=-0.05, n.s.). There was no difference in NCV during the first minute after milk ejection, when nursings terminated by the sow were compared with the rest of nursings (terminated by the observer or by the piglets). The NCV was higher in nursings terminated by the observer than in nursings terminated by the piglets (Wilcoxon T-test, n=14, p=0.04). These results suggest that NCV after milk ejection is an indicator of the piglets' motivation to massage the udder, but it has no influence on whether the sow will terminate the massage or not.

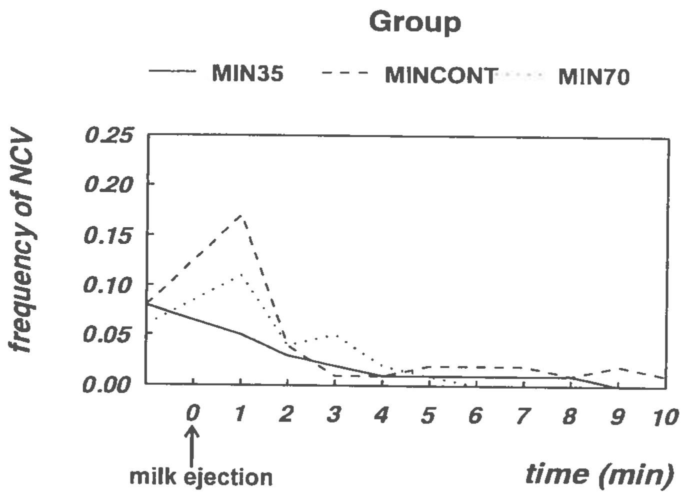

Fig. 1 Average number of NCV per piglet and nursing before and after milk ejection

Conclusions

Our results suggest that frequency of Nose Contact Vocalization depends on the nursing rhythm and indicates the motivation to massage the udder.

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Resting behaviour of heifers housed in pens with slatted floor, the effect of space allowance and access to a bedded lying area.

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Introduction.

The welfare of heifers housed in pens with fully slatted floor may be poor because of the low space allowance commonly used and the floor type. At low space allowances it may be difficult for all animals to lie down at the same time. Thus it seems likely that a reduction in space allowance will result in a reduction of the lying time, in particular among the low ranking individuals. Heifers may have problems changing position from standing to lying on the concrete slatted floor and this may result in fewer lying periods (Müller et al., 1989). This experiment investigates the effect of space allowance and access to a bedded lying area on resting behaviour of heifers housed in pens with slatted floor.

Material and methods.

The behaviour of 74 Danish Friesian (Black and White) heifers housed in 13 pens on 3 commercial farms was studied. Group size was the same within farm; either five or six heifers per pen. Twentyfour heifers were housed in 4 small pens (1.5m^2/animal) with fully slatted floor, 28 heifers were housed in 5 large pens (3.0m^2/animal) with a separate lying area, also with fully slatted floor, while 22 heifers were housed in 4 large pens (3.0m^2/animal) with slatted floor in the feeding area and straw bedding in the separate lying area (Hindhede et al., 1995). One farm included all three pen types, while the two remaining farms included two pen types. Heifers weighed on average 396 (s.d. 41) kg at the time of observation, and none of the animals were in heat. The behaviour and position of individual heifers were recorded at 5 minute intervals during 24 hours using direct observations. The effect of pen type on lying time and number of lying periods was tested by analysis of variance using mean square for interaction between pen type and farm as denominator for the F-test. In large pens the effect of bedding in the separate lying area on use of this area was investigated by Wilcoxon Mann Whitney Test using pen as the statistical unit.

Results.

The duration of lying down was affected by pen type ($F_{2,2}$=20.72; *). Heifers housed in small pens lay down less than heifers housed in large pens (643 (s.e. 26), 766 (s.e. 14) and 811 (s.e. 23) minutes for heifers in small pens with slatted floor, large pens with slatted floor and large pens with access to a strawed lying area; Figure 1). Comparing small and large pens with fully slatted floor, the variance of lying time was higher among heifers in small pens than in large pens ($F_{23,27}$=3.52; **). Heifers in large pens with straw in the separate lying area lay down more in this area than heifers in large pens with fully slatted floor (Wilcoxon Mann Whitney Test (df=3,4); *). The number of lying periods was also affected by pen type ($F_{2,2}$=241.5; **; Figure 2). The number of lying periods for heifers in small slatted, large slatted and large strawed pens was 6.6 (s.e. 0.6), 9.2 (s.e. 0.5) and 14.5 (s.e. 0.9), respectively.

Discussion and conclusion.

The results show that a reduction in space allowance may results in a reduction of the lying time, and that a space allowance of 1.5 m^2/heifer is insufficient for heifers of around 400 kg live weight. The larger variance among animals in small pens suggests that the lying time is reduced in particular among some individuals within the group. Thus the effect of social factors within the group may complicate examination of the effect of space allowance on lying time. Increased activity due to animals in heat may also conceal the effect of space allowance on lying time (Beneke, 1985). Heifers with access to a strawed lying area clearly preferred to lie in this area, which occupied half the pen (i.e. 1.5m²/heifer). However, not all animals could lie down at the same time in the strawed area and some individuals lay more in the feeding area of the pen, which had slatted floor. More lying periods in large pens with access to a strawed area was probably due to less problems getting up and lying down than in pens with fully slatted floor, which are hard and often slippery. More intentions to lie down and more interruptions of lying down have previously observed in pens with slatted floor than in pens with deep bedding (Müller et al. 1986), and these problems have been associated with fewer lying periods (Müller et al., 1989). Welfare of heifers housed in pens with slatted floor may be increased by ensuring a sufficiently high space allowance and by giving the heifers access to a bedded lying area.

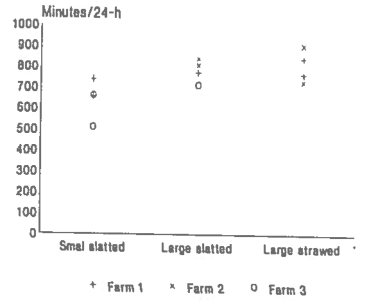

Figure 1. Mean lying time in pens of different types.

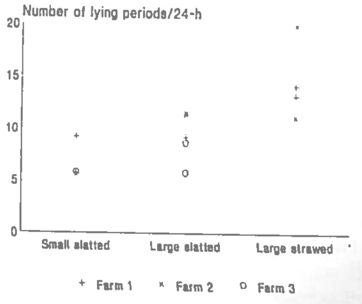

Figure 2. Mean number of lying periods in pens of different types.

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Rearing piglets in a poor environment: developmental aspects of social stress and coping strategies in pigs.

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Development of social stress.

In many mammalian species, the early socialization period appears to be critical for the development of appropriate species specific social skills in adulthood. For group housed pigs, this is of critical importance, because reduced social skills may result in more stressful social relationships.

The present study was designed to investigate whether preweaning rearing conditions may influence the development of social relationships in pigs in adulthood. For that purpose, two groups of piglets were either reared in a poor evironment indoors ($n=10$) or in an enriched environment outdoors ($n=14$) during the preweaning period. Piglets in the poor environment were reared in 4.2m² - pens with half concrete, half slatted floors and the mother sows tethered. The piglets from the enriched environment in contrast, were reared in a 0.5ha outdoor enclosure with loose-housed sows and half-open farrowing crates of 8m².

After weaning, the piglets were housed indoors, in pairs, in pens of 2mx2m during the entire investigation period and the effects of the preweaning condition on the development of social relationships were investigated. In addition, a number of physiological parameters were studied to investigate whether social relationships of adult pigs reared in a poor environment, might also be more stressful. These parameters included weight development, onset of puberty, expression of oestrous behavior, and heart rate and cortisol response after exposure to an acute non-social stressor.

The results show that pairs reared in a poor environment show more aggression than those reared in the enriched environment (Mann-Whitney U-test, $P < 0.05$). The consequences of this increased aggression seem to be particularly negative for the subordinate individuals: subordinates reared in the poor environment have a smaller daily weight gain (MANOVA, $P<0.0001$), are one month late with respect to onset of puberty (Mann-Whitney-U-test, $P<0.05$) and show elevated cortisol levels both before and 5 hr after exposure to an acute stressor (tethering stress, MANOVA, $P<0.05$). No differences were found with respect to expression of oestrous behaviour, behavioural reactions or heart rate in response to an acute restraint stressor.

It is concluded that being subordinate to a dominant penmate is stressful, but only for those subordinates that spent their early socialization period under barren conditions.

Stereotypies after chronic tethering stress.
Pigs reared in poor conditions and pigs reared in enriched conditions were tethered when they were one and a half year old. Development of stereotypies were studied after two months of tethering stress. The results show that pigs reared in a poor environment show more stereotypies than those reared in an enriched environment (MANOVA, $P<0.05$). At present it is being investigated a) whether pigs from the poor rearing condition are more sensitive to the deleterious effects of chronic tethering stress on the expression of oestrous behavior and b) what are the effects of treatment with an opioid-antagonist (naltrexone) on levels of stereotypies and expression of oestrus behavior.

Individual variability in coping strategy.
From the above described population of animals, pigs with an extreme low, and pigs with an extreme high heart rate response to restraint stress were selected. The selection procedure was as follows: 3 animals were discarded because of disturbances in heart rate registration. From the remaining 21 animals, one upper third was selected for the High Response group (HR, n=7, heart rate response during first 5 minutes of restraint stress: 142-159 beats per minute), one lower third was selected for the Low Response group (LR, n=7, heart rate response during first 5 minutes of restraint stress: 99-115 beats per minute). The remaining "middle responders" were not included in the analysis. The HR and LR-group were selected because different coping strategies have been proposed for animals that react to a stressor in a predominantly sympathetic as opposed to a predominantly parasympathetic manner (Hessing, 1993).

It was investigated whether HR and LR-animals differed with respect to the following behavioral and physiological parameters: tendency to react aggressively to an opponent, duration of "alert" in an open field test, latency to approach a novel object placed in the open-field, basal saliva cortisol samples, cortisol response to restraint stress, expression of oestrus behavior and number of stereotypies performed after two months of chronic tethering stress. The results show that the HR and the LR group did not significantly differ in any of the above mentioned parameters. A tendency of a difference was found with respect to the latency to approach a novel object (Mann-Whitney U-test, $P=0.1$).

It was subsequently investigated whether the HR and LR-pigs might have been reared predominantly in poor or enriched conditions. The results show that HR-pigs are predominantly reared in enriched environment whereas LR-pigs are predominantly reared in the poor environment (CHI-square, $P<0.01$).

It is concluded from these results that, at least in the pig, rearing condition may determine the adult "type" of responding to a stressor in terms of heart rate response to restraint stress. In addition, a sympathetic as opposed to a parasympathetic way of responding , needs not to correlate with behavioral and physiological parameters associated with mild stress exposure.

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Flocks of commercial laying hens: organised groups or collections of individuals?

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Introduction

In the wild, flocks are composed of birds of different sexes and ages. There is usually a well defined social organisation and a range of optimal flock sizes for various environmental conditions. In flocks of commercial laying hens, however, all the birds are the same sex and age. This leads to the question of whether the social organization found under natural conditions actually occurs under commercial conditions and what, if any, is the range of optimal group sizes for these conditions. The experiment reported here is the first in a series investigating optimal group sizes for laying hens managed commercially. We concentrated on measures indicative of group social dynamics and structure, with the aim of identifying behavioural parameters which were most affected by group size.

Materials and Methods

Litter floor pens of two different sizes were used, with three replicates of each pen size. The large pen contained 70 birds and the small pen 13 birds with the same allocation of resources (floor, feeding, drinking, perching and nesting space) per bird. All birds were individually marked. During 18 to 35 weeks of age, every bird in each group was observed as a focal bird for 2 minutes on 20 occasions, and over 100 instantaneous scans were made.

At the start of the focal observation the location of the bird in the pen, its behaviour and the identity and behaviour of all birds within a circle of 0.5m radius around it were recorded. The mean and standard deviation of locations for each individual were calculated to investigate use of space. The identities of the birds within the circle around the focal bird were arranged into a matrix of association to show how often each bird was seen together with each other and so whether there were subgroups. Calculations of the proportion of birds within this circle performing the same behavioural activity as the focal bird were used to estimate the first measure of synchronization. The second measure of synchronization was based on the scans of all birds in the pen. The number of birds feeding, drinking, preening, dustbathing and perching were noted during the scan and from that the proportion of all birds performing each of these behaviour patterns calculated. Significance tests were Mann-Whitney or, where appropriate, the data were transformed and an ANOVA performed.

Results

There was no evidence of location preferences, although there were specific birds in the large groups who were outside the 95% confidence limits for the standard deviation, showing they moved over either a larger or a smaller area of the pen than other birds. Neither was there evidence that particular pairs of birds were observed within 0.5m of each other more often than would be expected. In fact there was no evidence at all of subgroups from this method or from cluster analyses of the data.

There were differences in the time budgets of the birds in the large and small groups. Only those significant across all replicates are reported here. Birds spent more time on the perches in the large groups (13.8%) than the small groups (8.9%) ($P<0.05$) and a greater percentage of time preening on the perches in the large groups (7.6% vs. 4.4%) ($P<0.05$). Birds spent more time feeding from the feed trough in the large group (27.3% vs. 24.6%) ($P<0.04$) and more time foraging in the litter (1.7% vs. 0.8%) ($P<0.05$). The rates of threats and chases calculated per bird and minute were both found to be higher in the large groups (threats 0.057; chases 0.017) than in the small groups (threats 0.029; chases 0.001) ($P<0.005$ for both behaviours). From the measures of synchronization during the focal observations, birds ground pecking or drinking in the large groups had significantly ($P<0.05$) more neighbours within 0.5m than in the small groups. From the measures of synchronization during the scans, birds in the small groups were more synchronized for preening ($P<0.05$) than birds in the large groups.

Conclusions

There were few behavioural measures which were consistently affected by group size. There was more aggression in the large groups than in the small groups. Birds also spent more total time on the perches. Perches are often regarded as a safe retreat for birds and so it is possible that birds were using the perches as a consequence of the higher level of aggression. Reduced synchronisation in preening behaviour in the large groups might also be attributed to this higher aggression. There were effects of group size on the behaviours associated with feeding and drinking. The fact that birds spent more time feeding and more time foraging may reflect that there was more total feed trough and litter space in the large pen to monitor, even if the actual space per bird was the same. The greater synchronization within 0.5m for ground pecking and drinking in the large groups may also reflect the greater total space available. Thus a problem when investigating the effects of group size while controlling for stocking density is that the effects of group size are confounded by the effects of pen size. We feel that some of the differences in this study in feeding and drinking behaviour in particular, are due to pen size effects.

With regard to proposing an optimal group size for commercial laying hens, we might tentatively suggest some advantages to birds in the smaller group because of the difference in aggression, proportion of time perching etc. but there were often significant replicate-group size interactions meaning that each specific group differed and generalisations must be cautious. Surprisingly there was no evidence of social structure, such as location preferences or subgroups within these groups of birds, although this is in accordance with Widowski and Duncan (1994) who also found that hens did not organize themselves into groups with regard to specific individuals or specific locations. Perhaps we should begin to question whether homogenous groups of laying hens are a flock, with a clear social structure, or whether they are merely a collection of individuals who because of pen boundaries happen to be in the same place at the same time. This apparent lack of a social structure under commercial conditions will have consequences for the birds and one could speculate whether the higher risk for behavioural problems, such as feather pecking and cannibalism, is not one of these consequences.

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Nesting behaviour and reproduction of individually caged and group housed rabbits

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Introduction

In commercial breeding of rabbits, does are usually kept in small wire-mesh cages, provided with an open nestbox. The breeding does are unable to close the nestbox or to withdraw from it, which may result in disturbed maternal behaviour and a reduced reproductive performance. The present study focused on the nesting behaviour and reproduction of differently housed does.

Materials and methods

Subjects were New Zealand White rabbits. Cage-reared does were individually housed in wire-mesh cages, either with a corridor (experimentals, n=16) or without a corridor (controls, n=16) connected to the nestbox. Experimental rabbits were provided with hay to close the entrance to the nest. In addition, 6 groups of does (references, n=5 per group) were kept in group housing systems (as developed by Stauffacher, 1992), where they had a possibility to close the nest entrance with straw and to withdraw from the nest. Group housed references, consisting of cage- and group-reared rabbits, were studied in 3 trials with 2 groups per trial. Data were collected during parity 1 and parity 2.

From Day 1 (= the day after parturition) through Day 14, nestbox visits were recorded continuously. The degree of nest-closure was scored twice a day. Visits of caged does and of reference does in trial 1, with pups alive throughout this period, were analysed. Visits were classified as 'nursing' (long) or 'non-nursing' (short) visits, using frequency distributions of durations of visits. A nestbox was classified as closed, when more than half of the observations reached a score of 50-100%. Nest-quality scores and zootechnical parameters were recorded at regular intervals.

Results

Many caged does (30.9%) died before the end of the experiment, whereas all of the group housed does survived. None of the first parity and 27.3% of the second parity rabbits in the experimental cages met the criterion of a closed nestbox. In the group housing system 55.2% of the first parity and 88.9% of the second parity rabbits had a closed nestbox.

Caged experimental does showed a significantly higher frequency of short visits in week 1 of parity 1 and a significantly lower frequency of 'nursing' visits in week 1 of parity 2 than did controls (Fig. 1). Infant mortality rate until weaning was higher in experimentals than in controls (parity 1, 17.1% and 13.7%, respectively, parity 2, 40.1% and 15.1%, respectively, Mann-Whitney U test, N.S.). No significant correlations between several variables of nesting behaviour and reproduction in caged does were found (Spearman rank correlation, $\alpha^* = 0.0001$, *Bonferroni correction).

In the group housing system, only does with a closed nestbox paid few short visits to their nest and showed a once/day schedule of 'nursing' visits (Fig. 2). Open nestboxes were frequently disturbed by group members and closed nestboxes were frequently chosen by a second doe, in particular during parity 1. During parity 1 infant mortality rate was very high, both in closed and in open nestboxes (30.7% and 38.6%, respectively). Mortality rate was much lower during parity 2 (14.7%, 16 closed and 2 open nestboxes).

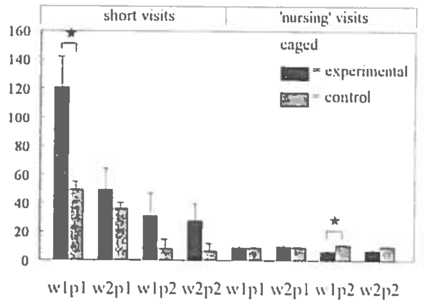

Fig. 1: Mean number (± SEM) of short and 'nursing' visits per rabbit during week 1 (w1) and week 2 (w2) of parity 1 (p1) and parity 2 (p2). (Experimentals, p1, n=15, p2, n=10; Controls, p1, n=14, p2, n=6; Wilcoxon matched-pairs signed-ranks test, * p< 0.05).

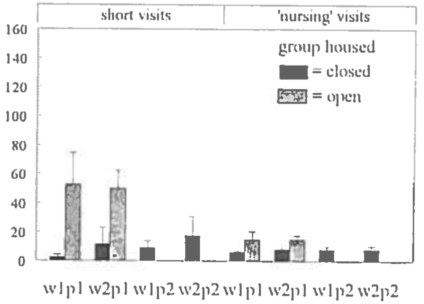

Fig. 2: Mean number (± SEM) of short and 'nursing' visits per rabbit during week 1 (w1) and week 2 (w2) of parity 1 (p1) and parity 2 (p2). (Closed, p1, n=4, p2, n=6; Open, p1, n=5, p2, n=0)

Conclusions

During their first parity, caged breeding does visit the nestbox very frequently. The cage modifications adversely affected nesting behaviour and reproductive performance, but within groups there were large individual differences. To prevent disturbed nesting behaviour and to improve reproduction and vitality of breeding does, marginal modifications of traditional cages are insufficient. Group housing may offer a reasonable alternative, if rearing conditions are adjusted and problems, such as failure to close the nestbox and double nestbox occupations can be prevented.

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Strain Differences in Feather Pecking Behaviour and Floor Laying in Hens Kept in Aviaries

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The development of alternatives to battery cages for commercial egg production has faced some major problems concerning 'inappropriate' behaviourial expressions. Feather pecking, with corresponding cannibalism, is the most serious threat to the welfare of loose housed hens, and floor laying, enhancing the risk of cloacal cannibalism and impaired egg quality, also constitutes an economic problem. Experiments were set up to evaluate these behaviours in layers.

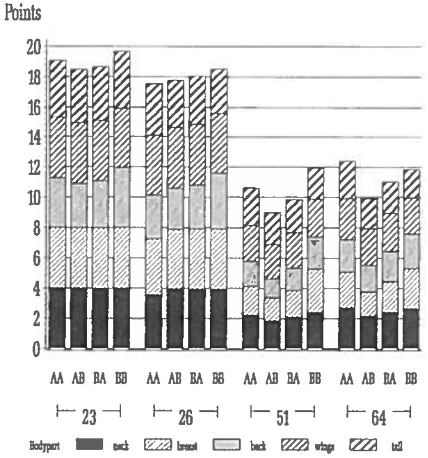
A total of 2,400 chickens of 4 commercial (Lohmann White (LSL) and Brown (LB), ISA Brown (IB), NorBreed 41 White (NB)) and 2 experimental strains (white shell) and their reciprocal crosses were reared in an aviary system (BOLEG 2) (in 1 group) and kept in an aviary system (LACO 3) (16 groups of 150 hens). Plumage scores were assessed 3-4 times during the laying period (commercial strains: samples of 36 of 150; experimental strains: all animals scored). Points (1 to 4) were given to 5 parts of the body and added for a total score (max. 20 points for perfect plumage). Floor laying was expressed as the number of eggs collected outside the nests in relation to the total number of eggs collected, averaged over the laying period (46 weeks). The experiment is currently being replicated.

Feather pecking was observed in 3-week-old chickens. Observation on pecking behaviour was made in 6-week-old chickens and will be reported elsewhere. Right after transfer to the laying house, the plumage of the 17-week-old chickens was nearly perfect. The plumage gradually deteriorated and a minimum was scored at 51 weeks of age, mean scores ranging from 7 (almost denuded) in LSL to 12 in experimental strain BB. Results from the first batch (of two) showed significant effects (ANOVA, $P<0.001$) of strain and age.

Floor laying was significantly lower (Wilcoxon, $P<0.05$) in commercial strains laying white shelled eggs compared to commercial strains laying brown shelled eggs (2.8% versus 7.1%). No strain difference was seen in the amount of eggs laid on the wire floors. This indicates that the strains laying brown shelled eggs were less motivated to move up to the nests. Also enhancing this was the fact that the litter in general appeared more dry and loose in the pens holding strains laying brown shelled eggs.

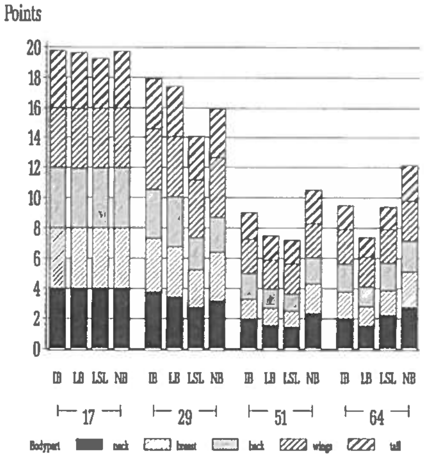
Plumage condition of experimental strains

at 23, 26, 51 and 64 weeks of age



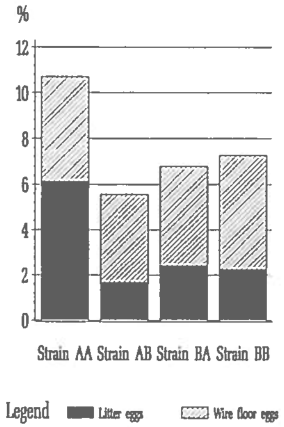
Plumage condition of commercial strains

at 17, 29, 51 and 64 weeks of age



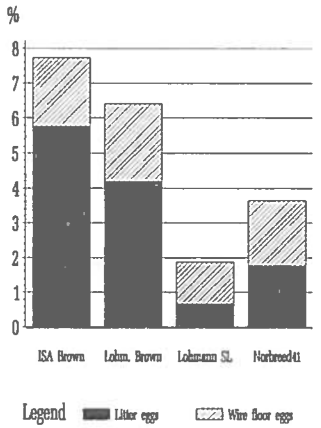
Eggs collected outside nests

in experimental strains



Eggs collected outside nests

in commercial strains



The role of selection for domestic behaviour in the alteration of physiological and productive characteristics in meat-wool sheep

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This paper reports an investigation into the influence of selection on the dominance of feeding reactions and the absence of defensive reactions in meat-wool sheep. This was studied for 10 generations, and combined selection for productivity on the function of the hypothalamo-pituitary-adrenal system (HPAS) with selection for productivity of 1-year-old sheep. During the breeding period, the behavioural rank in experimental rams (n=506) became 76.9% ($P<0.001$) higher than in controls (n=125). The glucocorticoid level following stress induced by judging fell from 6.6 to 1.7 µg % ($P<0.001$) in rams and from 6.8 to 2.3 µg % ($P<0.001$) in ewes. The basal level of these hormones became lower than in the control by 36.0% ($P<0.01$) in rams and by 27.8% ($P<0.01$) in ewes. HPAS reaction to isolation and fasting-induced stress was also weaker in experimental sheep. Breeding for behaviour was shown to result in a specific alteration of HPAS function and an increase of the basal and stress-induced glucose and free amine nitrogen levels in sheep. Live weight was 18.0% ($P<0.001$) and wool yield 12.8% ($P<0.001$) higher in experimental compared with control rams. The contribution of selection for behaviour to the increase of productivity was manifested in a larger breeding-induced live weight (26.4%) and wool yield (28.6%) increment in rams of the desired behavioural class 3-3 than in those of the eliminated class 0-0, which was equal to 9.3% and 0.0%, respectively. This was combined with an increase in the number of more productive rams of domesticated classes to 77.0% and a decrease of 0-0 class rams to 4.0%, against 35.4% in the control stock.

The combined breeding for behaviour and productivity characteristics is a good tool for controlling the physiological systems of ecological adaptation that lead to the utilisation of intra-breed reserves of productivity in the improvement of sheep.

Polymorphism of domestic behaviour and its adaptive significance in sheep

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Introduction

Polymorhpism of domestication-induced behaviour (traditionally defined as defensive with respect to man) has not been studied in domestic ungulates to any great extent. In the study presented in this paper, factors influencing the variation of this behaviour, its regulatory role and co-variability with physiological and productive traits at ontogenetic, population and inter-breed level were studied in more than 12,000 sheep.

Materials and Methods

The estimation of passive-defence reactions in sheep were made by recording the number of their approaches to food in 12-14 hrs after feeding in the presence of man. Sheep of type I (with absence of any avoidance responses to man), type III (which did not approach the food at all), and type II (with intermediate defensive reactions between I and III) were distinguished.

Results and Discussion

Individual peculiarities of defensive behaviour have a polygenic mode of inheritance and develop under the control of feeding behaviour and its interaction with farming factors in meat-wool rams (n=123) and ewes (n=433). Increasing age leads to formation of a similar behaviour phenotype characterized by an absence of defensive and dominance of feeding reactions in meat-wool rams (n=200) and ewes (n=300), and in Awasi (n=444) and black-head Pleven (n=400) breeds. The rate of age-dependent decrease in defensive reactions from 12 to 26 months in sheep of the Altai breed (n=30) was 24-28 % higher ($P<0.001$) 12-14hrs after feedng compared with 2 hrs after feeding.

The role of feeding motivation in the control and variation of negatively interrelated defensive-feeding reactions that comprise the domestic behaviour in sheep was estimated by testing sheep 12-14hrs and 2hrs after feeding. Sixteen behavioural classes were distinguished, including the "domestic" class 3-3 and "wild" class 0-0, diametrally contrasting with respect to the state of feeding and defense reactions. Unlike the basal level, the stress-induced level of glucocorticoids in periferal blood estimated in meat-wool ewes after the judging procedure, blood sampling or keeping in an unknown place, depends on their behaviour (d.f.=3/532, F=115.6, $P<0.001$), the stressful stimulus (d.f.=2/532, F=9.8, $P<0.001$) and the interaction of these factors (d.f.=6/532, F=4.7, $P<0.001$).

The influence of the interaction between behaviour and the kind of stressful stimulus on the development of specific HPAS reactions was confirmed when studying the reactions of this system in coeval Altai sheep to a) fasting, b) weaning, c) isolation from a flock, d) judging, e) competition for food, f) transportation, g) unknown place, h) long-term pairwise confinement in cages. Depending on the rank of hormonal reaction in classes 3-3 n=(20) and 0-0 (n=20), all the stressful stimuli are divided into 3 groups: their reaction to stimuli of the first group (a,b) is the same; the reaction to stimuli (c,d,e,f,g) is 20-176% stronger in class 0-0 ($P<0.01$-0.001);

and that to stimulus (h) is 53.1% stronger in class 3-3 than in class 0-0 ($P<0.001$) (3.2+/-0.15 mg %).

The role of motivation in the modulation of HPAS reactivity was found under motivation stress elicited in these sheep by species-specific acoustic alarm signals. Behaviour is also a factor controlling the feeding activity in rams (n=92) and ovulation and sexual maturation rate in ewes (n=141). The behavioural genotype influences the age-dependent increase of live weight and wool yield in meat-wool sheep. From 12 months of age, the live weight in ewes (n=12) from parents of class 3-3 was 4.3-5.2 kg or 10.6 % ($P<0.05$) higher than in their coevals from parents of class 0-0. Genetic correlations between behaviour and live weight (0.53) and wool yield (0.57) were found in sheep of Altai breed (n=170). Behaviour also influences the milk yield in I-IVth lactations in ewes of white Starozagorskaya (n=165) and black- head Pleven (n=236) breeds. The herd structure with respect to behaviour in 12-16 month-old ewes of Awasi (n=206), Ost-Friesian (n=201), Pleven (n=309), Starozagorskaya (n=84), Romanov (n=300), Altai (n=356), North-East Bulgarian (n=262), Karakul (n=493), polycarpous Karakul (n=160) and Mongolian (n=110) breeds, with the exeption of the Askanian (n=242) and Caucasian (n=255) breeds, is significantly different. Behavioural polymorphism in the low-specialized Awasi and Mongolian breeds is characterized by the absence of class 3-3 and the prevalence of class 0-0 that make up 77.3 and 95.2% respectively of sheep in these breeds. For well established commmercial breeds, a one-sided extension of the range of behavioural variation (which includes class 3-3) is characteristic, and an increase in the number of the more productive sheep of domestic classes (representing 86% of animals) is found in the Ost-Fresian breed. In these breeds, positive rank correlations have been found between the numbers of animals of domestic classes and the average breed fertility (0.82, $P<0.01$), milk yield (0.78, $P<0.01$), live weight (0.87, $P<0.01$) and wool yield (0.72, $P<0.05$).

Conclusions

Analysis of the data obtained in this work leads to conclusions integrating the regulatory role of domestic behaviour in the development of interrelated adaptive physiological and productive traits in sheep. It is hypothesized that: 1) behavioural polymorphism has formed as a result of disruptive selection under the influence of the selection for fitness for the maintenance in captivity which coincided with selection for productivity, and 2) behaviour is a signal character reflecting the laws of variation of the complex of general fitness traits that form the "constitutional type" in domestic sheep. This indicates the expediency of considering behaviour when breeding for improvement of adaptive and productive characteristics in sheep of various breeds.

Short-term diet selection by cattle offered a choice between clean or slurry-contaminated swards.

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Introduction

U. K. government legislation to reduce pollution may necessitate spreading slurry in spring on pasture that will soon be required for grazing. Shallow injection of slurry results in less herbage contamination than surface spreading, and may allow earlier subsequent use for grazing without detriment to animal intake. The aim of this trial was to assess the acceptability by cattle of swards treated with slurry by either of these methods.

Materials and methods

A short-term, indoor test was used to assess selection by cattle between untreated swards, and swards treated with slurry. Grass turves ($0.25m^2$), cut from a permanent pasture which had been maintained by cutting, were placed on a 20cm deep soil base in a sward box. Dairy cow slurry, applied at a rate of $36m^3.ha^{-1}$, was either spread evenly on the surface (S) using a watering can, or poured into 2 slots cut into the sward 10cm apart and 5cm deep, to simulate shallow injection (I). Control swards (C) were untreated. Swards were trimmed to uniform height prior to use. They were not watered after slurry application. Individual Limousin x Friesian steers were offered a chqice between a contaminated sward (S or I) and a control sward (C). The two contrasting sward boxes were placed adjacent to each other on a platform (25cm high) at the apex of a V-shaped test pen. Forty-two steers were offered paired combinations S vs C or I vs C at 10min, 2h, 24h, 4d, 7d, 14d and 21d after slurry application (6 steers on each occasion), and allowed to take 50 bites (p1) after which grazing was terminated. Three of the 6 animals were then allowed to resume grazing until no further grazing occured (p2). Time spent examing or eating from each sward, the number of bites taken from each sward, and the temporal pattern of these events were recorded by two observers who viewed the animals from a distance of 4m. Sward surface height (SSH) was measured using a sward stick before and after grazing in p1, and again after grazing in p2, with 50 contacts selected at random on each sward.

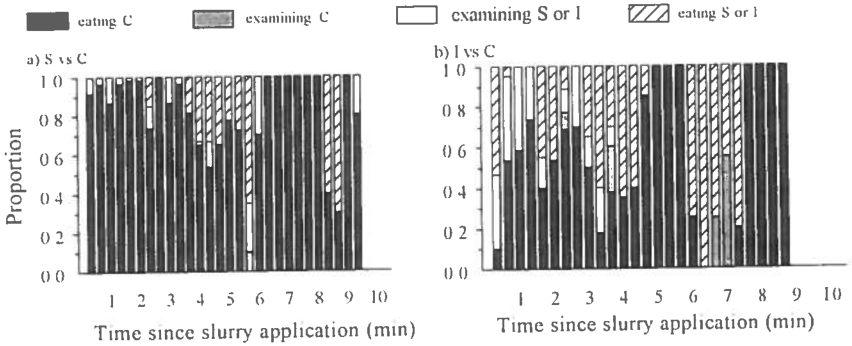

Fig. 1. Temporal pattern of ingestive behaviour, 7 days post slurry application.

Results

Examples of the temporal pattern of ingestive behaviour are shown in Figure 1. Each graph is the mean of data collected for 3 animals. Table 1 shows ingestive behaviour and sward measurements for (a) treated and (b) untreated swards in p1 and p2.

Table 1. Ingestive behaviour and sward measurements

	p1				p2			
	Treatment		sed	prob.	Treatment		sed	prob.
	S vs C	I vs C			S vs C	I vs C		
a) Treated swards (S or I) when each was offered with C								
Number of bites	1.6	8.9	2.07	<0.001	7.3	56.2	8.30	<0.001
Proportion of bites	0.03	0.18	0.041	<0.001	0.07	0.29	0.034	<0.001
Time eating (s)	2.4	11.8	2.34	<0.001	15.7	85.3	11.48	<0.001
Time examining (s)	5.3	3.9	1.38	0.295	20.6	34.7	6.84	0.049
Mean SSH reduction (mm)	3.3	9.0	2.15	0.010	2.1	17.7	2.62	<0.001
b) Untreated swards (C) when offered with either S or I								
Number of bites	46.9	41.1	2.16	0.009	83.6	117.9	18.52	0.074
Proportion of bites	0.97	0.82	0.041	<0.001	0.93	0.71	0.034	<0.001
Time eating (s)	48.3	41.0	2.96	0.016	123.0	147.0	27.5	0.392
Time examining (s)	6.4	4.5	2.01	0.365	28.3	49.2	13.64	0.136
Mean SSH reduction (mm)	18.4	25.2	2.47	0.007	13.8	23.5	2.97	0.003

More time was spent eating on I, a greater proportion of bites was taken on I, and SSH was reduced more on I in I vs C than on S in S vs C, in both p1 and p2. A greater time was spent examining and eating C, a greater proportion of bites was taken on C, and SSH was reduced more on C compared with the treated sward S or I in both S vs C and I vs C, in both p1 and p2. Grazing on C was modified when in the presence of a treated sward. Thus, SSH reduction was greater on C for I vs C than for S vs C in p1, although fewer bites were taken. This implies that there was an increase in the amount of herbage removed per bite from C in I vs C. There was no effect of time since application on the proportion of bites on treated or untreated swards.

Conclusions

These results indicate that cattle are more averse to herbage treated with surface-spread rather than injected slurry. Aversion to contaminated swards appears to persist unchanged until at least 21d post application regardless of application method.

Acknowledgements

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Effects of indoor and hut housing systems on clinical and physiological indicators of pregnant and farrowing sows

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Introduction

A diversity of different housing systems for pigs is being created due to public interest in animal welfare concerning housing and treatment of farm animals. For most of these housing systems the effects on the animals are not fully understood.

Animals, Material and Methods

The study presented (Link, 1993), investigated the effects of three different outdoor and indoor housing systems on sows over a period of 12 months.

In the standard system (Stand.-Var.), the sows were kept isolated except for a period of 4 weeks during which they could move around in groups daily for appr. 3 hours. In the eros system (Eros-Var.) sows were kept indoors in groups of four for a period of four weeks after weaning. Thereafter they were moved into single crates.

In the outdoor system (Outd.-Var.) pregnant sows were kept outdoors all seasons in a group of fifteen animals. They were fed by a computer controlled automatic system. For farrowing half of the group was placed in farrowing crates indoors, the other half delivered the piglets in outdoor huts. The following clinical and physiological indicators were recorded:

- clinical condition	- differential cell count	- serum electrolytes
- rate of illness	- acid-base status	- serum enzymes
- breeding performance	- metabolites in the blood	
	- antibodies and other constituents in the milk	

Results

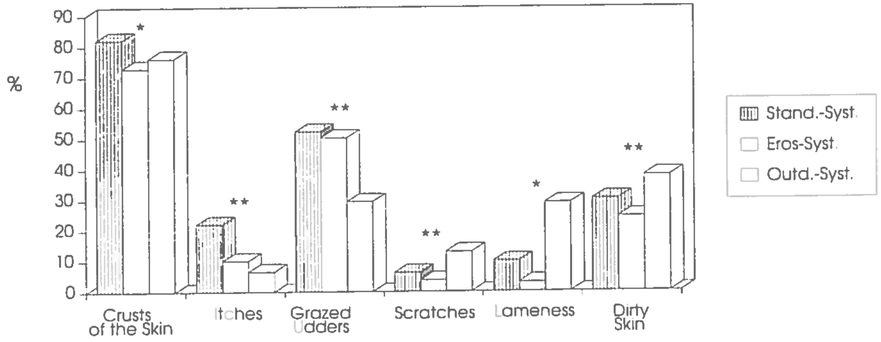

Figure 1. Proportion of sows showing crusts, itches, grazed udders, scratches, lameness and dirty skin ($* = P \leq 5\ \%$ $** = P \leq 1\ \%$).

Figure 1 shows the results of the clinical examination. Figure 2 shows blood parameters which have shown significant differences in the different housing systems.

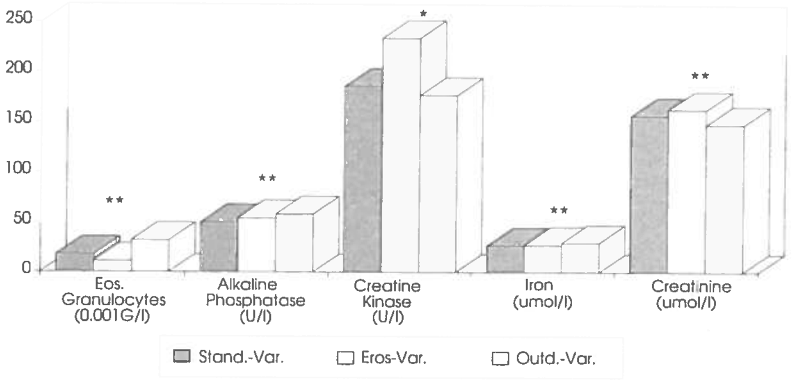

Figure 2. Blood indicators of the sows in the housing systems ($* = P \leq 5$ %, $** = P \leq 1$ %)

Conclusions

The higher rate of sows covered with dirt in the outdoor housing was caused by natural behaviour patterns like wallowing and digging in the pasture. This is a positive effect in terms of animal welfare; although the dirt should not consist of manure and urine, because of behavioural and hygienic aspects. A higher number of scratches on animals of the outdoor system goes along with more grazed udders in the indoor system caused by floor and slats.

Metabolism of the animals is affected by the different housing systems. The low level of eosinophilic granulocytes in sows of the indoor system is an indicator for some kind of stress (Haase, 1972; Unshelm, 1971). The stress syndrome causes an eosinopenia (Eder, 1987). In the outdoor housing the activity of the sows, social interactions and the influence of the outdoor climate lead to a higher uptake of oxygen, which is reflected in a lower oxygen saturation of the venous blood. The higher activity of alkaline phosphatase in the outdoor group indicates an increased skeletal metabolism by regular activity and exercise (Tumbleson a. Schmidt, 1986).

None of the housing systems tested in this study has shown exclusively positive results. In summary, group housing outdoors was superior to indoor housing systems with individual sow crates.

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The effect of food supplements on foraging behaviour in gilts

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Introduction

Pigs are opportunistic omnivores and have developed feeding strategies that depend on high levels of exploratory behaviour. On intensive units, sows are fed a concentrated diet which takes little time to consume, is low in fibre and is usually insufficient to satisfy the sow's appetite. These factors have been linked with many of the behavioural problems seen in sows (Appleby and Lawrence, 1987) and it has been suggested that they may be alleviated by supplementing the feed (Brouns *et al.*, 1994). The aim of this study was to examine how different food substrates could be used to increase foraging behaviour in gilts and thereby reduce the activities associated with poor welfare.

Materials and Methods

Twenty-four Large-White x Landrace gilts (83 kg) were housed in groups of 6 in 4 pens. The pens each comprised 6 feeding stalls joined to an outer communal area measuring 4 x 4.5 m which was deep-bedded with straw. The gilts received daily, 1.5 kg of complete barley-based diet which was estimated to be in-between maintenance and appetite requirements. In a 4 x 4 Latin-square design experiment, each pen was subjected to the following treatments for one week: no addition (Control); 6 kg of fresh straw (Straw); 1.5 kg of above feed scattered amongst bedding (Feed); 10 kg turnips/potatoes (Roots). Behaviour was observed by instantaneous point sampling from 0900-1200 and expressed as a percentage of total observation time. Data was analysed using analysis of variance.

Results

For the four treatments, the order for both increasing inactivity and increasing pen-directed behaviour was Roots, Feed, Straw and Control. The differences between Roots and Control were significant ($P < 0.05$) for both inactivity (6.7% v. 36.1%) and pen-directed behaviour (1.5% v. 6.9%). There were no differences between Feed and Straw for these behaviours: (23.9% v. 26.0%) and (4.9% v. 6.8%) respectively. Agonistic behaviour did not differ significantly between treatments (mean: 1.1%). There were no significant differences in the amount of social, maintenance or locomotor behaviour between treatments. Anti-social activities such as the treatment of other pigs as substrates were not observed.

The order of increasing foraging activity (behaviour directed at the straw and/or roots) was Control (19.3%); Straw (31.9%); Feed (37.3%); Roots (62.8%) which was consistent over days. In the Control, Straw and Feed treatments, foraging was mainly explorative and straw-directed and decreased between 0900-1200. In Roots, foraging was significantly greater ($P<0.05$), mainly root-directed and did not decrease between 0900-1200. Root-directed behaviour changed from exploration (nosing and rooting) to ingestion over days.

Conclusions

The presentation of food supplements to gilts was found to reduce pen-directed behaviour and increase activity, specifically foraging type behaviour. The supplements provided a source of environmental enrichment which promoted the activities that pigs appear highly motivated to perform. The behaviour of the gilts indicated that the order of increasing enrichment provided by the four treatments was Control; Straw; Feed and Roots.

In extremely barren conditions, pigs become apathetic showing low levels of activity which indicates a reduced responsiveness in an environment lacking stimulation (Broom, 1986). Behaviour may become directed at inappropriate objects such as pen-fittings and develop into stereotypies. Some of these anomalous activities are related to food restriction and become reduced when pigs are fed to appetite. However, pigs fed *ad libitum* remain highly motivated to perform foraging behaviour spending over 25% time in activities directed at rooting and chewing amongst straw bedding (Arey, 1993). Both the appetitive and consummatory phases of foraging would therefore appear to be important to pigs.

For food restricted sows, the provision of root crops would probably have the greatest effect in improving welfare by reducing both hunger and boredom. This would also be applicable to group housed sows as there was no increase in aggression - one of the main welfare concerns of sows kept in groups.

The activities directed at the roots were more ingestive than exploraty which suggested that they may have had less of an effect where pigs were fed a complete diet to appetite. This conclusion could also be made of the Feed treatment. Feed is expensive and its use for promoting foraging behaviour would lead to concern over wastage. Straw on the other hand is relatively cheap. Furthermore, there was little difference in the behaviour of the gilts on the Feed and Straw treatments. For pigs given an adequate diet, the daily addition of fresh straw represents a satisfactory means of increasing environmental enrichment and promoting natural foraging behaviour.

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Choice between cages with and without nest boxes in farmed foxes

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Introduction

The barrenness of the cages of farmed silver foxes (*Vulpes vulpes*) and blue foxes (*Alopex lagopus*) is one of the major complaints against fox farming. Traditionally, only breeding females have been provided with breeding boxes for giving birth and nursing the pups. Otherwise foxes have lived in their cages without any furnishing. Whole-year nest boxes and resting platforms have been recommended as a possibility to improve foxes' welfare (European Convention, 1991). However, the available scientific evidence to support this recommendation is scanty and controversial.

In the present study the strength of the need of juvenile silver and blue foxes for a wooden nest box was assessed in a preference test including a deprivation from access to the nest box.

Materials and Methods

Juvenile female silver foxes (n=14) and blue foxes (n=12) were exposed to a 11-day experimental procedure in August-October in an unheated barn. Prior to the experiment each fox lived in a standard fox cage (L115xW105xH70 cm) without any furnishing.

In the experiment, each fox had access to two standard cages: one provided with a wooden nest box and other without furnishing. The access from cage to cage was via an opening (20x20 cm) just below the cage ceiling. The opening could be reached with the aid of ladders. The nest box was situated on the floor of the cage and the fox could use either its interior (main chamber L41xW40xH35 cm and a smaller anteroom) or roof (L70xW44 cm, 33 cm from the cage ceiling).

On Day 1 of the experiment the nest box was in the left cage. On Day 4 the nest box was transferred to the right cage. On Day 9 the fox was shut in the empty (left) cage for 24-hours and access to both cages was allowed again on Day 10. The foxes were fed once a day in the empty cage and water was available *ad libitum* in both cages.

The behaviour of the foxes was video-recorded for the whole 11-day experiment. The tapes were analyzed using instantaneous sampling method with a 5 min sample interval yielding a total of 3168 sample points per animal.

Results

The transfer of the nest box from the left to the right cage did not affect foxes' behaviour in regard to the nest box.

The deprivation did not have any effects on the behaviour of the blue foxes. The silver foxes spent a larger proportion of the working day (0800-1600 hours) in the nest box after (11±16 %) than before the deprivation (6±9 %, P<0.05, Wilcoxon matched pairs signed ranks test). Silver foxes were more active in the evening (1600-2400 hours) and in the small hours (0000-0800 hours) following the deprivation than before the deprivation: 39±9 vs. 32±9 (P<0.05) for the evening and 33±7 vs. 24±8 (P<0.05) for the small hours, respectively.

The transfer of the nest box and the deprivation had only minor effects on the foxes' behaviour. Thus, the data from ten days (excluding the deprivation day) were pooled to compare the two species. The silver foxes were in the nest box cage 86±8% (mean±SD) of time, which comprised rest (44±11 %) and activity (15±3 %) on nest box roof, the time spent in the nest box (19±13 %), rest (1±1 %) and activity (8±2 %) on the net floor. The time spent in the empty cage included rest (3±6 %) and activity (10±4 %). The corresponding figures for the blue foxes were 66±21, 11±12, 9±4, 12±11, 23±12, 11±3, 20±17 and 14±4 % of time. The interspecies differences were significant ($P<0.05$, Mann-Whitney U-test) for all the variables except for the time in the nest box ($P=0.0998$).

A recombination of the data (Table 1) shows that both silver and blue foxes allocated their active time rather evenly for various parts of the cage system. The silver foxes chose to rest almost exclusively on the roof of or in the nest box whereas the blue foxes were non-exclusive in their resting site choices. Note that the time spent in the nest box was assumed to be rest.

Table 1. Allocation of rest and active time (% of ten days) of silver foxes (n=14) and blue foxes (n=12) between empty cage and cage furnished with nest box.

Location	Rest		Active	
	Silver	Blue	Silver	Blue
In nest box or on its roof	63	23	15	9
Wire mesh floor of nest box cage	1	23	8	11
Wire mesh floor of empty cage	3	20	10	14
Total	67	66	33	34

Conclusions

From the present results it might be concluded that silver foxes prefer a solid surface to the wire mesh as a resting place. However, this conclusion is not supported by earlier results (Bakken *et al.*, 1994; Korhonen&Niemelä 1995). The preference for resting sites situated high up in the cage has been observed earlier in silver foxes (Bakken *et al.*, 1994). Thus, it is possible that the silver foxes in the present study chose the roof of the nest box as a resting site because it was the highest suitable place in the double cage system.

We recognize the weaknesses of preference tests, but share the opinion of Hutson *et al.* (1993) that these tests provide a useful tool for identifying the environmental features that animals prefer. Assuming that greater use indicates greater need, silver foxes should benefit from the nest boxes more than blue foxes.

These two apparently similar fox species with these obvious differences in their preferences offer an excellent opportunity to study the relationships between preference, need and animal welfare by also employing methods other than simple preference tests.

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Effects of single-space feeder design on feeding behaviour and performance of growing pigs.

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Introduction

Computerized feed intake recording systems are used by research centres and breeding companies to monitor the individual food intake of pigs kept in groups. Various such feeders have been designed, and at present most, if not all, such feeders are single-spaced, allowing only one animal to feed at any one time. They differ mainly in the design of the entrance and, more specifically, the level of protection offered to the feeding pig. The aim of the present experiment was to investigate fully the effect of single-space feeder entrance design on the performance and feeding behaviour of growing pigs by using designs offering three levels of protection.

Material and Methods

Ninety crossbred entire male pigs with a mean initial live-weight of 34.4±0.6 kg (mean±s.e.) were used. Three replicates were carried out, each using 30 animals allocated in groups of 10 to one of three different entrance designs: Low (head-guard), Medium (standard full length race), and High (enclosed pneumatic race) protection against disturbance of the feeding pig by pen-mates. Each pen consisted of an insulated kennel, a dunging area with two water bowls and one single-space computerized feeder fitted with one of the three racetypes. Each group was kept in the pens for 29 days during which period the animals were weighed weekly. Between 09.00 and 10.00 h the pens were cleaned and fresh straw provided five days a week. The hoppers were re-filled with a commercial pelleted grower diet at the same time every day. In order to completely eliminate any potential effect of learning difficulties and feeder failures only feeding data from days 18 to 28 were included in the analysis.

Results

The results are presented in Table 1. No significant differences were found between treatments in daily food intake, daily live-weight gain, and feed conversion ratio. Pigs on treatment High had significantly longer ($p<0.05$) visits to the feeder, and they ate more per visit ($p<0.05$) than pigs on the two other treatments. Pigs on treatment Low ate faster ($p<0.05$) than pigs on the other treatments. No differences were found between treatments in daily feeder occupation. Feeder visits where no food had been eaten were most frequent on treatment Medium and least frequent on treatment High ($p<0.001$). The circadian pattern of feeder occupation was similar for all treatments.

Discussion

The increase in feeding rate found when feeders were equipped with a head-guard (low protection) would indicate, that pigs using a feeder of this type may be more disturbed by other pigs whilst feeding, resulting in a more forced feeding pattern with smaller meals eaten more rapidly. This effect on feeding rate was also found by Nielsen and Lawrence (1993), when group size reached twenty, which also resulted in fewer and longer feeder visits. Individually penned animals, on the other hand, have significantly shorter and more frequent feeder visits than group housed pigs (de Haer and Merks, 1992; de Haer and de Vries, 1993). The increased protection offered by the fully enclosed race was expected to eliminate disturbance of the feeding pig and hence simulate the individual housing situation. However, the feeding behaviour displayed by pigs using this type of race did not resemble the feeding pattern of individually kept animals, but was more similar to that observed in large groups. The fully enclosed race

Table 1. Performance and feeding behaviour of group housed pigs provided with one of three different kinds of feeder design.

Treatment (Entrance design)	Low (Head-guard)	Medium (Standard)	High (Pneumatic)	s.e.d.
n	28	27	24	
Initial live-weight^{+}	38.0	31.5	33.1	3.7
Final live-weight	61.4	53.8	54.1	4.6
Daily feed intake (g/d)	2055	1941	1889	130
Daily live-weight gain (g/d)	794	810	773	35
Feed conversion ratio (g/g)	2.59	2.40	2.45	0.07
Number of visits (day^{-1})	13.26	13.98	10.39	1.89
Duration (min/visit)	4.82^{a}	4.81^{a}	6.21^{b}	0.37
Feed intake (g/visit)	172^{a}	157^{a}	202^{b}	11
Feeding rate (g/min)	36.9^{a}	33.2^{b}	32.8^{b}	0.8
Feeder occupation (min/d)	57.1	60.6	59.4	4.3
Non-feeding feeder visits (day^{-1})	0.79^{b}	1.08^{a}	0.41^{c}	0.09

$^{+}$All subsequent means (except final live-weight) are adjusted for differences in initial live-weight.

^{a,b,c} Within rows means followed by different superscripts are significantly different ($p<0.05$).

was not only the most protective, it was also the most difficult to enter. In rats, meal frequency has been found to decrease and meal size increase with decreasing accessibility of the food (Levitsky, 1974). It is therefore likely that although a fully enclosed feeder protects the feeding animal from disturbance it simultaneously makes the trough less accessible resulting in similar changes in feeding pattern to those seen with increased competition.

Conclusion

Although racetype had no effect on the performance of the animals, we cannot eliminate the possibility that racetype may have affected the ranking of the pigs according to performance. As opposed to the pneumatic race, the use of a standard race does not decrease the accessibility of the food below that already imposed by the social environment, and, furthermore, the standard race appears to prevent the increase in feeding rate seen in pigs using the low protection feeder.

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Effects of spatial restriction and behavioural deprivation on open-field responses, growth and adrenocortical reactivity of calves.

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There are few examples where behavioural deprivation has been shown to be stressful to animals. Calves kept in crates show more open-field activity and greater adrenocortical reactivity than calves kept in groups, and this has been interpreted as stressful effects of behavioural deprivation. However, individual crates and group-housing differ in many aspects. To determine if behavioural deprivation alone has stressful effects, we reared male dairy calves (n=48) in identical individual pens that were either 2.1m or 0.6m wide. The latter was too narrow to allow the calves to turn or adopt normal resting postures.

In the narrow pens, calves' growth rates were significantly reduced. Plasma growth hormone levels were significantly lower in the crates than in the pens but hematocrit and plasma levels of cortsiol, IGF, insulin, glucose and ascorbic acid (often reduced by stress) were not affected. At 9 weeks of age, 2IU/kg metabolic bodyweight of ACTH was injected i.v. and blood samples drawn every 20min for cortisol assays. ACTH injections led to substantial increases in plasma cortisol, but cortisol levels were unaffected by housing method. The calves were individually tested in an 'open-field' at 10 and 20 weeks of age, and their activity and heart rate were recorded. Calves housed in crates ran and jumped more than did calves housed in pens.

This study shows that behavioural deprivation as a result of spatial restriction can reduce growth, possibly through reduced growth hormone secretion, without increasing cortisol levels or affecting adrenocortical reactivity. Spatial and behavioural deprivation alone also increases open-field activity.

The effects of positive, negative and minimal handling on behavioural and physiological responses to being tethered in pregnant pigs

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Introduction

Various studies have demonstrated that a positive human-animal relationship improves the welfare of farm animals on both behavioural and physiological levels (e.g. Hemsworth and Barnett, 1991; Pedersen, 1994). It has also been demonstrated that the housing system affects the welfare of farm animals (e.g. Barnett *et al.*, 1991; Jeppesen and Pedersen, 1991). By combining these two, until now isolated, areas of research in one study, their relative importance for our husbandry animals and possible additive effects can be examined.

In the present study, an approach was made to combine the two areas of research, testing the hyphothesis that an improved human-animal relationship might obviate previously demonstrated negative effects of a housing condition. The housing of pregnant pigs in tether stalls of a particular design has been demonstrated to adversely affect their welfare (e.g. Barnett *et al.*, 1985) and regular pleasant handling of pigs has been found to reduce fear of humans and reduce stress-sensitivity (e.g. Hemsworth *et al.*, 1986). The aim of the study was to examine if the nature of the human-animal relationship modified the behavioural and physiological responses of pregnant pigs to being tethered.

Materials and Methods

Twenty-four primiparous pregnant pigs were randomly assigned to 3 different handling treatments: minimal, positive and negative. The pigs were moved individually to indoor concrete-floored partial stalls (0.5x1.1m) with neck-tethers 2 days before handling commenced. Positive (stroking and patting on approach) and negative handling (brief electric shock on approach) was imposed 3 min day^{-1} during which the amount of physical contact between handler and pig was noted. The minimal treatment was subjected to routine husbandry practices, only. After 3 weeks of handling all pigs were cannulated under full surgical anaesthesia. The pigs were allowed 4 days of recovery before collecting the following data: daytime profiles of cortisol, activity and behavioural responses to humans in an arena test, cortisol responses to human proximity, cortisol responses to an ACTH-challenge and immunological responsiveness to an injected mitogen.

Results

In the positive treatment, the amount of physical contact between pig and handler increased during the experiment (Kruskal Wallis T-test, $P<0.05$). No significant change of physical contact during the experiment was found in the negative treatment ($P>0.1$). Behavioural responses in the arena test did not differ between treatments (ANOVA, $P>0.1$).

Daytime profiles of total and free plasma cortisol were significantly lower in the positive treatment compared to the negative treatment (ANOVA, $P<0.01$) and tended to be lower compared to the minimal treatment (ANOVA, $P=0.06$). The positive treatment also showed a lower concentration of total and free plasma cortisol pre- and post- human proximity compared to the negative treatment (ANOVA, $P<0.05$). No differences were found between treatments in adrenocortical reactivity to an ACTH-challenge (ANOVA, $P>0.1$). The immunological responsiveness in the positive treatment was stronger than in the negative treatment (ANOVA, $P<0.005$) and tended to be stronger than in the minimal treatment (ANOVA, $P=0.08$).

Conclusion

Since this study is a preliminary one, a firm conclusion is not possible. However, the results support the hypothesis that the nature of the human-animal relationship affected the physiology of tethered pregnant pigs, and that a positive human-animal relationship obviated some of the negative effects of being tethered by lowering the physiological stress level (low base levels) and by strengthening the immunity. The study failed to demonstrate any effects on behavioural levels. This could be explained in several ways: 1) The low number of animals in each treatment. 2) Different postures of the human in the handling and test situation. The pigs were trained to have positive versus negative experience with a squatting human with an outstretched outstretched arm. In the test situation , the human was standing erect and passive and might for that reason be perceived as quite another stimulus. 3) The pigs were influenced by conflicting motivations. Being free and thus able to explore the novel environment might have been more attractive than trying to gain contact with a passive human in the arena.

In further studies, a combination of different housing systems and different levels of human contact should be included to evaluate the importance of these two parameters to the animal. It should be emphasized, though, that welfare in our husbandry animals might not be a question about unidirectional but rather multidirectional solutions. The importance of the nature of the human-animal relationship should not be forgotten in the search for an optimal physical environment.

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Influence of running on leg weakness of slow and fast growing broilers

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Introduction

Leg weakness of broilers is a problem in poultry production. The incidence is influenced by genotype, nutrition and management, but the precise cause of leg weakness is unknown (Riddel, 1992; Sörensen, 1992). The aim of this experiment was to investigate the influence of running on leg weakness.

Methods

A total of 40 male broilers of a fast (Lohmann) and slow growing strain (Label-Rouge) were used. Half of them (20 animals per genotype) were trained to run on a PC-operated treadmill (Fig. 1). The daily distance run was 100 m during a 20 min test. The birds were fasted for a 4 hours period prior to the test.

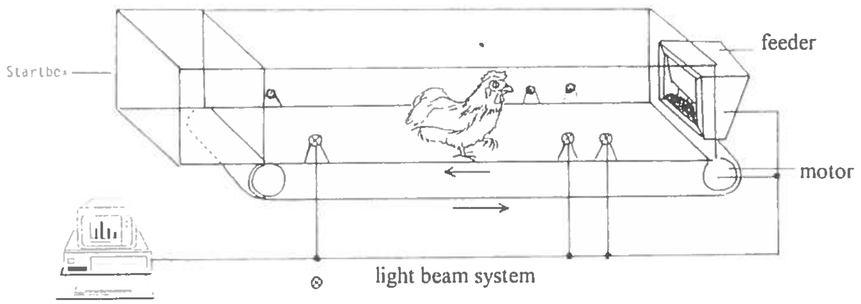

Figure 1. Treadmill for broilers

The other half of the birds were kept on litter in small boxes at a density of 8 animals.m^{-2}. The locomotor activity of these broilers was recorded by video-tracking (Jander Videometric Products). The bone development, e.g. the density and thickness of the corticalis were measured at the proximal end of the tibia by computer tomography using osteodensitometry (Company Stratec). In addition the kinetogram of walking were also recorded with a video-tracking system.

Results and Discussion

The weight gain was not influenced by training. The slow growing broilers reached only 60% of the live weight of the fast growing strain. The untrained broiler chickens of the fast growing strain ran an average distance of 12.4 meter per hour. Their locomotor activity was highly variable (Table 1).

Table 1. Distance travelled in meters per hour (x±SD) by slow and fast growing broiler chickens as measured by video-tracking

Age in weeks						
Strain	1	2	3	4	5	6
Fast growing broilers	20.7±11.3	21.5±6.3	7.9±3.7	7.5±3.5	8.3±4.5	9.3±3.5
Slow growing broilers	36.9±20.7	37.1±16.8	39.3±17.3	35.4±15.4	34.8±18.1	35.1±14.4

There was a sharp drop in activity in the third week of life of the fast growing broilers. The slow growing strain maintained a high activity of 36 $m.h^{-1}$ up to 6 weeks of age. The distance travelled was in general accordance with those found by Preston and Murphy (1989) and Lewis and Hurnik (1990).

Daily training on treadmill delayed the decline in activity in the fast growing birds up to 6 weeks of age. The trained broilers reached only 30% of locomotor activity of the untrained broilers in the 6th week. The trained and untrained slow growing broilers had no problems walking the 100 m during the test.

Training on the treadmill not only improved the walking ability but also influenced the bone development. Thickness and density of the corticalis were higher in the trained compared to the untrained birds (Fig. 2).

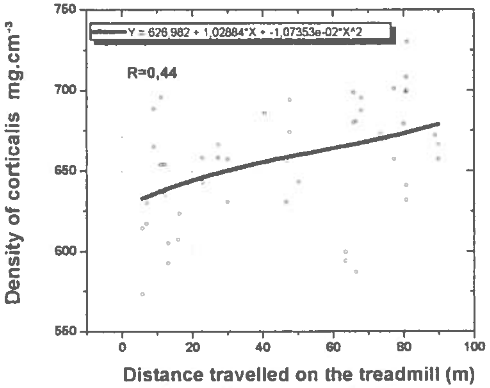

Figure 2. Density of corticalis ($mg.cm^{-3}$) in response to distance traveled on the treadmill (m)

In conclusion, management factors which increase the locomotor activity in commercial broilers may help to reduce the problems of leg weakness.

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Open field activity early in the behavioural development of blue foxes
(Alopex lagopus)

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Introduction

Belyaev et al (1985) reported that silver foxes (*Vulpes vulpes*) selected for tameness had a longer primary socialization period than animals selected for aggressiveness. They used the decrease in the open field activity as an indicator of the start of limiting the socialization period. This decrease was found to occur in cubs from aggressive vixens between 35 and 40 days of age. No decrease in the activity of cubs from the tame population was seen from 30 to 60 days of age. It has also been shown that silver fox cubs that are highly active at 30 days of age generally exhibit a more offensive behaviour strategy later in their life and have greater reproductive success (in the case of vixens) than their less active counterparts (Bakken, 1994). In the presented study we characterized the ontogeny of open field behaviour in farmed blue foxes and documented individual stability in test score during the period from thirty to sixty days of age as well as great differences between individuals and between litters in open field behaviour. This is the first step in an investigation to find methods for selecting for more offensive and less easily frightened farmed blue foxes.

Material and methods

At birth, 10 blue fox litters, each of them consisting of at least four female and four male cubs, were chosen for the experiment. The animals were housed in standard wire-mesh cages (130x105x62 cm) including a wooden nest box (ca 70x44x35 cm). One male and one female cub from each litter were randomly allotted into four experimental groups. The open field test was for the first group carried out at an age of 25 days and repeated at 30, 35, 40 and 60 days of age. For groups two, three and four, testing was initiated at an age of 30, 35 and 40 days, respectively. All groups were subsequently retested following the procedure described for group one. Group five consisted of cubs deriving from nine other litters (9 female cubs and 9 male cubs) , and was tested only once, at an age of 60 days. This group served as a control when analyzing the effect of repeated testing on open field activity. The square "open field" area comprised a wooden floor subdivided by white lines to form 25 squares, each of equal size. The size of the squares varied according to the age of the cubs (19x19 cm at the 25- and 30- day tests, 23x23 cm at the 35- and 40- day tests and 34x34 cm at the 60 day test), thus corresponding to the average body length of the cubs at each age. After placing a cub in the starting position (subarea in the middle), its spatial and temporal locomotory patterns were recorded for 3 min. The cubs activity are expressed in relation to the total number of lines crossed in the open field during the test period.

Results

Cubs average activity increased from the beginning of the experiment (6.4± 10.0 and 17.2± 13.4, at 25 and 30 days of age, respectively), to reach a maximum between 35 (57.8± 45.7) and

40 (59.6± 44.4) days of age. Activity at 60 days of age was significantly lower (39.2± 33.4, P<0.001) than at 40 days of age. Activity in the open field was greatest for cubs tested for the first time. However, this result was only significant at 40 days of age, when cubs tested for the first time at that age were twice as active as cubs that had already been tested at least once (88.2± 52.2, 49.4± 36.7, p<0.001). Large between-individual variation (p<0.001) was found, and cubs with higher than average activity in the early test tended to be more active in later tests. Significant differences in activity were found between litters (p<0.001) but not between sexes.

Discussion

Generally, cubs were most active at the ages of 35 and 40 days. This indicates that the average sensitive period of primary socialization in farmed blue foxes is between 35 and 40 days of age. However large amounts of between individual and between litter variation in the open field activity were found, but also a tendency for stability in activity level in the open field within individuals during the behaviour ontogeny from 30 to 60 days of age. This may indicate great variation in the length of the primary socialization period between different cubs and between cubs from different litters. However, before starting selection for more offensive and less frightened farmed blue foxes after the length of their primary socialization period more knowledge is needed about the relationship between the length of the socialization period and the animals behaviour later in life as well as more knowledge about the cause for the variability between cubs and litters in open field activity.

Acknowledgment

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Experiments on Stress-induced Delayed Oviposition in Hens

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Introduction

Exposing laying hens to stressors such as change in group composition can induce oviposition delays (Hughes 1979). Although the physiological mechanisms underlying stress-induced oviposition delays are not known it is hypothesised that opioids released in response to stress inhibit the secretion of arginine vasotocin, the neurohypophyseal hormone responsible for promoting uterine contractions. This is analogous to the disruption of parturition and lactation in mammals due to stress-related opioidergic inhibition of oxytocin release (Leng & Russell 1989).

The aim of these experiments was to investigate how the duration of oviposition delay is related to the timing of stress (Experiment 1), and to investigate the role of opioids in this response through the use of an antagonist (Experiment 2) and an agonist (Experiment 3).

Experiment 1

A pilot experiment suggested that periods of social stress of up to 6 h can induce oviposition delays, with some birds not laying during this disturbance. These birds were more likely to lay shortly after the end of the stress period when their ovipositions were less than 130 min overdue. This, along with the range of oviposition delays for eggs laid during stress periods, led to the hypothesis that hens become less able to lay their eggs after delays of more than 130 min, even if the stress is removed. The aim of this experiment was to test this hypothesis by exposing hens to periods of social stress of various duration, starting 1 h before expected oviposition.

ISA-Brown laying hens (n=47), 26 weeks old, were housed individually in cages while oviposition times were recorded automatically. When a hen's next oviposition time could be predicted from the egg laying records it was exposed to a period of social stress (relocation to another cage containing 3 unfamiliar hens). Each bird was exposed to one period of social stress which began 1 h before its predicted oviposition time and lasted 0.3-6 h.

From the egg laying records on adjacent days, an expected oviposition time for the day of treatment was calculated. The difference between this and the observed oviposition time, the delay, was calculated. Nineteen birds did not lay during their period of stress. These hens were significantly less likely to lay shortly after (<1 h) the stress ending if oviposition was already more than 130 min overdue (Fisher exact test, p<0.05). The mean oviposition delay for 5 eggs not laid shortly after the stress ending was 11.0 h. The range of oviposition delays (max. = 168 min) for eggs laid during stress also supports the hypothesis that birds become less able to lay following a delay of around 2-3 h, and then retain their eggs for much longer.

Experiment 2

This experiment investigated the effect of the non-specific opioid antagonist nalmefene on the duration of stress-induced oviposition delays.

From 36 ISA-Brown hens, 27 weeks old and housed as before, 18 birds with predictable oviposition times were selected and randomly allocated to receive an intravenous injection of either nalmefene (0.5 mg/kg, n=9) or saline (0.5 ml/kg, n=9). Each bird was injected 30 min before its predicted oviposition time and then exposed to stress by housing it in a new cage with 5 unfamiliar hens. Oviposition times during stress were recorded and their delays calculated as before.

Oviposition delays were significantly reduced by treatment with nalmefene compared to saline (p<0.01, by two-tailed Mann-Whitney test, See Fig. 1).

Fig. 1

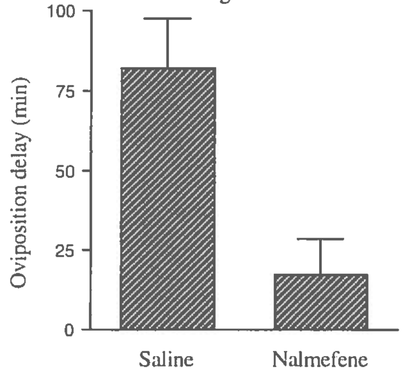

Fig. 2

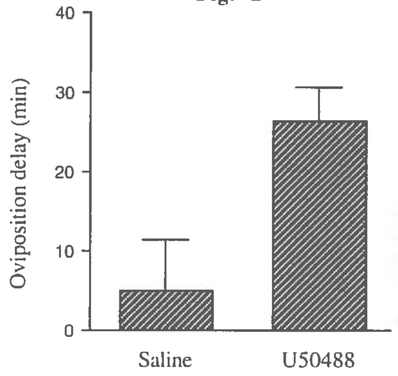

Fig. 1: Duration of oviposition delay in stressed hens treated with 0.5 mg/kg nalmefene (mean + SEM, n=9) or 0.5 ml/kg saline (mean + SEM, n=9).

Fig. 2: Duration of oviposition delay in unstressed hens treated with 4 mg/kg U50488 (mean + SEM, n=9) or 0.9 ml/kg saline (mean + SEM, n=11).

Experiment 3

The aim of this experiment was to investigate the effect of the selective kappa agonist U50488 on oviposition time. Previous tests with morphine, a mu receptor agonist, were inconclusive.

From 35 ISA-Brown hens, 47 weeks old and housed as before, 22 birds with predictable oviposition times were selected and randomly allocated to receive an intravenous injection of either U50488 (4 mg/kg, n=10) or saline (0.9 ml/kg, n=12). Birds were injected 30 min before their predicted oviposition times then left undisturbed in their usual cages. Oviposition times following the injections were recorded and their delays calculated as before.

Ovipositions of the U50488 treated birds were delayed significantly longer than those receiving saline ($p<0.05$, by two-tailed Mann-Whitney test, See Fig. 2).

Conclusions

Stress-induced oviposition delays fall into two categories, long-term and short-term (<3h), with the timing of stress relative to the expected oviposition time influencing which of these occurs.

The non-specific opioid antagonist nalmefene reduced the duration of oviposition delay in response to social stress. The selective kappa opioid agonist U50488 induced oviposition delays in unstressed birds. Both these findings support the hypothesis that endogenous opioids are involved in mechanisms underlying stress-induced oviposition delays.

Acknowledgement

The financial support of the British Egg Marketing Board (MR) is gratefuly acknowledged.

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Age at Tail Docking Affects Physiology and Behaviour of Lambs

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Introduction

Livestock are subject to a wide variety of stressors including nutritional, environmental and psychological stimuli. During the past decade a significant number of researchers have initiated investigations on the effects of stressors on domestic livestock. A primary factor driving this area of research has been a global concern over animal well-being.

Tail docking, the amputation of the tail of sheep, has been performed traditionally by livestock producers. This procedure is commonly performed to improve sanitation, prevent disease and reduce fleece contamination with feces. Additionally, docking female lambs is desirable to enhance breeding efficiency and lambing ease. Last, in the United States, the carcass of the lamb is improved aesthetically and, as a result, the carcass tends to have a higher market value. Interestingly, docking, like castration and dehorning, is typically performed in the absence of tranquilizers, anesthetics and analgesics. Previously, our laboratory reported that the method of docking but not age at docking had a significant effect on the post-docking responses of lambs (Mazzaferro *et al.*, 1993; St. Louis *et al.*, 1994). In the United States, the Consortium (1988) suggests that lambs be docked during the first two weeks of life. They also recommend that lambs docked with an emasculator should be docked by one week of age. Alternatively, older lambs (i.e., older than two weeks of age) should be administered a local anesthetic before docking.

This investigation was designed to determine the physiological and behavioural responses of 7- and 14-day old lambs to a common production manipulation, tail-docking. We sought to evaluate the hypothesis that docking earlier is less stressful and therefore more desirable in the context of the well-being of the animal.

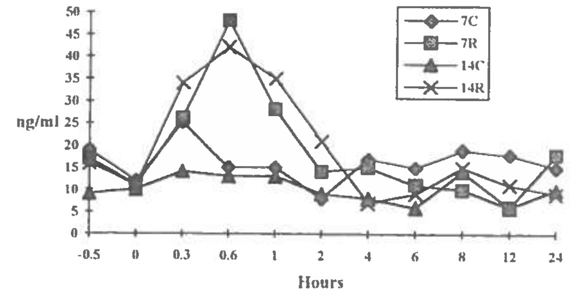
Materials and Methods

Twenty-two, Dorset lambs were randomly assigned to one of four treatment groups: tail docking by application of an elastrator ring at 7 days of age (7R; n=5), sham-docking at 7 days of age (7C; n=5), tail docking by application of an elastrator ring at 14 days of age (14R; n=6) and sham-docking at 14 days of age (14C; n=6). Prior to docking, at the time of docking and at 0.3, 0.6, 1, 2, 4, 6, 8, 12 and 24 hr after docking a blood sample was taken, processed to yield serum and evaluated for cortisol. Behaviours were videotaped during the docking procedure and for the hour following docking. An ethogram was developed for each animal. Frequencies of behaviours were then pooled under general headings including care solicitation, displacement, investigative, ingestive, locomotor and abnormal activities. All data were analyzed by an analysis of variance using the General Linear Model of the Statistical System (SAS), separating means using Duncan's New Multiple Range Test.

Results

Serum cortisol significantly ($P<.05$) increased in both the 7R and 14R groups versus the endocrine responses of the 7C and 14C groups (Figure 1). However, the cortisol profiles between 7R and 14R were not significantly different.

Figure 1. Serum cortisol



At the time the lambs were docked, the lambs showed a limited behavioural inventory. While animals were restrained, they typically displayed some care solicitation or locomotor activity including bridging (extending the neck back), pedaling (stationary running) and vocalizations (data not shown). The responses of the lambs in each of the treatment groups during handling were similar. For the most part, the expression of these behaviours was probably more a function of restraint required for docking rather than docking

The frequency of normal behaviours (care solicitation, ingestive and investigative) was not affected by docking ($P>0.05$) at either age. Alternatively, docking altered a number of locomotor activities. At both 7- and 14-days of age, the frequency of movement and positional changes (restlessness) was greater ($P<0.05$) in both docked groups than sham-docked groups. Further, 14R lambs were more ($P<0.05$) restless than 7R lambs. The frequency of abnormal behaviours (displacement and locomotor) was greater ($P<0.05$) in docked lambs than sham-docked lambs. Docked lambs kicked, thrashed and were ataxic more frequently ($P<0.05$) than sham-docked lambs. Importantly, the 14R lambs were ataxic more frequently ($P<0.05$) than 7R lambs.

Conclusions

Although cortisol levels were similar in 7- and 14-day old lambs docked lambs, the repertoire of behaviours displayed by the 14-day old, docked lambs indicated a greater degree of stress or distress. Further, the stressor, docking, appeared to elicit the display of abnormal behaviours rather than alter the display of normal behaviours. We therefore accept the hypothesis that docking at an earlier age is less stressful than docking at a later age.

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Location of handling and dairy cows' ability to discriminate between gentle and aversive handlers.

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Previously, we found that dairy calves sometimes did not generalize fear of humans from one location to another. We examined whether dairy cows (n=24) could learn to avoid handlers in one location but approach them in another location based on how they were handled in each place. Each cow was treated 7 times, both in their home stall and in a special treatment stall, by one person (previously unknown to the cows). In one stall, the cows were treated aversively i.e. they were slapped on the muzzle each 15s, while in the other stall the same person treated them gently, i.e. stroked them and offered hay or grass. Each treatment period lasted 2min. During a test session, the treatment person stood in front of the cows and the distance the cow kept from the person was scored each 5s for 1min. The cows were tested in both their home and the treatment stall. Prior to the treatments, the cows stood further from the treatment person when in the treatment stall compared to the home stall. The cows defecated more frequently when treated aversively than when treated gently. After 7 treatments, the cows stood further from the person when in the stall in which they had been treated aversively compared to when they were in the stall in which they had been handled gently. The cows that had been treated aversively in the treatment stall stayed further away from a second, unfamiliar person in the treatment stall than in the home stall. However, this did not apply for cows that were treated aversively in the home stall.

In a following experiment, 12 cows were alternately handled in two special treatment stalls by one person who handled then gently in one stall and aversively in the other stall. After 11 treatment sessions, the cows stood further from the person when in the "aversive" stall than when in the "gentle" stall. The cows showed this difference in their reactions to a second, unfamiliar person in the two stalls, but only during the first 20s of the 1 min test.

When handled in an aversive manner, cows will develop an aversion to the cue that best predicts the occurrence of the handling procedure. This may be the person who administers the handling or the location in which the handling occurs. Dairy cows can readily learn to avoid or approach the same person based on the location and generalize their responses to unfamiliar people in those same locations. One way to reduce the extent that cows develop fear of their handlers as a result of aversive management procedures, is to apply these procedures outside the cows home pens, in special treatment pens.

The effect of stocking density on walking ability, tonic immobility and the development of tibial dyschondroplasia in broiler chicks

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Introduction

The choice of stocking density in broiler production is generally made to maximize economical returns. However, the resulting high stocking density leads to reduced growth rate and increased incidence of diseases, especially leg problems (Kestin et al., 1994) and various types of dermatitis. The high stocking rates also results in adverse environmental conditions characterized by wet litter and high ammonia levels, which are significant factors responsible for the adverse density effects (Matthes, S.,1993; Thomsen, 1993; Gordon, S.H. & Tucker, S.A.,1993; Proudfoot et al., 1979). High stocking density may also lead to behavioural changes but only a limited work has so far been done. With increasing density, Blokhuis and van der Haar (1990) found a significant decrease in walking, dustbathing, pecking and scratching behaviour. Behavioural studies have also been applied to assess the quality of walking ability ("gait"; see Kestin et al., 1992). In this study we examined the impact of different stocking densities and breeds on fear reaction (tonic immobility, TI), walking ability (gait) and tibial dyschondroplasia (TD), which is one of the major causes of leg weakness in broiler chickens (Grashorn,1992).

Materials and Methods

We studied 41 groups (341-2250 birds/group) in total; two in experiment 1, 12 in experiment 2 and 3, and 15 in experiemnt 4. The birds were kept in 6 chicken houses (18x10.80m), equipped with automatic heating, watering and ventilation systems. The houses were either divided into two or four sections with an floor area of 37,5m^2 or 75m^2 each. The stocking densities were 9, 13, 17, 21, 25 and 29 in experiment one and two, 18, 24 and 30 in experiment three and 20, 24 and 28 in experiment four. We used the following breeds: Ross 208 in experiment 1-3, ISA Vedette, La Belle Rouge, Scanbrid and Ross 208 during the fourth experiment. From day 8-42 of age each focal chick (10-12 in each group) was tested once every week for walking ability using a gait score from 0-5 (0=normal, 5=poorest gait) and for TI measured in seconds. By the end of each experiment the chicks were killed and examined for the development of TD using a score from 0-3 (0=no TD, 3=more than half of the head of the bone affected).

Results

An analysis of variance of the data from the first experiment revealed that the average average TI value for groups with 9 birds per m^2 (102 sec) was significantly lower ($p < 0.01$) compared to that of 29 birds per m^2 (171 sec). A similar trend was found in experiment 2 in which the average TI values increased significantly with increasing stocking density

($p<0.0001$) for all comparisons between stocking densities except between groups with 17 and 21 chicks per m^2). In experiment 3 groups with 18 birds per m^2 had significantly lower TI values than those of 24 ($p<0.01$) and 30 chicks per m^2 ($p<0.001$). In experiment 4, the lowest TI duration (at 40 days of age) was found for La Belle Rouge (119 s) and the highest for ISA Vedette (582 s) while Ross 208 and ScanBrid had intermediate values. The investigation revealed significantly increased gait score ($p<0.05$) and incidences of Tibial dyschondroplasia ($p<0.05$) among broilers from groups kept at stocking densities above 20 birds per m^2. Tibial Dyschondroplasia incidences varied between breeds. No cases of TD was found among the La Belle Rouge chicks.

Discussion

The results confirms previous studies on stocking density effects for gait (see Kestin et al., 1994) and tibial dyschondroplasia (Grashorn, 1992). Our results additionally indicate that the severity of gait problems and the incidences of TD gradually increases over all densities; i.e that there is no threshold level for a density response within the range of densities examined in the present study. This result may be due to a reduction in activity as stocking density increases. The results concerning fear are new and interesting, but similar results have been found in laying hens in battery cages (Sefton and Crober, 1976). Further experiments are needed to reveal the cause(s) of the density dependent increase in fear. We suggest that it is related to a reduction in dustbathing and/or the increase in gait problems. The increasing social tension as crowding increases may also be significant. Finally, wet litter and high ammonia levels are density dependent and may, therefore, be an additional causal factor for fear in broilers.

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Correlation between ACTH response and growth pattern in Holstein calves

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Introduction

Milk production in dairy cows is largely affected by environment. Resistance to environmental stress varies between individuals possibly becoming weaker with higher production. The genetic value, however, is estimated under the assumption that all cows in the same environment are affected by a similar kind of stress. A cow with genetically high milking ability could be mistakenly culled, if she is kept in poor rearing conditions where she cannot express her ability. For reducing this risk, we have to develop a method to estimate sensitivity of individual cow to various environmental stresses. We have shown earlier that the body weight is largely affected whilst withers height is not affected by the environment (Sasaki et. al. 1994). In this experiment, the cows were injected with adrenocorticotropin (ACTH) at three different levels to mimic stress. ACTH is normally released as a response to external stress. In this study, correlations between reaction strength to ACTH injection and growth traits were calculated to find predictors for growth pattern.

Method

10 Holstein female calves (173±14kg body weight, aged 5 months) were subjected to ACTH trials. They were fed with the same diet 10 days before the first injection. 0, 2, 4, 6, 0 IU/MBS (metabolic body size) of ACTH was injected to each calf on 5 consecutive days. 0 IU/MBS on the 1st and 5th day was used as placebo. Blood sampling and ACTH injection were carried out through jugular vein cannulas placed a day before the trial began. Cortisol (Cor), glucose (Glu), triglyceride (TG) and free fatty acid (FFA) concentrations in plasma were analyzed. The response to ACTH injection was analyzed by the area under response curve (AUC) of metabolites. The data were adjusted for daily rhythm by subtracted the AUC value to placebo. Body size variables, body weight and withers height, were measured monthly from 1 to 10 months of age. Rate of increase in body weight and withers height were estimated by regressing the traits on age. Finally, the correlation between growth rate and AUC of metabolites to ACTH injections was computed. Statistical analyses were carried out by Statistical Analysis System (SAS 1985).

Results

The concentration of Cor increased after ACTH injections showing its peak at 40 to 60 min after injection. The effect could be seen for 180 min after 2 IU/MBS ACTH injection and for 240 min after giving 4 and 6 IU/MBS . Glu and TG levels also increased. FFA had a peak at 100 min after 6 IU/MBS injection. The response was proportional to the dose of ACTH. Rate of increase in body weight and withers height varied from 27.3 to 29.9 kg/month and from 4.1 to 4.7 cm/month, respectively. Rate of increase in body weight showed high negative correlation with the AUC of Glu and FFA at 6 IU/MBS injection. The correlation between body growth rate and AUC of Glu was highest (r=-0.67 to -0.78) for the measurements taken from 80 to 160 min after injection (Fig.1). The correlation between body growth rate and AUC of FFA was high (r=.53 to 0.58) up to 80 min after the injection. AUC of TG at all ACTH injection levels had a high correlation with body growth rate. The correlation between withers height and AUC of Cor was positive and had the highest values (r=0.26 to 0.27) at 80 to 120 min after ACTH injection with 6 IU/MBS. Correlations between withers height and AUC of Glu at all ACTH levels were positive and increased during the first 60 min being especially high (r=0.56 to 0.60) for 2 and 6 IU/MBS (Fig. 2).

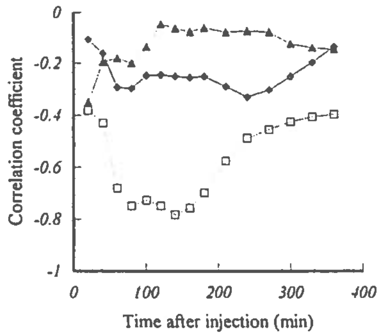

Fig 1. The correlation coefficient between the area under response curve of glucose after ACTH injection in 5 months old calves and body growth rate from 1 to 10 months of age.
ACTH injection levels were
◆ 2 IU/MBS, ▲ 4 IU/MBS, □ 6 IU/MBS

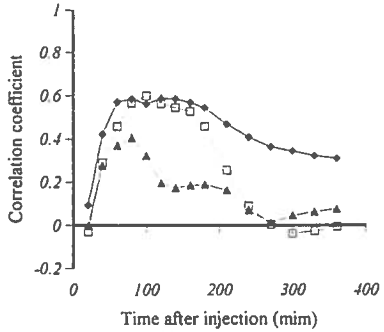

Fig 2. The correlation coefficient between the area under response curve of glucose after ACTH injection in 5 months old calves and rate of increase in withers height from 1 to 10 months of age.
(See Fig. 1 for the symbols.)

Conclusions

The body growth rate and AUC of Glu were negatively correlated. The correlation between rate of increase in withers height and AUC of Glu was positive. The results showed that the calves showing high response in Glu level to ACTH injection had a low body growth rate and a high rate of increase in withers height. The response of blood Glu level to ACTH injection could be used to predict growth pattern in calves.

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Behavioural and physiological changes of goats after tethering

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Introduction

The animal has an intrinsic motivation for performing certain behaviours. If behaviour is restricted, the animal may suffer from psychological stress. It is thought that confinement results in the restriction of locomotion, investigative behaviour, and social behaviour. There have been papers published concerning the stressfulness of limited space allowance, confinement, and tethering. However, in most of these studies, the test periods were under 2 or 3 months and only plasma cortisol and activity patterns were investigated.

In this study, conflict behaviours were classified as indicators for psychological stressfulness at first. These indicators as well as physiological indicators were adopted for investigating the stressfulness of tethering for 10 months.

Materials and Methods

At first, conflict behaviour in 4 male goats of Japanese original breed aged 20−40 months old was observed. The goats were each put into a big cage and trained in the associative learning of food supply and ringing of a bell for 5 days. Each goat's behaviour under the conditioned stimulus of ringing only (extinction in classical conditioning) was compared with those under food supply with ringing for 1 h.

After that, 5 male goats were individually put into cages (L80 × W60 × H80cm) and were tethered to the cage front with a 60 cm−chain, and reared for 10 months. They were fed haycubes of 50 g/kg live weight daily at 9:00 and 17:00. The behaviour of the 5 goats was checked at 1 min intervals from 13:00 to 17:00 at 1, 2 days, 1,2, 3, 4, 6, 9 weeks, and 4, 5, 6, 7, 8, 9, 10 months after tethering using the scan sampling method. Behaviour was classified into feeding, drinking, resting, ruminating, self−licking, grooming(scratching, rubbing), investigating(sniffing, looking around), biting, and teeth−grinding. The ratio of neutrophil/lymphocyte and the percentages of leukocytes were also checked after observing behaviour showing the physiological indicators of stress. Behavioural and physiological data were analyzed in the two−way classification with individuals × observation periods. If the F−value of each factor is significant, indicators are compared among levels in each factor using the LSD.

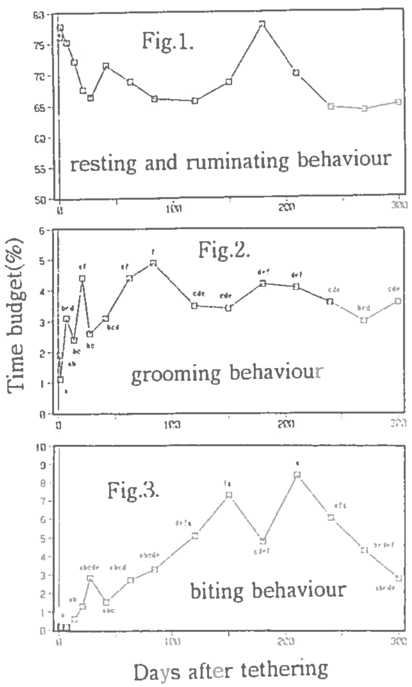
Results

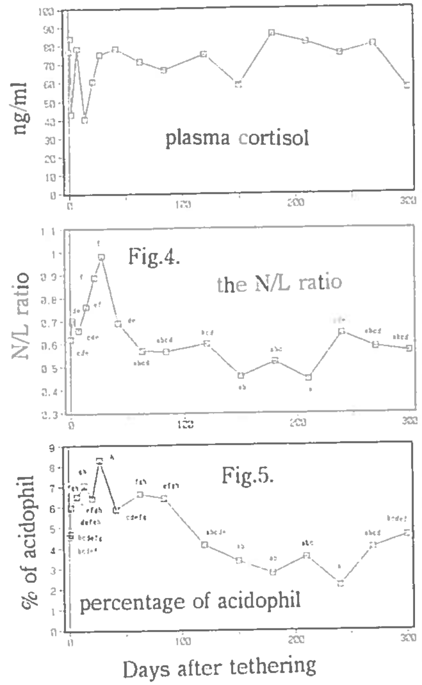
Resting and rumination increased under the extinction at the first stage of fasting. Grooming and self−licking increased under the extinction at the second stage of fasting. Biting increased under the extinction at the third stage of fasting. Some goats showed teeth−grinding and butting behaviours under the extinction at the second and third stages of fasting.

The goats responded behaviourally in 3 phases of tethering, that is, from the start of tethering to 4 weeks, from 6 weeks to 5 months, and from 6 months to 7 months (Figs.1−3), and physiologically with 2 phases, that is, from the start of tethering to 4 weeks and from 5 to 7 months (Figs.4−5). Behavioural responses were quite similar in each of the 3 phases. The goats showed an increase in low level stress indicators at first, then an increase in the middle level stress indicators, and lastly an increase in high level stress indicators. The amount of high level stress indicators also increased with phases. After the second phase in behavioural responses, one goat performed stereotypic head−turning behaviour. Physiological responses seen were a higher ratio of N/L in the first phase and a strong suppression of acidophil in the second phase. It is concluded that tethering is very stressful, because it induced behavioural and physiological stress responses repeatedly for 10 months. The data shows that behavioural indicators may be more sensitive and stable than physiological ones.

Conclusion

In this study, the goats responded behaviourally with 3 phases and physiologically with 2 phases to tethering. It is concluded that confinement is one of the strong stressors causing wavelike stress responses.





Is Broiler Breeder Welfare Improved by Using Qualitative Rather than Quantitative Food Restriction to Limit Growth Rate?

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Introduction

Female broiler breeders subjected to commercial quantitative food restriction during rearing eat about a third as much as unrestricted birds. They eat their daily ration in about 10 minutes, are highly motivated to eat at all times, show abnormal behaviour characteristic of frustration of feeding, and have elevated blood indices of stress. Taken together, these facts indicate that their welfare is compromised and that the current food restriction contravenes FAWC's (1992) first "freedom" (freedom from hunger and thirst). The purpose of this study was to see whether there is behavioural or physiological evidence to suggest that their welfare is improved by using qualitative rather than quantitative food restriction to limit growth rate. Qualitative restriction with free access to food can be achieved by either diet dilution, appetite suppression or reduction of dietary protein.

Methods and Results

Based on the results of a preliminary trial, the following 8 treatments (n = 12 individually caged birds per treatment) were compared from 2 to 10 weeks of age: (diet dilution) **1**. 400 g/kg unmolassed sugar-beet pulp; **2**. 300 g/kg oat hulls; **3**. 600 g/kg oat hulls; **4**. 500 g/kg softwood sawdust; (appetite suppression) **5**. 50 g/kg calcium propionate; (quantitative controls) **6**. the daily ration recommended in a commercial Management Manual; **7**. twice that amount; **8**. ad libitum feeding. All treatments were based on a starter mash from 2 to 6 weeks and a grower mash from 6 to 10 weeks, free access to food was constant with all except treatments 6 and 7, and the daily photoperiod was 8 h. As well as growth, food intake, excreta production and digestibility, measurements were also made of behaviour and blood indices of stress.

The qualitative restriction treatments 1, 3 and 5 produced body weight gains closest to both the control treatment 6 and the recommended growth rate (Fig. 1). The concentration of a dietary diluent or appetite suppressant can presumably be modified during rearing to achieve the recommended body weight at sexual maturity. However, coefficients of variation (standard deviation divided by the mean) in weight gain with most qualitative restriction treatments were at least twice as great as the recommended maximum level of 0.08.

To summarize the behaviour data (Fig. 2), there were significant ($P<0.05$) effects of feeding treatment on all activities except pacing. The quantitative restriction treatments 6 and 7 caused most drinking (6 only), preening and object pecking. Treatments 2 and 8, with the highest weight gains, caused most sitting and least drinking and standing. Of treatments 1, 3 and 5, with weight gains closest to 6, 1 and 3 reduced sitting while 5 reduced feeding. Treatment 4, with the lowest weight gain, caused most feeding and least sitting and preening. Times spent sitting (the only index of consistent inactivity) with different treatments were correlated closely ($P<0.001$) with corresponding weight gains. The level of activity observed may thus reflect the suppression of growth rate.

There were significant effects of feeding treatment on all blood indices of stress. Increased stress was indicated by three indices with the qualitative restriction treatments 1 and 4 (Fig. 3). When the control treatment 6 is compared with 1, 3 and 5, where weight gains were closest to it, 1 caused a higher heterophil/lymphocyte ratio, monocyte frequency and corticosterone concentration, and there were no significant differences with either 3 or 5.

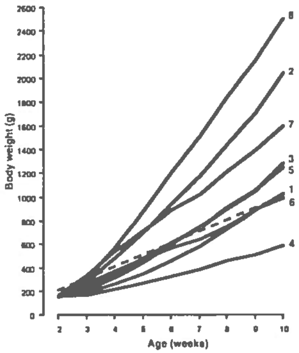

Fig. 1: Mean body weight at different ages with the eight treatments (indicated by the numbers after each line). The dashed line represents the recommended growth rate.

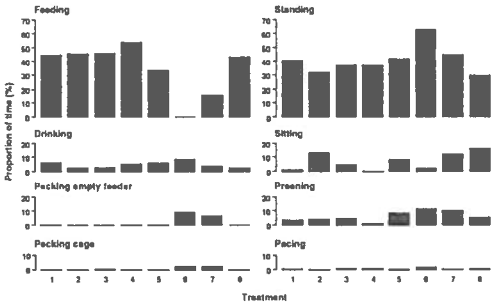

Fig. 2: Mean proportions of time spent in different activities with the eight treatments, from observations made on two afternoons in every week.

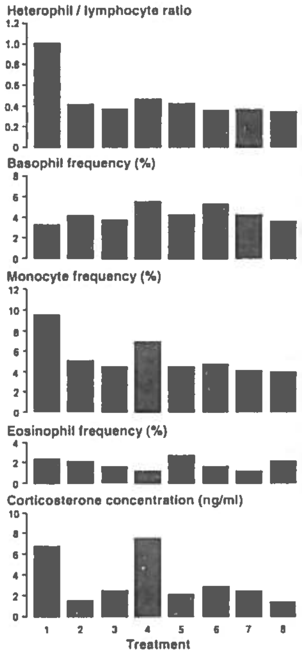

Fig. 3: Mean blood indices of stress with the eight treatments, from samples taken at 6 and 10 weeks of age.

Conclusions

1. Different methods of qualitative food restriction, with free access to food, can be used to control growth rate within desired limits.
2. Problems with these methods include reduced uniformity in weight gain, increased excreta production and/or increased cost.
3. Although these methods appear to suppress abnormal oral behaviours, they do not alter the increased general activity which is correlated with suppression of growth rate, and which may more accurately reflect associated chronic hunger.
4. Suppression of abnormal oral behaviours by these methods may only rarely correspond with reduction in blood indices of stress, and so cannot be taken to indicate improved welfare.
5. Some of these methods can add to physiological stress.
6. There is insufficient evidence of improved welfare, based on both behavioural and physiological criteria, to justify advocating the suitability of any of these methods for commercial use.

Acknowledgement

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Reference

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A study of courtship and mating behaviour in pigs in an outdoor multi-sire mating system.

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Introduction.

In 1980 only 4% of dry sows were kept housed outdoors, but by 1995 it is estimated that 20% of the national herd will be based outdoors. A significant disadvantage of moving to these more extensive outdoor systems is that there is less control over specific, important periods such as at mating. Mating is the most critical period in the breeding cycle of the sow because it is at this time that the maximum number of pigs born per sow per year is fixed. It has to be ensured that all sows are mated at their first oestrus after weaning and the sows must be inseminated at the correct time of oestrus in order to fertilise to maximum number of ova shed. As matings are unsupervised, a boar may mate with one or several sows many times during a short period. This will probably have a detrimental effect on semen quality resulting in a lower number of pigs born per litter or a return to oestrus. This study was carried out to observe the mating behaviour of pigs in an outdoor, multi-sire mating system and the subsequent effect on litter productivity.

Materials and Methods.

The study was conducted on a 1400 sow outdoor unit situated in the North East of Scotland and involved 96 Pig Improvement Company, Line 12 (50% Duroc) sows. Sows were weaned at between 17 and 24 days, sorted into groups of 8 according to body condition and size and placed into service paddocks along with 4 Large White boars. In 4 different weeks, 3 groups of 8 sows and 4 boars were studied from 4 to 8 days post-weaning. Observation began at dawn (7.00 AM) and continued until dark (4.30 PM). During the observation period, any interactions that took place were recorded, along with the time of occurrence and the duration. The behaviours observed were classified into the following categories: head to head, nosing of genito-anal or flank regions, following, mounting, mating and aggression. It was also noted whether intromission occurred. The sows were checked at night to see if those in oestrus were active after dark and if any matings were taking place.

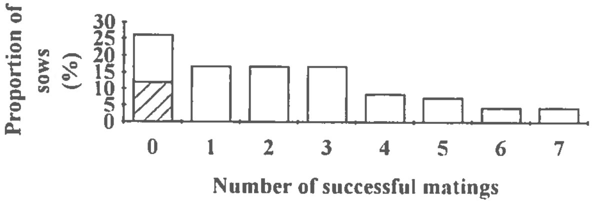
Results.

During the observation period 352 attempted matings were observed although only 55.1% of these were thought to be successful. Of the 44.9% of matings that were unsuccessful it was observed that 50.0% were due to another boar having intervened and so terminated the mating. This was either due to the intervening boar being more dominant than the boar mating or due to the sow being distressed and so running off. In 44.3% of the failed matings the sow caused the termination of the matings by running off. This was probably due to either the sow not being fully on heat or the boar causing discomfort to the sow. The final reason for a mating being unsuccessful was that the boar dismounted the sow before ejaculation, this was quite rare and only accounted for 5.7% of the unsuccessful matings. In 62.9% of the successful matings, termination was due to the boar dismounting the sow. The sows terminated the mating in 26.8% of the observed matings by walking or running away and only 10.3% of successful matings were terminated by the intervention of a second boar.

Of the 96 sows studied, 71 sows (74.0%) were successfully mated. Within the 26.0% of sows that were not successfully mated, 12 sows (12.5%) were not observed to come into oestrus during the 4 day observation period. Of the 84 sows that were judged to come into oestrus, the boar did not attempt to mate with 5 (6.0%) while the boars attempted unsuccesful matings with 8 (9.5%). Sows were mated 2.6 times on average during the observation period although this ranged from 0 to 7 times (Fig 1.). Of the 48 boars studied, 5 boars (10.4%) were observed not to successfully mate with any of the sows.

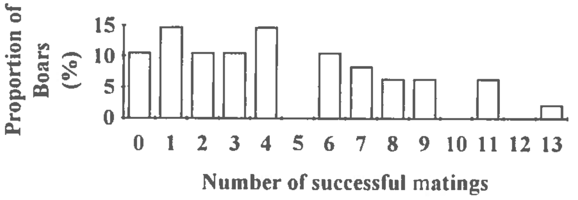
The boars on average mated 4.1 times during the 4 day observation period but the range in number of matings was from 0 to 13 (Fig 2.)

Figure 1. Number of Successful Matings Per Sow



▨ = 12.5% of sows that did not come into oestrus during the observation period.

Figure 2. Proportion of Boars and Number of Matings Per Observation Period



Conclusions.

There are several possible reasons for the variation in the number of times sows were mated. Firstly the time when the sows came into oestrus was variable so in the cases where sows were mated less frequently it could be because many sows were on heat at the same time. This would mean that the 4 boars may not have been physically able to mate with all the sows. A second reason is that the length of time a sow is in oestrus will determine the number of matings she receives. Therefore a sow that has a longer oestrus period will be mated more times than a sow that is in oestrus for only a short time. A third reason could be that the boars may have been more attracted to certain sows in oestrus than others. Finally, as the boars are kept in groups there is competition between them.

The number of matings carried out by each boar may have a significant effect on the herds performance. When a boar is not successfully mating with any of the sows his share of matings have to be carried out by the other boars. Therefore some boars have to mate more times than the optimum number within a given period with the effect of a fall in semen quality. This may result in sows either not holding to service and returning to oestrus or else low numbers of piglets born if the pregnancy runs to term.

The observations indicate that mating sows in an outdoor multi-sire mating system is highly inefficient and greater control at the time of matings such as individually penning boars would be beneficial in improving herd's performance.

Acknowledgement.

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Behavioural priorities for resources by laboratory mice.

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Introduction

It is necessary to understand how animals prioritise behaviours for both fundamental and applied purposes. It has been suggested that animals optimise their fitness by prioritising behaviours according to a cost:benefit analysis on performance of the behaviour itself, and/or switching from one activity to another (e.g. McFarland, 1993). The cost incurred by performing a behaviour or switching might be directly measurable e.g. energetic, or less ascertainable but nonetheless essential for survival e.g. risk of injury or drowning. In practical terms, if we know how animals rank the importance of a variety of resources which allow them to perform specific behaviours, we can provide those resources which the animals rank highest when we design environments to suit the animals' needs.

If a behaviour is important, it will be defended despite increasing cost or reduced time availability. In a previous study (Sherwin and Nicol, 1995) it was shown that if mice had to paddle through shallow water to gain access to feed, the pattern of feeding behaviour was changed indicating the mice perceived travelling through water as a cost. However, the time spent performing a behaviour may not always reflect its importance. The frequency of patrolling behaviour, for example, might be defended more than the total amount of time spent in this exploratory activity. In the present study, shallow water was used as a natural cost in an examination of the prioritisation of behavioural organisation by mice given access to several simultaneously available resources.

Materials and Methods

The apparatus comprised four resource cages arranged around a central cage. Each of the resource cages was connected separately to the central cage by a 136cm long tube. The mice could gain access to any one of the resource cages by crawling through the appropriate tube. To return, the mice could either retrace their path through the tube, or use a one-way door which allowed the mice to return directly to the central cage. The resource cages contained one of the following; powdered food, an overturned cup providing shelter, a large empty space (38 x 38cm), or visual access to another mouse. The cost of gaining access to the resources was increased by filling 30 or 120cm of the tunnel with water to a depth of 2cm. Each treatment (0, 30 or 120cm of water) was continued for 3 consecutive days, during which time the number and duration of visits to each resource were recorded continuously. This was repeated for 11 mice.

Results

Some resources were visited significantly more frequently than others, and for significantly greater proportions of the day (see Table 1). These differences were consistent between and within mice. This consistency in behaviour strongly indicates that the mice were responding in a meaningful way to the presence of the resources, rather than simply moving randomly about the system

The presence of 30cm of water significantly reduced the mean number of visits to each of the resources to approximately half that recorded when no water was present. The addition of water to 120cm caused further reductions in the mean number of visits, but these differences were not significant. The number of visits decreased to 0 only rarely (always for the shelter resource), indicating that the benefit of gaining access to all the resources outweighed the cost imposed.

At all 3 lengths of water, the proportion of time spent in the food cage was significantly greater than that spent with any of the other resources. As the length of water increased, the proportion of time spent with food increased, while the proportion of time spent with the other resources generally decreased, though not always significantly.

The proportion of time in areas other than the 4 resources i.e. in the tunnels and central cage ("Remaining"), was significantly reduced by 120cm of water but not by 30cm.

(Table 1) The effect of shallow water on gaining access to resources

Water length (cm)	Feed	Mouse	Shelter	Space	Remaining
	Proportion of 24hrs spent in resource cage				
0	0.57 ±0.07^{a}	0.06 ±0.01^{b}	0.06 ±0.05	0.09 ±0.01	0.23.±0.06^{a}
30	0.65 ±0.01^{ab}	0.03 ±0.01^{a}	0.05 ±0.04	0.05 ±0.01	0.23 ±0.05^{a}
120	0.76 ±0.05^{b}	0.04 ±0.01^{ab}	0.05 ±0.03	0.08 ±0.02	0.09 ±0.01^{b}
	Number of visits to resource cage (/24h)				
0	30.1 ±3.6^{a}	23.7 ±2.1^{a}	16.2 ±2.5^{a}	32.4 ±2.8^{a}	
30	16.8 ±2.1^{b}	15.1 ±2.5^{b}	8.7 ±2.3^{b}	19.5 ±3.6^{b}	
120	12.9 ±1.7^{b}	12.2 ±2.3^{b}	7.8 ±1.6^{b}	14.9 ±2.3^{b}	

Values represent mean± SEM calculated from 11 mean values for individual mice (N=3 days at each cost). Significant differences (P<0.05, ANOVA) between means within columns are indicated by dissimilar superscripts.

Discussion

The results confirm previous findings (Sherwin and Nicol, 1995) that mice respond to a traverse of shallow water by reducing the number of visits to resources, i.e. they behave as though water is aversive. Presumably, the mice perceived travelling through water as a real or potential cost, and adjusted their behaviour according to a cost:benefit analysis.

It is inconceivable that the increase in time spent in the feed cage observed when water was placed in the tunnels (2.64hrs) represents an increase in the amount of time spent feeding. Rather, we suggest that as the cost of making visits to the feed increased, the mice became more reluctant to leave the feed having once paid the cost, anticipating they would have to pay the cost again for future visits. In addition, the mice often slept in scattered feed which they had dug from the feeder. Since no other loose substrate was available in the system, it seems plausible that the powdered feed was considered as (substitute) loose substrate for nesting. It should be noted that the mice could easily have survived without ever leaving the food cage (this was designed to simulate a laboratory cage). Despite this, the mice paddled through the water to gain access to the other resources on many occasions each day.

Only the proportion of time spent in areas other than the 4 resources was significantly reduced by the presence of 120cm water compared to 30cm. This indicates that the duration of time spent in the tubes and central cage was not defended, but was forsaken to maintain time spent with the other resources when gaining access became costly.

The numbers of visits to, and proportions of time spent in the cages providing shelter and visual access to a mouse were lowest at all three costs. This indicates the mice were least motivated to gain access to these resources. The mice visited the large space most frequently at all three costs. Although the amount of time spent in the large space was relatively small, the fact that it was visited more frequently than even the food shows the mice remained strongly motivated to gain access to this resource.

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Evaluation of the maternal characteristics of the Meishan synthetic and European White breeds of pig

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Introduction

Milk production in well managed sows is largely determined by maternal breed, litter size and piglet vigour. Genes from the highly prolific Meishan breed, which has the ability to rear larger litters have been introduced into commercial UK sow lines. The ability to rear larger litters could be due to maternal (genetic or post-natal) influences or to hybrid vigour in cross-bred piglets.

Materials and methods

A 2x2x2 factorial experiment was used to investigate the influence of maternal breed (Meishan synthetic 50% [M] or pure-bred European Landrace and Large White [W]), piglet breed (25% M or crossbred W) and litter size (8 or 12) on behaviour and production. Sows were fed a 180g/kg CP, 14.5 MJ/kg DE diet to appetite over lactation. Suckling patterns, sow and piglet behaviour were measured on days 4, 8, 12, 16, 20 and 27. Observations started at 8am, immediately after feeding, and continued for a four hour period. Sow weight, backfat measurements and piglet weights were measured within 24hrs of farrowing then weekly thereafter; feed intake was recorded daily.

Results

Differences in suckling behaviour were attributable only to breed of sow. M had shorter suckling intervals than W (Fig 1). The proportion of suckling attempts which resulted in milk letdown was higher for M in early lactation (day 4 - 95 v 86 sem 2.3% p<0.01; day 8 - 96 v 86 sem 2.1% p<0.001). The proportion of successful suckling attempts which were initiated by the sow decreased in both breeds over the lactation. (day 4 - M=96, W=96%; day 27 - M=63, W=59%). The duration of successful suckling decreased over the lactation (day 4 - 5.2 sem 0 10 min; day 27 - 4.4 sem 0.08 mins). In early lactation M spent more time lying with the udder exposed and less time standing than W (Tab 1). Time spent lying with the udder exposed decreased over the lactation in both breeds. M spent more time feeding in later lactation, and had a greater frequency of shorter feeding bouts throughout (Fig 2). Litter growth rates were higher for M sows, irrespective of breed of piglet and litter size (17.0 v 14.6 sem 0.42kg/week, p<0.001).

Conclusion

Sows containing 50% M genes had better maternal characteristics than W breeds of sow. They were more docile, had better suckling behaviour and reared heavier piglets.

Acknowledgements

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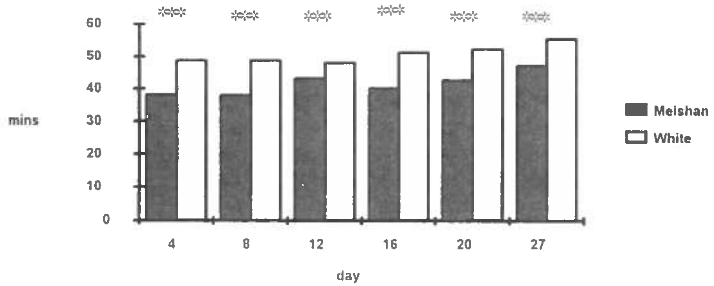

Figure 1: Effect of sow breed on interval between successful sucklings

Table 1: Activity of two breeds of sow; Meishan synthetic (M) and White (W) over lactation

Percentage of time spent feeding

Day	M	W	sem	sig
4	9.21	8.95	0.63	ns
8	10.16	10.75	0.82	ns
12	10.29	10.54	0.69	ns
16	15.75	13.63	0.76	*
20	22.00	17.06	1.20	**
27	21.09	14.41	2.60	ns

Percentage of time spent standing

Day	M	W	sem	sig
4	5.69	9.60	2.22	ns
8	5.60	10.32	1.57	*
12	7.16	13.41	1.64	**
16	6.64	18.14	2.39	***
20	12.76	16.8	2.26	ns
27	4.43	17.36	4.80	ns

Percentage of time spent lying on side

Day	M	W	sem	sig
4	64.04	50.43	3.71	**
8	64.71	47	3.08	***
12	54.95	42.19	3.11	**
16	57.29	39.24	3.57	***
20	37.76	34.90	3.42	ns
27	35.68	26.91	7.80	ns

Percentage of time spent lying on belly

Day	M	W	sem	sig
4	11.68	19.75	3.15	ns
8	11.59	24.63	2.73	***
12	16.80	25.13	3.20	*
16	14.06	20.75	2.91	ns
20	19.14	22.53	2.61	ns
27	26.30	30.38	7.70	ns

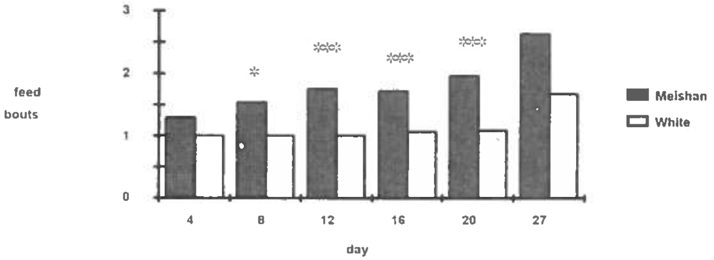

Figure 2: Number of sow feeding bouts during four hours of observation

Behavioural characteristics of meat pigs on the fermenting litter floor

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Introduction

The usual pig housing system with concrete, slatted floors and little space reduces nose and mouth movements, which are both common behaviours in pigs. At the same time, many abnormal behaviours can be observed in pigs housed in these systems. These include pushing their companions' belly with their nose and chewing the projected parts of companions, e.g. ear, tail, leg, etc. These abnormal behaviours may indicate the existence of frustration and stress. This system can also result in an increase in environmental pollution e.g. problems treating faeces and urine can result in the contamination of the underground water or rivers. This is now one of the most difficult problems facing the Japanese livestock industry.

However, a few Japanese farmers use an alternative system, the fermenting deep floor system, which may have some advantages. The pigs are housed on a deep litter of more than 50cm of sawdust. When faeces and urine are excreted these are mixed with the litter by the pigs, starting an aerobic fermentation. The water is vaporised (reducing the possibly of it penetrating the ground) and the faeces are treated by microbes.

After the fattening period, the floor litter is removed and used to produce fertiliser. Consequently, this system has the advantage that farmers do need not take out the faeces nor treat the urine. However, if the pens are too crowded, the fermentation is suppressed and the floor becomes wet and dirty. Many farmers also report that the viscera of the pigs on the fermenting floor system have less indices of diseases and their meat is better when the floor is properly managed. However, only a few scientific studies have investigated whether this system is superior to concrete floor systems.

This paper reports a study on the behavioural characteristics of fattening pigs on a fermenting floor compared to those found on the usual floor system and in a free-range system.

Materials and Methods

Eleven young pigs were housed in a typical concrete floored pen (2.0 x 3.8 m). Four young pigs of four months of age were housed in a field of Bahiya grass (33 x 30 m). Fifty young pigs of about three months of age were housed in the fermenting floor pen of 4.0 x 4.5 m for fattening. However, the floor became wet and dirty 2.5 months later, and so six pigs were housed in another fermenting floor pen, which did not become dirty and stayed dry.

Their behaviours were recorded at 0.5, 1.5 and 2.5 months after the being introduced to the treatments. A video system recorded the pig's behaviour for six hours during the day. This was analysed by taking one-minute samples.

Results and Discussion

The behaviours were classified into: resting (lying, sitting etc.), sniffing (ground, companion etc.), treating with nose and mouth (digging or rooting, treating companions, eating and ranging etc.), moving and others.

Resting

Initially, the pigs on the concrete floor system had the longest resting times, whereas pigs in the free-range system spent more time lying. Resting time on the fermenting floor system was in-between the other two treatments, with the pigs spending more time sitting.

Later in the study, resting time increased in the fermenting system, approaching the level found in the usual concrete floor system. In the second fermenting floor trial, resting time did not increase, suggesting that resting time on the fermenting floor was influenced by the condition of the floor i.e. wet or dry.

Sniffing

Sniffing time was initially much longer in both the free-range and fermenting floor systems. However sniffing time decreased in the fermenting floor system (and approached the level of the concrete floor system) during the latter stages of the study. Most of the sniffing behaviour was directed to the floor, indicating that the fermenting floor was not attractive to the pigs when it was wet and dirty.

Treating with the nose and the mouth

The free-range system had the longest treating time, followed by the fermenting system and finally the concrete floor system. Digging was also frequent in the fermenting floor and free-range systems.

Interactions with the companions were fewer in the fermenting floor and free-range systems compared with the usual concrete floor system. Although the characteristics of the fermenting floor system disappeared in the latter stages of the study, it was kept for more that three months in a different study.

Conclusion

These results show that the fermenting floor acts as a reward and stimulates the pigs' behaviour when it is kept in a properly fermenting condition.

Do pigs find loud novel sound aversive ?

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Introduction

Due to increasing mechanisation farm animals are frequently exposed to loud novel sounds. These may last for a few seconds or up to several hours, however in almost all situations the animals cannot reduce the sound which they are exposed to through normal avoidance behaviour. It is unknown how strong a motivation animals have to avoid these loud sounds. Previous experiments have demonstrated that pigs exposed to loud novel sound show an increase in heart rate (Spensley et el, 1994) and changes in behaviour. Though these responses have been suggested to be indicative of aversion, this has not been demonstrated conclusively.

Chickens have been shown to avoid sounds of over 87 dB (McAdie et al, 1994). Using a two panel operant technique McAdie et al (1993) found that chickens would consistently bias their behaviour away from the sound treatments and no habituation occurred. However Nicol et al (1991) found that chickens showed no aversion to sound in a passive avoidance experiment. An experiment looking at active avoidance in pigs came to a similar conclusion. Stephens et al (1985) failed to train pigs to avoid sound by pressing a panel, they had been able to train some other pigs to avoid a combination of sound and vibration using the same apparatus. These results suggest that either the sound was not aversive enough to reinforce the response or that the response was inappropriate to avoid a sound.

The experiment reported here aimed to determine whether pigs find sound aversive using a two paddle passive avoidance technique and to determine whether the physiological and behavioural changes observed mirror the degree of avoidance by the pigs.

Materials and Methods

Six Duroc X Landrace female pigs weighing approximately 75 kg, housed in pairs on straw bedding were used in this study. The pigs had free access to water but were only fed 80% of their *ad libitum* food intake in their home pen at 17:00 hours. All the pigs had previously been trained to work on a two paddle operant apparatus for a small food reward weighing approximately 8.0 gms. The paddles were situated three metres apart, in adjacent corners of the experimental room. The food was delivered to a small trough midway between the paddles. The pigs were working on a variable interval 30sec non-independent schedule for the food reward and, after a basal rate of responding had been recorded, the treatment was introduced on a fixed ratio of 1 onto a randomly assigned paddle. Half the pigs started with the treatment on the right paddle and half on the left: After four sessions the treatment was swopped to the opposite paddle. Each pig was able to work the paddles for a period of 90 minutes at the same time each day. The treatment was sound lasting 2s played at 98 dB(Lin) with a very short rise time. The sound was from a continuous loop tape which had been pre-recorded with various mechanical sounds and presented in a random order.

The mechanical sounds were two seconds each of metal dustbin lids struck together, air line, hammer striking metal tube, electric drill, car alarm and a pressure washer. This combination of sounds was repeated throughout the whole tape so that there was no silent periods. Measurements taken were number of roots performed on each panel and the maximum heart rate 20 seconds before and after roots on the treatment paddle. Control measurements were carried out during experimental session 3,4 and 5. Treatment sessions were 6 to 13.

Results

There was a significant bias in rooting behaviour away from the control sessions 4 and 5, during treatment sessions 6,7,and 9, Figure 1 (P>0.05). Only the bias shown during session six was significantly different from sessions 3,10,12 and 13 (P>0.05). Significantly greater percentage increases in heart rate were recorded during the first half of the treatment sessions when compared to the control (P>0.05) Figure 2.

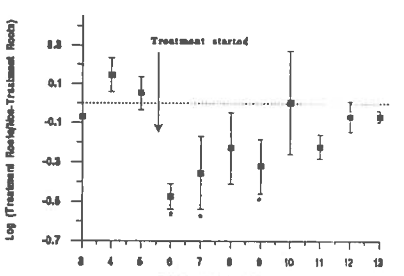

Figure 1; The mean ± sem bias in rooting for each session, n=6. (*=P<0.05)

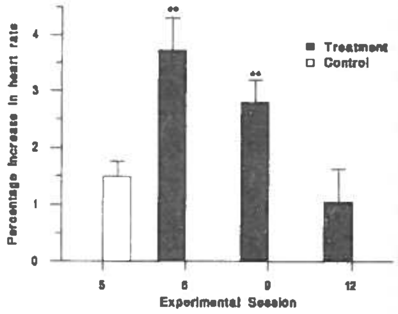

Figure 2; The mean ± sem percentage increase in heart rate after rooting the treatment paddle, n=6.(**=P<0.01)

Conclusions

Pigs appear to find loud novel sounds aversive when they are in a familiar environment. Both operant and physiological data indicate that the aversiveness of the sound decreases as the amount of exposure increases. This suggests that pigs do not find sound intrinsically aversive, it is the novelty which they find mildly aversive. Therefore sudden loud sounds should be avoided within the pigs' environment.

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When and how hens use perches in cages

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Introduction

Battery cages are the predominant housing system in Japanese poultry operations. However, the system has been criticized from the viewpoint of animal welfare, especially in Western and Northern Europe. One possible improvement is to equip cages with perches. Ruszler and Quisenberry (1970) found that perches resulted in highly significant improvements in livability and eggs per hen housed. Luescher et al. (1982) reported that no significant differences between cages with and without perches were found in egg production, feather condition and excitability. They observed that most of the resting time at night was spent sitting on the perch in hens housed in 2 birds per cage. The authors' previous study also found almost the same tendency (Tanaka et al., 1993). Tauson (1984), however, showed that the hens in cages with a perch had significantly lower egg weight and higher frequency of cracked eggs, and he observed no significant difference between cages with and without perches in frequency of feeding or drinking behaviors. Some of the differences in the results of previous reports may have been caused by variations in the perches themselves (Duncan, et al, 1992). The objective of the present study was to clarify when and how hens use perches in cages.

Materials and Methods

The experimental cage (420 x 800 x 530 mm) with 2 feeders, one at the front and the other at the back, was made by modifying the commercial cage. A drinker was attached to each feeder. Two wooden perches were installed 100 mm (front perch) and 400 mm (central perch) from the front. Two cages were placed into the experimental chamber (12 m^2) and one bird was housed in each cage. The room temperature was maintained at 22±1ºC, and the illumination cycle was 14 h of light (06:00-20:00) and 10 h of darkness. The hen behavior was videotaped for 24 h using an infrared camera and a time-lapse video recorder. The following activities were recorded in each 5-min interval: feeding, drinking, resting, preening, and other. The birds could perform all activities on both the floor and perches. Feed and water intake from each feeder and drinker were also measured for 3 days. Sixteen hens (28~36 wks of age) were used in total.

Results and Discussion

Percentages of feed and water intakes on floor and perch were shown in Fig. 1. Each bird tended to eat and drink on one side. Thirteen hens consumed most of water standing on the floor ($P<0.001$). Ten of them consumed most of feed standing there, too ($P<0.01$ or $P<0.001$). There were 3 hens which consumed most feed and water standing on the front perch ($P<0.001$). Preening and resting were observed everywhere in cages in the light period. In the dark period, 12 birds spent most of time for roosting on the perches (8 were on the central and 4 were

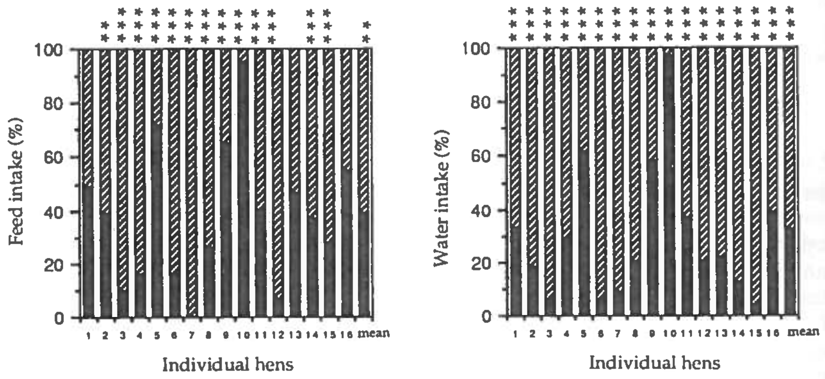

Fig. 1. Percentages of feed and water intakes on floor and perch.
▨ = On floor, ■ = On perch, **= $P<0.01$, ***= $P<0.001$

on the front perches), which was similar to the results of Luescher et al. (1982) and Tanaka et al. (1993). However, 4 birds roosted mainly on the floor. The birds tended not to move when the lights were turned off suddenly. If the illumination changed gradually, the bird could prepare for resting or sleeping during the dusk period (Tanaka and Hurnik, 1991), and the perches might have been used more.

Four out of 16 hens laid eggs from perches. This was suggested as a cause of cracked eggs by Tauson (1984), but all eggs in this study were collected intact.

Conclusions

These results show that every bird has its own behavioral needs and preferences for perches. Therefore, hens should be given enough cage space to choose either perch or floor at any time.

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Behavioral responses of piglets to shadows and darkness

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Introduction

On transfer of livestock from one place to another, some factors influence response and movement of the animals. Shadows that fall across alleys or chutes and bright spots of sunlight can cause animals to balk (Grandin, 1987). Furthermore, illumination of a barn may influence the behavior of animals (Grandin, 1980, 1982). This study examined the effects of shadows and darkness on the behavioral responses of piglets. We used 1 week old piglets because they were assumed to have had little experience with shadows and darkness at that age.

Materials and Methods

Twentysix one-week-old piglets were used for two tests. The stimuli evaluated in the test of 'response to shadows' were a vertically striped shadow (VS), horizontally striped shadows (HS), painted black and white vertical stripes (VP), painted black and white horizontal stripes (HP), a moving shadow of human shape (MS), a spot light (SL) and no shadows as a control (NS). In the test of 'response to darkness', piglets were held in an enclosure, then allowed access to a like-sized adjacent enclosure. Treatments (original enclosure and exposed enclosure) were light to light (LL), light to dark (LD), dark to light (DL), dark to dark with provision of dazzling light beam (DDL), dark to dark with provision of a light beam from the back (BLD) and dark to dark (DD).

Results

The average latency of piglets getting to the front of the experimental box was compared among the treatments (Fig. 1). Latency of SL was the shortest of all the treatments and significantly ($P<0.05$) shorter than that of a control (NS). Latency of painted black-white patterns in VP and HP was shorter than that of shadows in VS and HS and that of the control (NS). There was a significant ($P<0.01$) difference between latency of VP and VS. In VP, the piglets had a significant ($P<0.01$) tendency to walk on the black lines rather than the white lines, according to the x^2 analysis.

The average latency times of the piglets to cross the partition was compared among the treatments (Fig. 2). Latency of DL was significantly ($P<0.05$) shorter than that of the other treatments. When the piglets started from the light section (LD and LL), they moved significantly ($P<0.05$) faster to the other light section (LL) than to the other dark section (LD). On the other hand, when they started from the dark section (DL, DDL, BLD and DD), provision of the beam of light (DDL and BLD) significantly ($P<0.01$) hastened their movement to the other dark section as compared the situation without the beam (DD). But latency of DL was even shorter ($P<0.05$) than that of DDL and BLD.

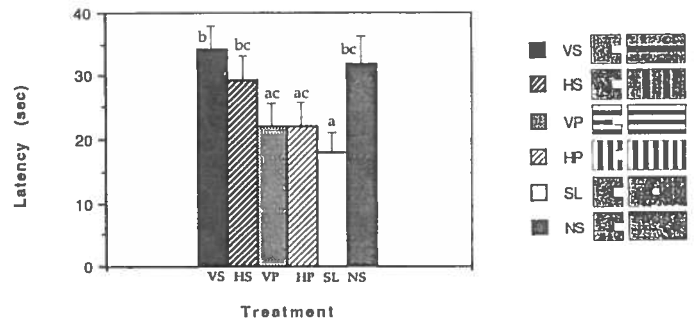

Fig.1. Mean latency of the piglets getting to the front of the experimental box in the 'response to shadows' experiment. Means with different letters are different at $P<0.05$.

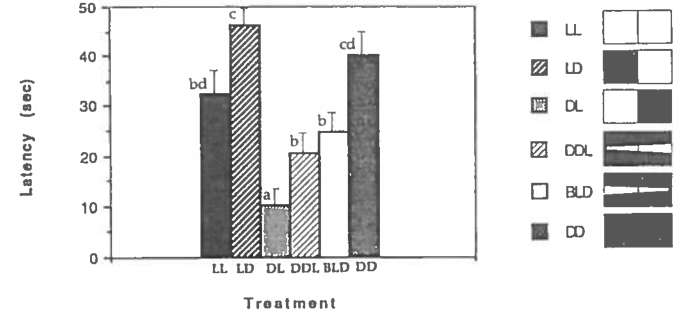

Fig.2. Mean latency of the piglets moving to other section of the box in the 'response to darkness' experiment. Means with different letters are different at $P<0.05$.

Conclusion

The results of the present study indicate that darkness frightens the piglets and that piglets have a tendency to move toward a more brightly illuminated area. They respond to the sharp contrast of black and white patterns on the floor and they try to pass them as quickly as possible. Further research is needed to develop proper handling techniques for pigs, which will lead to improvement of the human-farm animal relationship.

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Relationships between heart rate in response to videotaped handling scenes, temperament and weight gain in Holstein calves

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Introduction

Recent studies have provided evidence on the accuracy of visual recognition of objects (food) and individuals (human and animal faces) by sheep similar to that described in monkeys and humans (Kendrick, 1992). It has also been shown in cattle that they possess visual dominance over auditory in feed acquisition and they seem to possess a hierarchy of colors in associating a color with a feed (Uetake and Kudo, 1995). In addition, it has been reported that visual and auditory stimuli given to calves by VTR monitor showing scenes of calf handling could change heart rate (HR) and behavior (Uetake et al., 1994). Therefore, the susceptibility of an animal to its surroundings may affect the physiological state, such as growth. On the other hand, the susceptibility may depend on the animal's temperament. In this study, we investigated the relationships between HR in response to some videotaped handling scenes, temperament score and body weight gain in calves.

Materials and Methods

Eleven Holstein calves were tested at the age of 3 and 6 months. The animals were each in turn tethered to an experimental stall (120 × 160 cm) with 130 cm high walls, and the HR was monitored. A 29" television monitor was immediately in front of the stall, and the following three scenes of calf handling each lasting a few minutes were shown to the animal: feeding calves (F), driving calves outdoors for exercise (E) and dehorning calves (D). A scene of a resting calf (R) was also shown as the control. These scenes were shown in rotation.

The animals were tethered in stalls with free access to hay and water, and were each normally fed 8–10 kg of silage and about 1.2 kg of concentrates at 8:30–9:00 and 15:30–16:00. Each day around noon four animals went through the test, this taking about 4 hours altogether. The animals were able to exercise in the paddock after the test.

Temperament score was determined according to the activities when body size and weight was measured. Numerical scores from 1 (very quiet) to 4 (nervous) were assigned. Scoring was conducted when the calves were 6 months old.

Results

HR during scenes F, E and D relative to HR during scene R (100%) are in Table 1. The HR during scene F increased significantly ($P<0.01$) for 3 months old. The HR during E did not change for either age. The HR during D decreased significantly ($P<0.05$) for both ages.

Table 1. Heart rate (mean ± SD, %) during scenes F, E and D relative to heart rate during scene R (100%) for 3 and 6 months old. See text for definition of F, E and D.

Age	scene		
(month)	F	E	D
3	112.5 ± 11.7 **	100.8 ± 7.4	94.4 ± 7.0 *
6	102.7 ± 7.5	99.3 ± 7.6	94.4 ± 7.1 *

* P<0.05; ** P<0.01

Pearson correlation coefficents between HR during scenes F, E and D, temperament score and weight gain are in Table 2. There was a significant correlation between temperament score and body weight gain (r=−0.63, P<0.05). However, HR during respective handling scenes did not correlate significantly with either weight gain or temperament score.

Table 2. Correlation coefficients between heart rate during scenes F, E and D, temperament score and weight gain. See text for definition of F, E and D.

Variable	Weight gain for 3 months	Weight gain for 6 months	Temperament score at the age of 6 months
Heart rate during			
F	−0.39	0.05	−0.08
E	0.27	−0.48	0.53
D	0.16	−0.09	0.47
Weight gain for 6 months	–	–	−0.63 *

* P<0.05

Conclusions

The heart rate was seen to respond to videotaped handling scenes in Holstein calves. The more quiet calves had higher weight gain for 6 months. The heart rate in response to handling scenes was not correlated with weight gain and temperament score.

Acknowledgements

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Microdialysis study of the caudate nucleus of stereotyping and non-stereotyping bank voles

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Introduction

Most studies concerning the neurobiochemical mechanisms of drug-induced and conflict-induced stereotypies have been carried out with systemic administration of psychopharmacological drugs. Such a methodology can only tell that a given neurotransmitter is involved somewhere. Modern neurobiochemical techniques include intra-cerebral microdialysis, which allows the monitoring of neurotransmitter activity directly in particular brain areas.

The bank vole has been used for many years as a laboratory model for stereotypies induced by barren environments, for both ethological and neurochemical investigations. It has been demonstrated that the jumping stereotypy shown by the species (Ödberg, 1986) undergos a developmental process at the behavioural (Cooper and Ödberg, 1991) as well as the biochemical level (Kennes *et al.*, 1988), suggesting possible different emotional states. Critical changes seem to occur between the age of 4 and 6 months.

The present study is concerned with older established stereotypies, i.e. in animals which have been performing them for several months after the above-mentioned transition period. It explores to what extent differences exist between stereotyping and non-stereotyping individuals in the basal levels of dopamine (DA), its metabolites 3,4-dihydroxyphenylacetic acid (DOPAC) and homovanillic acid (HVA), and the serotonin metabolite 5-hydroxyindoleacetic acid (5-HiAA) in the caudate nucleus.

Materials and Methods

Stereotyping and non-stereotyping voles (ages varying between 13 and 21 months) were selected by behavioural electronic recording (see Ödberg, 1986). Microdialysis experiments were performed under isoflurane/O_2 anaesthesia whilst the body temperature of the animals was continuousely maintained at 37.5°C. A 2 mm microdialysis probe (CMA 12, Carnegie Medicin AB, Sweden) was stereotaxically inserted into the right caudate nucleus and perfused 2ml/min of Ringer solution. Stereotaxic coordinates were determined by using the stereotaxic atlas of the albino mouse (Slotnick and Leonard, 1975) as a reference and correcting the coordinates after verification of the probe placement. Fifteen minutes after insertion of the probe, dialysates were collected every 25 minutes for 250 minutes. Samples of 20 ml were assayed immediately with reversed-phase liquid chromatography combined with dual electrochemical detection. The limit of detection (signal-to-noise-ratio = 3) for DA was 20 fmol/20 ml. Probe placement was histologically verified.

Table 1. Average basal levels of the 4 compounds in dialysates from the caudate nucleus of stereotyping (ST) and non-stereotyping (NST) voles. Values are expressed as pmol/20 ml dialysate (SD). N = number of animals. *U* = Mann-Whitney *U* test (two-tailed).

	N	DA	DOPAC	HVA	5-HiAA
NST	6	0.089 (0.025)	18.78 (4.74)	8.48 (2.53)	2.90 (0.34)
ST	10	0.074 (0.022)	16.73 (2.26)	7.87 (1.14)	2.01 (0.34)
U		22; NS	24; NS	27; NS	1; *P*=0.002

Results and Discussion

These preliminary results (the NST group will be increased) show that although stereotyping individuals tend to have lower basal levels of DA and metabolites, these differences are never significant. However, levels of 5-HiAA are significantly lower in stereotyping voles. The absence of differences in DA and metabolites is surprising as its it known that this transmitter is involved (Kennes *et al.*, 1988). This could be due to a homeostatic process. The next experiment will compare animals younger than 4 months when the probability of finding differences shouldbbe greater. The effect of challenges (e.g. KCl) will be studied as well as basal levels.

This experiment was not intended to study serotonin (5-HT), although it was planned to examine that transmitter in the future. 5-HiAA was included in the current study because the HPLC setup could assay it as well. Following this serendipitous finding, we should focus more of our attention towards a serotonergic involvement and relations between the two systems. It is known that raphe fibres innervate the striatum. 5-HT re-uptake blockers are currently used in humans and in dogs against obsessive-compulsive disorders (OCD). The terms "stereotypy" and "OCD" have been sometimes used synonymously, but without sufficient supporting scientific data. Clear definitions are also lacking. Further exploration of their respective neurobiochemical mechanisms should provide harder data as to decide whether or not a conceptual difference is justified.

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Studies on the range of behaviour reactions of dairy cows

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Introduction

There are no ethological standards for the design and estimation of buildings and housing systems for farm animals. The standards used in some European countries cannot be adopted in our animal husbandry because of the close interrelations between breed and housing system. The objective of the present investigation is to compile a catalogue as a guide for the elaboration of ethological standards according to housing system.

Materials and Methods

The basic behaviour of cows of the Holstein-Fresian (HF) and the Bulgarian Brown (BB) breeds were studied in a number of trials between 1986-1994. The experimental groups were formed from cows in different physiological states: the beginning, middle and end of lactation, and dry. The treatments comprised: 200 (4x50) HF cows kept loose (T1), 280 (4x70) HF cows (T2) and 180 (4x45) BB cows kept loose in deep litter (T3); 120 (3x40) BB cows kept tied-up (T4). The following behaviours were studied (by visual group chronometry using a TV camera and monitor system): eating behaviour, moving, rest and aggressive behaviours. The ethograms obtained were processed using Petit's (1969) method. Data were statistically processed by a specially programmed PC package using methods described by Bender *et al.* (1989).

Results

The eating behaviour data for the experimental animals are presented in Table 1. In T1, the time spent eating was 19-33% of the total twenty-four-hour period, predominantly during the day. With the advance of pregnancy, and before calving, the total time for eating decreased. Cows ruminated 22-43% of the 24-hour period. The season and physiological state did not significantly affect the time spent eating. Rain had an adverse effect on the eating behaviour during all seasons - the total eating activity decreased and the time spent ruminating in a standing position was increased.

In T2, the time spent eating was 15.8-29.8% of the 24-hour period and the animals spent 17-31% of the day ruminating. The season influenced the rumination time, with time spent ruminating the longest in spring and autumn. The time spent ruminating also increaseed with the advance of lactation.

In T3, the range of variation of time spent eating was limited - only 18-22% of the 24-hour period. This was because the animals were tied-up during rearing and so immobilized. The time spent ruminating was 17-22%.

Time spent ruminating in a standing position was about 40% of the total rumination time (without respect to diet composition, lactation stage and the season) when the cows were kept tied-up, suggesting that the animals were in discomfort.

Table 1. Time spent for studied behavioural reactions (min per cow from the total twenty-four-hour period).

Season	T1 MIN	T1 MAX	T2 MIN	T2 MAX	T3 MIN	T3 MAX	T4 MIN	T4 MAX
				Eating				
Winter	286.2	295.4	323.6	400.9	227.1	358.3	260.6	305.8
Spring	250.4	350.6	321.4	382.9	312.0	236.9	125.3	150.0**
Summer	316.3	385.5	238.2	295.7	238.5	341.6	267.6	307.3
Autumn	314.6	476.5	319.9	343.4	315.6	351.9	293.9	325.7
				Rumination				
Winter	347.4	420.2	243.3	291.0	265.0	396.0	202.5	314.1
Spring	360.4	425.7	319.0	358.9*	346.4	401.5	238.8	252.8
Summer	286.6	358.1	214.7	324.8	261.0	379.9	251.8	282.9
Autumn	405.9	586.6**	337.5	436.0**	355.9	430.8	261.0	295.3
				Rest				
Winter	536.1	595.7	523.2	556.2	592.7	666.4	327.3	400.8
Spring	635.7	692.2*	509.1	534.1	493.4	605.2	414.7	436.4
Summer	510.9	631.1	589.8	600.9	505.0	544.7	374.3	400.7
Autumn	514.0	625.5	653.5	701.9***	572.9	576.6	372.9	403.7
				Moving				
Winter	27.7	37.5	29.3	40.8	18.2	61.4*	-	-
Spring	24.8	51.1	22.2	26.7	26.7	30.6	-	-
Summer	12.0	32.3	19.5	29.4	30.4	49.4	-	-
Autumn	20.0	27.3	25.1	48.3	21.6	34.8	-	-

The duration of rest for the loose housing system was 36%-53% and for tied-up housing system it was 34%-40.5% of the 24-hour period. All experimental animals showed that the duration of rest has a positive correlation (+.287<r<+.322) with the phase of lactation and a negative correlation (-.223>r>-.189) with the environmental temperature. The share of the moving activity was 3-5% and wasn't influenced by the housing conditions or the breed.

Conclusions

The eating behaviour can be used as the most characteristic indication of the state of comfort i.e. to what degree the biological requirements of animals are met. The duration of rest has a positive correlation with the phase of lactation and in a negative correlation with the environmental temperature. The variation in values for the behavioural reactions (Cv<30) gives reason to consider them a reliable basis for the elaboration of a catalogue containing the parameters of the housing systems studied in this investigation.

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The effects of space allowance on behaviour, social interactions and lesion scores of group-housed sows

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Introduction

In addition to the physical space that a sow requires for standing or lying, it is well understood that sows also require social space if they are to show normal behaviour. This study measured how activity levels and social interactions were changed by different floor space in pens with individual feeding stalls, and related this to a physical indicator of welfare - the level of skin lesions.

Animals, materials and method

Eight established groups of six pregnant sows (7-10 weeks post service) were used in a replicated Latin square design of experiment, to compare four pen sizes: 2.0, 2.4, 3.6, 4.8m^2/sow. Sows were individually fed in stalls and then confined to the specified space allowance in a straw bedded area for the rest of the day. For the last 48 hr of each 7 day period, a continuous video recording was made of every pen. The video tapes of the recording were analysed for activity patterns by 5 minute time sampling and for social interactions by using an ethogram modified from Jensen (1980). Aggressive behaviours were defined as follows: HH: a rapid thrust upward or sideways with the head or snout against the neck, ears or head of the other. HHB: as HH, but with bites directed towards head, ears or neck. HB: as HH, but against any part of the body behind the ears. HBB: as HB but with bites. Intention Movements: the sow gives an intention action, particular in suddenly head movement. She usually chased away another without touching. Skin lesions were scored at the beginning and the end each treatment period by using the methodology modified from de Koning (1985).

Results

Time spent rooting increased with increasing space allowance, whereas time spent dog-sitting and standing inactive was reduced. The total number of social interactions in 48h and the incidence of aggressive behaviour were greatest in the smallest pen, which also gave the highest incidence of skin lesions on all parts of the body.

Table1. The effect of pen size on the means of general behaviours (no. of observations /sow in 48 hr), interactions (no. of observations /pen in 48 hr) and skin lesions (total no. of lesions /sow in 7 day period)

		2.0m^2/sow	2.4m^2/sow	3.6m^2/sow	4.8m^2/sow	sed	P	Sig.
General Behaviour	Standing	133.38^{a}	96.88^{ab}	79.50^{b}	68.25^{b}	19.87	0.019	*
	Rooting	184.00^{a}	205.37^{ab}	244.00^{bc}	286.38^{c}	23.32	0.001	**
	Dog-sitting	104.87^{a}	75.75^{b}	51.87^{bc}	45.38^{c}	11.9	0.000	***
Social Interaction	TI	816.75^{a}	434.63^{b}	484.37^{b}	314.75^{c}	37.78	0.000	***
	AI	269.63^{a}	107.77^{c}	147.14^{b}	78.89^{c}	18.26	0.000	***
Skin Lesion	FEN	21.00^{a}	10.13^{b}	9.25^{b}	7.75^{b}	2.56	0.000	***
	S	37.38^{a}	21.75^{b}	20.88^{b}	16.63^{b}	2.48	0.000	***
	BCU	37.35^{a}	24.50^{b}	16.00^{c}	18.13^{bc}	3.22	0.000	***
	RTV	33.25^{a}	16.00^{b}	10.88^{c}	10.63^{c}	2.40	0.000	***

TI = Total interactions; AI = Aggressive Interactions
FEN = Face, Ear & Neck; S = Shoulder; BCU = Body Center & Udder; RTV = Rump, Tail & Vulva
* = $P<0.05$, ** = $P<0.01$, *** = $P<0.001$

Discussion

The highest frequency of Rooting occurred in the largest pen (4.8m^2/sow). Rooting is an exploratory behaviour and its expression has been considered an indication of good welfare. Dog-sitting has been considered to be an abnormal behaviour. Therefore, the results indicate that increased abnormal behaviour occurred with decreasing pen area allowances.

When considering social interactions, the lowest numbers of interactions occurred in the largest pen. Jensen (1982) states that this is due to the sows having enough room to perform avoidance. Ewbank and Bryant (1972) said that submission and domination relationships were only enforced in competition situations. In the largest pen (4.8m^2/sow), there were less aggressive interactions, which would appear to be due to the sows not having to compete for space resource. In the 2.0m^2/sow sized pen the interactions were by far the most numerous recorded. Barnett et al. (1992) and Jensen (1984) state that there is suppression of behaviours in very small space allowance. The 2.0m^2/sow sized pen appeared not to reach this point. The number of interactions was very high in this pen when compared to other pens; this would appear to be due to the pen area allowance being limiting but not suppressing interaction. The greater aggression in this pen was also reflected in higher skin lesion scores.

From an animal welfare point of view, fewer aggressive interactions are good for the animal. Increasing the pen area allowance reduces aggressive interactions, while reducing the space allowance to a limiting situation might have the same result. However, in a limiting situation space might prevent the sows carrying out necessary social interactions and cause other problems, such as crowding stress.

Conclusion

The results indicate that a minimum space of 3.6 m^2/sow was necessary in the conditions of this experiment to promote good welfare. This result cannot be generalised to situations of different group size or feeding method.

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Feed quality and abnormal oral behaviour in lambs housed individually on unbedded slats

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Introduction

Sheep housed individually in slatted pens with no bedding perform several abnormal oral activities including bar-biting and slat-chewing (Cooper *et al.*, 1994). These activities may be described as stereotypic, since they are repetitive, and do not obviously serve a purpose (Done-Currie *et al.*, 1984, Marsden and Wood-Gush, 1986). In this experiment, the effects of variation in feed quantity and feed quality were investigated, to establish if abnormal oral activities were a response to absolute feed restriction or to deficiencies in specific dietary components.

Materials and Methods

120 Suffolk lambs from a line of high body confirmation and low genetic diversity were observed in this study. All were born to Scottish Blackface surrogate dams following embryo transfer. Lambs were weaned between 8 and 12 weeks of age and individually housed in wooden slatted, unbedded pens (1m x 2m). Each pen had a feed hopper and a water bucket.

Lambs were randomly allocated to one of three feed treatments: AL (n=63; conventional feed *ad lib.*; 195g CP/kg DM); R. (n=28; restricted quantity of the conventional feed; 33% of *ad lib.* intake); and LP. (n=27; high energy, low protein feed *ad lib.*; 91g CP/kg DM). Conventional and LP feeds were balanced to give equivalent energy densities (ME 10.6 mj/kg DM) and fibre (ADF 200g/kg DM) and all pellets were of similar size and shape. The feeds were presented twice daily, at 0830h and 1530h. Water was available *ad lib* for all three treatments. At 33 weeks of age all lambs received 100g of poor quality, chopped hay (ADF 495g/kg DM) per day, in addition to their treatment ration.

Lamb behaviour was recorded on four occasions in 30, 32, 34, and 36 weeks of age. For each day, the lambs were observed for five hours in total (0800-1000h, 1200-1300h and 1500-1700h). Data was collected by behavioural scan sampling each lamb once every five minutes, with the lambs posture, activity and substrate recorded on each scan. The incidence of each behavioural category was converted into a percentage of total time and analysed using repeated measure analysis of variance following arc-sine transformation.

Results

Initially, R lambs spent least time feeding and most time bar-biting (Table 1). R lambs also performed more slat-chewing than AL lambs, but LP lambs performed most slat-chewing. The provision of hay increased the time spent feeding (F=24, df=1, $P<0.001$), and chewing (F=13, df=1, $P<0.001$). Hay also decreased the time spent (F=27, df=1, $P<0.001$). There was, however, no effect of hay on the time bar-biting (F=0.18, ns). R lambs still spent most time bar-biting, and AL lambs still spent least time slat-chewing (Table 1).

Discussion

Lambs fed a ration that was restricted in quantity performed more bar-biting and more slat-chewing than lambs on the same feed *ad lib.* Lambs on a ration that was restricted in protein only performed more slat-chewing than lambs on the conventional feed. Providing hay, only effected the performance of slat-chewing and not bar-biting. We, therefore, propose that these two repetitive activities have different underlying causes.

Slat-chewing may be the attempt to increase intake of specific dietary components. Chewed slats may have provided small amounts of fibre from splinters or non-protein nitrogen from urine/faecal contamination that can be converted to protein by gut bacteria. Hay disrupted slat chewing either by increasing processing time (feeding, chewing and ruminating) or by providing a more appropriate feeding substrate. In addition, long strand fibre from the hay is also a more suitable substrate for rumination and for the functioning, maintenance and absorption of nutrients from the ruminant gut. In other trials of lambs on *ad lib.* diets, lambs with unlimited access to hay spent less than 1% of their time slat chewing (Cooper *et al.*, 1995)

Bar-biting better fits the definition of a functionless, stereotypic behaviour. It was a response to absolute feed restriction, and appeared to have no obvious benefit to lambs, though it may have increased salivation. Bar-biting was not disrupted by provision of hay, so either bar-biting was unrelated to fibre intake, or the quantity of hay was too small, or the activity was emancipated from its original causal factors. In other experiments on restrictively fed lambs, providing the pellated ration *ad lib* reduced, but did not extinguish the incidence of bar-biting (Cooper *et al.*, 1994).

Conclusion

Slat-chewing appeared to be a novel expression of diet selection in a restrictive environment, whilst bar-biting appeared to be a stereotypic response to feed restriction (hunger). Hay may be used to prevent slat chewing in stall housed lambs, but was less effective in preventing bar-biting.

Table 1. Activity of lambs in observations before and after the provision of hay

Treatment	AL	R	LP	*P*
Activity (PreHay)				
Feed	13	5	14	***
Chew	3	2	3	ns
Bar-Bite	2	8	2	***
Slat-Chew	9	19	24	***
Activity (Post Hay)				
Feed	18	8	19	***
Chew	6	5	6	ns
Bar-Bite	2	7	3	***
Slat-Chew	6	14	18	***

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Stereotypic wire-gnawing in laboratory mice does not reduce stress

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Introduction

Animals exposed to barren housing conditions often develop stereotyped behaviour patterns (Mason 1991). According to the coping hypothesis stereotypy may serve a coping function to modulate arousal (Valenstein 1976). The adaptive significance of stereotypies would lie in their potency to attenuate the deleterious physiological consequences of stressors (Dantzer 1991). To test the coping hypothesis we selectively prevented the performance of stereotypic wire-gnawing in ICR-mice and measured acute and chronic effects on the hypothalamus-pituitary-adrenal (HPA-) axis and the sympathetic-adrenal-medullary (SAM-) axis (Manser 1992).

Materials and Methods

All subjects (40 male Zur:ICR, Institute of Laboratory Animal Science, University of Zürich-Irchel, Switzerland) were kept in pairs under SPF-conditions in standard polycarbonate cages (16x22x14 cm), provided with rodent pellets and water *ad libitum* and sawdust as bedding on a reversed 12:12 h light:dark cycle (lights on at 2200 hours).

Based on stereotypy base lines at 80 days of age the animals were assigned to four equal size groups (N=10) with experimental (EXP-) and control (C-) groups of high- (HIGH) and low-stereotyping (LOW) individuals.

At d -4 we recorded a 24 h videotape for behavioural base lines followed by a blood sample for corticosterone base lines. At d 0 a second videotape was recorded during which stereotyped wire-gnawing was prevented by modified cage-lids with reduced distances between the metal bars. In C exchange with non-modified lids controled for the effect of manipulation. A second blood sample followed the next morning. A third and fourth blood sample were taken at d 4 and 7. At d 9 we recorded a third 24 h videotape for the analysis of behavioural long-term effects. At d 10 each animal was subjected to an ACTH challenge test to assess chronic activation of the HPA-axis (Manser 1992). Immediately after sacrifice the adrenals were extirpated for determination of SAM-activation by TH- and PNMT-activity (Manser 1992).

Results

The experimental cage-lids effectively prevented EXP from wire-gnawing. Levels of wire-gnawing in C were not affected by control manipulations and remained stable throughout the study (Repeated measures ANOVA, $F_{2,36}$=0.83, P=0.427). In EXP-HIGH the prevention of wire-gnawing resulted in a short-term decrease of total activity at d 0 that accounted for about 60% of the amount of wire-gnawing prior to prevention (paired t-test: T=2.31, df=9, P=0.046; Fig. 1). This effect had disappeared until d 9. Compared to behavioural base lines EXP (and, in particular, EXP-HIGH) in the long-term (d 9) performed more variable active behaviour considering that they did not develop new stereotypic patterns.

The prevention of wire-gnawing was associated with elevated plasma corticosterone levels in EXP 24 h later (Repeated measures ANOVA, $F_{3,33}$=3.78, P=0.019; Fig. 2). However, the increase from base lines to d 1 was significant only in EXP-HIGH (paired t-test: T=-2.837, df=8, P=0.022). At d 4 and d 7, HPA-activity was back at base lines in both groups.

The prevention of wire-gnawing revealed no significant effects on measures of chronic activation within both, the HPA- and SAM-system. Similarly, C-HIGH and C-LOW did not differ with respect to chronic stress levels.

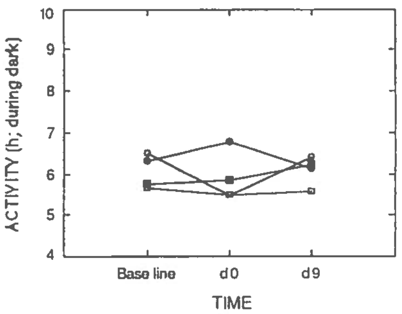

Fig. 1. Total activity of EXP-HIGH (o), EXP-LOW (▫), C-HIGH (●), and C-LOW (▪).

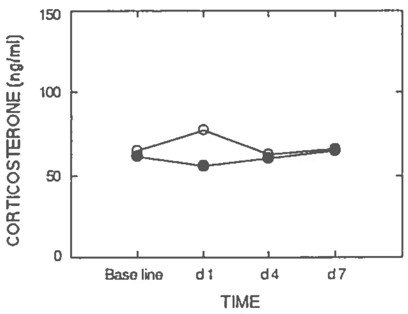

Fig. 2. Plasma corticosterone levels of EXP (o) and C (●) in the course of the experiment.

Discussion

Equal levels in chronic stress parameters in C-HIGH and C-LOW suggest that the long-term activation of both the HPA- and SAM-axis is independent of stereotypy performance. If it was due to a coping effect of stereotypy performance the prevention of stereotypic wire-gnawing should lead to an increase in the endocrine stress response. Our results clearly contrast with this prediction and suggest that stereotypy performance does not affect these two endocrine systems.

However, 24 h after the prevention of wire-gnawing, we measured a significant elevation in plasma corticosterone levels that was greater in high- than in low-stereotypers. This effect is consistent with the coping hypothesis. A similar effect in bank voles, *Clethrionomys glareolus*, was interpreted in favour of the coping hypothesis (Kennes & de Rycke 1988). However, at d 4 and d 7, the elevation was restored at base lines. Although, this may reflect a feedback mechanism (Manser 1992), we suggest an alternative explanation. General activity in EXP-HIGH in the short-term decreased after prevention of wire-gnawing. This may reflect the impact of the treatment on behavioural organization, forcing the animals into a new organization of behavioural routines in space and time. The short-term elevation of plasma corticosterone levels may thus represent a stress response to the disturbance of behavioural organization. It is restored as soon as new routines are established. The point is that not the stereotyped form of the behaviour is relevant to endocrine homeostasis but rather the state of behavioural organization. Stereotyped wire-gnawing in ICR was compensated by equal amounts of more variable behaviour without lasting effects on endocrine activation. This hypothesis could be tested by assessing the impact of the prevention of some other, non-stereotyped, aspect of behaviour on stress levels.

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Study on Rats' Emergency Reaction to Acute Stress Stimuli

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Introduction

Tsukuba high (THE) and low (TLE) emotional rats were selectively bred for studies on emotionality (behavioral reactivity). Our previous study demonstrated that sympathetic activity was higher in THE than in TLE, while conversely, parasympathetic activity was higher in TLE than in THE under normal conditions (Yayou et al. 1993).

Emergency reaction of animals has mainly been studied from the viewpoint of sympathoadrenal reaction (Cannon 1929). In this study, using these animal models, we investigated responses of both sympathetic and parasympathetic nervous reaction and its relation to behavioral responses to three types of acute stress stimuli.

Materials and Methods

Animals were exposed to Cage Switch Stress (CSS), Electrical Footshock Stress (EFS), and Cage Drop Stress (CDS) after saline, atropine (parasympathetic blocker) or propranolol (sympathetic blocker) injection. CSS was evoked by placing the rat into a plastic cage with water of a depth of 1 cm. EFS by irritating the rat an electrical foot shock (1.7mA, 0.5 sec), and CDS by placing the rat into a plastic cage and dropping it from a height of 15 cm. The behaviors of rats after stress were continuously observed. Electrocardiograph was continuously recorded using a telemetry system, and percent change of heart rate (%−HR) was compared between the two strains.

Results

Exploration was observed after CSS and EFS, but there were no differences between the two strains and among pharmachological treatments. Freezing was observed after CDS, and duration of freezing time was significantly longer in THE than in TLE (Table 1). After CSS and EFS following atropine treatment, %−HR was significantly larger in TLE than in THE (Table 2, 3). After CDS following saline treatment, bradycardia was observed only in THE and it disappeared with atropine treatment (Table 4).

Table 1. Mean (and S.D.) duration of freezing time in THE (n=4) and TLE (n=4) by CDS after saline (1ml, i.p.), atropine (2mg/kg, i.p.) and propranolol (4mg/kg, i.p.)

Strain	Mean duration of freezing time (sec)		
	Saline	Atropine	Propranolol
THE	180(0)	100.3(81.4)	156.3(38.2)
TLE	24(34.1) *	13.3(9.9)	10.3(4.5) *

Note that observation of freezing lasted 180 sec.
Significant differences between strains are indicated by * =P<0.05.

Table 2. Mean (and S.D.) percent change of control heart rate by CSS in THE (n=4) and TLE (n=5) after saline (1ml, i.p.), atropine (2mg/kg, i.p.) and propranolol (4mg/kg, i.p)

Time(min)	Mean percent change of control (%)					
	Saline		Atropine		Propranolol	
Strain	THE	TLE	THE	TLE	THE	TLE
0−1	121.5(3.7)	119.2(1.8)	105.4(4.5)	120.6(4.1) *	102.7(3.7)	100.6(3.1)
2−3	118.2(13.6)	118.2(2.6)	100.1(3.1)	121.0(1.7) *	103.1(2.6)	103.2(4.5)
4−5	110.4(5.3)	107.6(5.6)	98.5(4.6)	116.3(2.2) *	105.8(4.0)	101.2(4.4)

Note that CSS was conducted from 0 to 5 (min).

Significant differences between strains are indicated by * =P<0.05.

Table 3. Mean (and S.D.) percent change of control heart rate by EFS in THE (n=4) and TLE (n=5) after saline (1ml, i.p.), atropine (2mg/kg, i.p.) and propranolol (4mg/kg, i.p)

Time(min)	Mean percent change of control (%)					
	Saline		Atropine		Propranolol	
Strain	THE	TLE	THE	TLE	THE	TLE
−1−0	110.0(3.1) ^{a}	107.5(3.2) ^{a}	104.2(3.3) ^{a}	107.0(2.2) ^{a}	103.5(4.8)	101.1(2.3)
0−1	123.2(7.0) ^{b}	120.0(5.7) ^{b}	108.4(4.0) ^{b}	121.4(3.8) ^{*b}	106.2(2.9)	103.2(2.4)
2−3	114.3(4.4)	114.2(10.0)	104.8(2.4)	115.5(6.6) *	106.9(2.1)	102.9(2.7) *
4−5	113.0(1.9)	109.5(5.2)	103.8(2.8)	114.1(4.5) ^{*b}	103.4(1.2)	102.2(3.8)

Note that EFS was given at 0 (min).
Significant differences between strains are indicated by * =P<0.05.
Significant differences within the same column are indicated by different letters; $^{a,\ b}$ =P<0.05.

Table 4. Mean (and S.D.) percent change of control heart rate by CDS in THE (n=4) and TLE (n=5) after saline (1ml, i.p.), atropine (2mg/kg, i.p.) and propranolol (4mg/kg, i.p)

Time(min)	Mean percent change of control (%)					
	Saline		Atropine		Propranolol	
Strain	THE	TLE	THE	TLE	THE	TLE
1−2	113.6(7.1) ^{a}	106.6(10.5)	111.4(5.0)	107.0(7.4)	102.5(4.0)	104.5(3.8)
2−3	93.0(9.2) ^{b}	103.2(7.5)	108.6(5.8)	107.2(6.3)	93.9(3.1)	97.7(2.7)
4−5	97.7(5.0) ^{b}	101.6(6.2)	105.8(6.3)	103.7(3.8)	99.3(3.8)	99.7(1.9)

Note that CDS was conducted at 2 (min).
Significant differences within the same column are indicated by different letters; $^{a,\ b}$ =P<0.05.

Conclusions

It was concluded that autonomic response to acute stress stimuli could be divided into two groups: sympathetic−dominated response for CDS and EFS in which THE showed smaller increase in sympathetic activity than TLE, and parasympathetic−dominated response for EFS in which THE showed larger increase in parasympathetic activity. Behavioral reaction could be divided into exploration accompanied by increase in sympathetic activity and freezing accompanied by increase in parasympathetic activity.

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