Proceedings of the 30th International Congress of the International Society for Applied Ethology

14-17 August, 1996

Guelph, Ontario, Canada

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Edited by

I.J.H. Duncan,

T.M. Widowski,

& D.B. Haley

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The D.G.M. Wood-Gush Memorial Lecture

Animal ethics and animal welfare science: bridging the two solitudes

David Fraser

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Since the 1970's, animal ethicists and animal welfare scientists have increasingly tried to provide frameworks in which to understand and articulate the proper treatment of animals. The two groups set about this task using such different concepts, assumptions and vocabulary that they functioned as "two solitudes", with little communication or understanding between the two camps. Some influential ethicists addressed the issues using logic and ethical theory, but put little reliance on empirical information in applying their ideas to practical problems. Ethicists also tended to analyze the issues using concepts (rights, duties) that are not amendable to scientific analysis. Meanwhile, animal welfare scientists sought to "measure" animal welfare as if it were a value-free concept, and tried to distance their activities from the issues addressed by animal ethicists. More recently, however, philosophers working in animal ethics have taken more account of scientific information in their thinking, and have provided valuable critiques of animal welfare science. Ethicists have also addressed animal issues using concepts (e.g., telos) more amenable to scientific analysis, and theories (e.g., communitarian rather than egalitarian) more readily applicable to practical issues of animal use. At the same time, scientists in animal welfare and other fields have shown increased sophistication in describing the interplay between science and value issues. These developments have made the thinking of animal ethicists and animal welfare scientists more compatible than before, and are opening new avenues for science to contribute ethical issues of animal use.

Plenary Session

The Behaviour & Welfare of Laboratory Animals

Experiential and environmental effects on the laboratory animal: the neuroscience perspective

Bruce A. Pappas

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Acceptable scientific trade craft demands that the laboratory animal's environment be characterized by standardization, minimal handling, social isolation and monotony. This is based partly on logistical and economic factors and as well on the concern that deviation from these features could add variability to research data. Neuroscience research indicates that this latter concern is indeed legitimate. For example, handling, particularly early in life, alters later responsivity to stress. Remarkably, it also reportedly exerts a life-long influence, modifying aging-related behavioral decline and neuron-loss in the brain. Isolation housing affects brain chemistry and among other things, this has consequences for the study of drug effects. It also has implications regarding rodent models of human emotional disorders. Research also indicates that the husbandry of laboratory animals is inappropriate for many other neuroscience objectives. The most compelling example derives from the experimental manipulation of environmental enrichment for the laboratory rat. The comparison of enriched-housed (EH) vs impoverished-housed (IH) rats indicates that the EH rats show greater higher-order branching of dendrites of cerebral cortical neurons, more cortical synapses and greater capillary density in cortex. Some differences in brain chemistry are also observed. EH rats perform better on tasks of spatial problem solving. One can only guess regarding the comparative emotional lives of EH vs IH rats. EH/IH rats differ regarding the effects of certain brain lesions, cerebrovascular insufficiency, neurotoxins and perhaps, aging. Arguably, EH rats are more appropriate for the study of the effects of these and other brain-compromising factors. More research is needed regarding this possibility however, before firm conclusions can be drawn. In this regard, it is interesting that current evidence suggests that environmental/experiential factors are risk-factors in human age-related dementia. Hopefully, this will stimulate funding for animal research to elucidate the basis of this phenomenon.

Housing and welfare in rats

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Rats are widely used in laboratories and in many countries some assessment of their welfare is made by those responsible for considering ethical aspects of animal experimentation. Most of a rat's life is spent in a cage but cage design has been determined by considerations of ease of management and hygiene rather than by taking account of all of the needs of the rat. Welfare is usually considered by those involved in management and care but the level of that consideration varies greatly from one animal house to another. In this review, general conditions in the building will be considered briefly and aspects of the animal's cage will be considered in detail.

In most animal houses, disease, temperature, humidity, air-flow and exposure to noxious chemicals are controlled. The extent of intermittent noise can sometimes be too great and sounds which we call ultrasound can cause problems for rats as there are many sources which are not obvious to humans. Continuous lighting can disrupt normal behaviour and some light levels appear to be uncomfortably high. Feeding *ad libitum* can result in obesity and reduced life expectancy but how should these disadvantages be balanced against the effects of food restriction?

Wild and domestic rats are social animals that have strong preferences for digging, hiding and manipulation of materials suitable for nest-building. Rats form stable social groups and most strains show little aggression when unfamiliar animals are introduced. There are indications of poor welfare in isolated rats so they should be kept in groups. Animals are often kept in clear or translucent plastic cages with open wire mesh tops. These provide little opportunity for concealment and rats in such cages show strong preferences for opaque nest boxes, opaque tubes and substantial nests if they have the opportunity to construct and use them. Data indicate that rat cages usually provide too little opportunity for hiding and object manipulation. More complex environments can be constructed readily, for example by the linking of cages and the provision of nest boxes and nesting materials. The costs of doing this are small in capital expenditure terms but a small amount of extra time must be spent by care staff. Another part of the rat's environment where research demonstrates the inadequacy of some caging is flooring. Rats show strong preferences for nesting on solid rather than mesh floors, and abnormal behaviour is less often reported on solid floors so wire mesh floors should be avoided wherever possible. If better housing design is combined with good quality care, rat welfare can be substantially improved.

Recognition and assessment of adverse effects and humane endpoints in animal research

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The suffering of laboratory animals in science is of considerable public concern, and, more often than not, is an unwanted experimental variable as adverse effects, such as pain, distress and fear, can confound the scientific results. Experiments should be devised, therefore, that cause the minimum level of suffering necessary to achieve the scientific objective, and that level of suffering should be rigorously justified in terms of potential benefit likely to accrue from the work. In order not to cause avoidable suffering, which I contend is unethical, 'best practice' has to be determined (the same is true for any other area of animal use such as farming, zoos) and to do this any suffering has first to be recognised and then assessed in some way. Recognition of animal suffering by animal caretakers, veterinarians, pet owners etc. is generally on the basis of something amiss with an animal's behaviour or appearance, but this is often subjective and needs refining in some way if it is going to be quantified. Agreement on the relevant criteria to assess suffering would promote dialogue between interested parties in any debate on a specific use of animals.

A scheme for the classification of adverse effects based on physiological concepts of pain, fear, distress and distress will be presented. Pain involves well known afferent pathways from both somatic and visceral parts of the body. Specialised receptors (nociceptors) in the skin and joints respond to excessive heat, mechanical pressure and local release of peptides such as bradykinin. Visceral receptors respond more to distension and inflammatory peptide release. The nerve impulses generated from these receptors ascend to the thalamus, having passed through the 'gates' of the descending inhibitory pathways, and from there to the cortex where the feeling of 'pain' is experienced. This may result in measurable changes in an animal's behaviour. There may also be measurable changes in circulating substances as a consequence of the 'painful' condition (eg. inflammatory cytokines, acute phase proteins).

Fear is caused by an animal perceiving a 'threat' by senses such as smell, sight and sound (the 3 major sensory Ss for the detection of threat by mammals; taste and touch appear to be less common but fish respond to vibration). The brain then activates involuntary sympathetic nervous system pathways leading to direct stimulation of the adrenal medulla and the release of catecholamines such as adrenaline and nor-adrenaline (dopamine may also be released). These hormones can be measured directly and indirectly through their well defined physiological effects (eg. heart rate, blood pressure, peripheral

vasoconstriction). A third pathway (ie. other than pain and fear) is often co-activated and involves the hypothalamus, anterior pituitary, and adrenal cortex leading to the release of corticosteroids (other pathways are also activated). These steroids can be measured directly in the circulation as well as their effects on other organs and cells eg. blood glucose, reduced white cell counts, reduced lymphocyte activation. The stressors that cause the release of catecholamines, corticosteroids and other hormones, if prolonged or because the animal fails to adapt or cope with its new environment, will lead to other measurable effects sometimes presenting as a failure to develop or thrive in some way (eg. a loss or failure to gain bodyweight as expected, breeding inefficiently, an increase in subclinical and clinical diseases). I have termed this prolonged response dystress, derived from the Greek *dys* having a connotation of bad (as in other clinical terms such as dystocia, dysentery, dysmenorrhoea, dyspepsia, dyspnoea).

Finally, there is a fourth category of physiological (psychological) responses by an animal which is emerging in studies of animal wellbeing and include changes in endogenous central nervous system hormones (such as opioids, benzodiazepines, serotonin, adrenaline, nor-adrenaline) and their receptors. The emotional states initiating or reflecting these changes can be encapsulated by the term 'mental distress' and include boredom, frustration, depression, torment, grief, sadness. Other emotional states such as pleasure and happiness may also involve these and other CNS receptors and hormones. Manifestations of distress include stereotypic behaviours, changes in receptor density binding, central and peripheral release of hormones, all of which can be measured. A further assessment that can be made in states such as pain, anxiety and depression is to test responses to drugs known to reverse these conditions in humans and animals.

From these four physiological categories one can start to construct practical measures for the recognition and assessment of emotional states (and a database of them). Examples will be given that have led us in Birmingham to develop 'score sheets', where the cardinal signs that are likely to be encountered during an experiment are listed and recorded as present or absent, as and when necessary, by animal care and scientific staff. The data derived from such careful, rigorous and 'holistic' observations have been used to devise humane end points in experiments which are then validated to ensure important data are not lost. These score sheets have other advantages than simply an attempt to measure animal suffering. They have facilitated a positive and concerted welfare approach by scientific and animal care staff, and done much to promote animal care staff morale and motivation.

Finally, a few comments will be made on routine husbandry and scientific practices based on research in our laboratory using radiotelemetry and corticosteroid measurements which have revealed some interesting results.

Scientist - animal interactions: are they an inevitable source of research confounding?

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Scientists and animals interact daily in a variety of research settings. There is a growing body of evidence to suggest that these encounters, in which specific humans are reliably paired with hedonic events, have measurable impact on animal subjects. I will argue that most research animals are capable of discriminating individual humans. These humans may readily enter into Pavlovian associations with the hedonic stimuli that are a normal part of the research agenda. Such conditioning has been described by Gantt *et al.* (1966) in terms of "Person as CS" (Conditioned Stimulus). The response to such conditioning may be seen in terms of motivational conditioned responses (CRs). These CRs may affect research outcomes in a variety of ways, not all of which are intended or anticipated. Most behavioural and biomedical research is not immune to these effects. My talk is based on a recent book ("The Inevitable Bond," Davis & Balfour, 1992) which suggests we can (1) minimize such disruptive or confounding effects on our research, and (2) use scientist-animal interactions to maximize subject motivation and, in so doing, enhance the research process.

Improving the welfare of laboratory animals: what can animal care staff do?

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Prior to 1980, laboratory animal management practices focused primarily on providing a clean environment. This resulted in husbandry practices whereby animals were often isolated in barren cages, tanks, or pens. Activities of animals centred around eating and drinking, as little opportunity was afforded animals to engage in other species-specific behaviour.

This created a dilemma for staff working in laboratory animal facilities. Already these people were under scrutiny by the public for their involvement in the use of animals for research and teaching. Knowing that the environmental provisions were not meeting the behavioural needs of several of their charges, and not being empowered to make changes, staff found it difficult to maintain their morale and to contribute positively to the management of their animals.

In an effort to effect changes in the husbandry standards provided by the Central Animal Facility at the University of Guelph, a list of concerns were identified and priorities were established to address important husbandry issues. Recognizing that proposed solutions were not in keeping with the current philosophies of housing laboratory animals, animal care administrators risked ridicule and lack of support by colleagues, scientists and staff. Changes were made in cooperation with, and under advisement of all staff. Any strategies proposed were investigated and implemented under close scrutiny to ensure there was no harm to the animals or interference with the research study or instructional exercise in which the animals were being used. If tangible improvements were not noted for the animals, changes were deemed to be successful so long as proposed husbandry procedures did not harm the animals, and providing it increased the morale of the staff.

Initial changes made to the housing of animals included limiting single housing, and promoting loose and group housing of animals wherever possible. As a result, animals were often provided with larger enclosures, more enriched environments, and greater opportunities for the expression of natural behaviour of all species housed in the facility. Management changes, which included the provision of hay for domestic species, shredded paper and other devices for rodent species, as well as the elimination of any financial incentive to house rodents in wire-bottom or small cages, were also implemented. Dog-walking and cat, rabbit and rodent socializing programs were developed which involve both paid and volunteer staff. People hired into these positions are primarily students who have a desire to be involved in improving the life of laboratory animals, and who wish to gain experience in working with these species.

In order to co-ordinate our efforts, and to minimize inconsistencies in the provision of enriched environments, we established a voluntary position of Environmental Enrichment Officer (EEO). The EEO's responsibility is to monitor the enriched housing activities within the facility by compiling bimonthly activity reports, sharing ideas, leading the discussion on environmental enrichment at the weekly staff meetings, and listing strategies implemented in the facility for reference by staff members.

Several concerns identified by staff and investigators regarding laboratory housing and care have been addressed as a result of the aforementioned changes. The benefits of these accomplishments include improved animal welfare by providing more of the social and physical needs of animals; improved public attitude about the care provided for animals used in teaching and research; increased staff empowerment and morale; and improved animal models used in research.

We have created an atmosphere which promotes the exchange of ideas between animal care staff and investigators, and legitimizes the staff's need to provide more stimulating environments, not only for our animals, but also for the staff.

Spoken Papers

Early weaning enhances the later development of stereotypy in mink

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In the wild, young mink do not leave their mother until 11 - 12 weeks old. On fur farms, however, they are separated from her at eight weeks, three weeks after weaning. This experiment investigated the role this plays in the development of stereotypy. From each of 53 litters one female was removed when seven weeks old, and another at eleven weeks. By nine months, Early-separated females were more stereotypic than their Late-separated sisters (Mean % time spent in stereotypy: Early-separated - 30.7%, Late-separated - 23.9%; $Z = 2.04$, $P = 0.043$, one-tailed). At ten months, the females were moved to two different sheds due to reorganisation on the farm. In one, neighbouring non-experimental females were mated for breeding. In this shed the subjects' stereotypy increased over the levels at nine months, and the treatment groups no longer differed. In the second shed, the subjects were not disturbed in this way. Here, their stereotypy levels did not increase, and Early-separated females remained more stereotypic than Late-separated ones ($Z = 2.04$, $P = 0.020$, one-tailed; $n = 15$; Mean % time spent in stereotypy: Early-separated - 44.0 %, Late-separated - 23.0%). Early-separated females' stereotypies also consisted of a greater proportion of completely fixed sequences ($Z = 2.07$, $P = 0.014$, one-tailed). This adds to previous mink research showing that age at separation from the mother increases tail-biting, and leads to two conclusions: 1) Mothers influence the behavioural development of young mink, even long after nutritional independence (possible mechanisms for this will be discussed); 2) Subtle aspects of husbandry could explain why levels of abnormal behaviour differ greatly from farm to farm.

Vocal cues reflect physiological stress response in domestic pigs (*Sus scrofa domestica*)

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There is evidence that properties of acoustic signals reflect an animal's internal state. As the concept of stress is a well established model for internal homeostatic processes we asked in this study whether and how far vocalizations can be used to indicate a physiological stress response in domestic pigs.

Pigs (eight castrated males, seven months old) were exposed to two kinds of tests: In SEP subjects were separated from groupmates; in IMMO subjects were separated and immobilized by restricting the degree of ambulation. Vocalizations, motor activity, and heart rate were recorded continuously, and blood samples were taken via an indwelling catheter. The acoustic structures of vocalizations were analyzed using a multi-parametric approach based on digitized spectrograms. Blood samples were analyzed for levels of cortisol, ACTH, epinephrine and norepinephrine.

(1) Increasing levels of cortisol, ACTH, and epinephrine indicated a physiological stress response in both tests. (2) Clear correlations between epinephrine and specific acoustic parameters, motor activity, and heart rate were found in SEP but not in IMMO. (3) Epinephrine was increased significantly in phases of SEP as well as in phases of IMMO, during which pigs vocalized with high intensity. Covariations with motor activity and heart rate were less clear. (4) Cortisol and ACTH did not correlate with any of the parameters measured.

Our results suggest that in stressful situations a specific quality of sound (accentuation of higher frequencies, enhanced frequency modulation) reflects an increased level of epinephrine, although increased epinephrine-levels did not correspond to signal characteristics in a straightforward way. Finally, vocalizations appeared to be more suitable to indicate a certain stress response than heart rate or non-acoustic behaviours. Different degrees of behavioural control over a stressful situation (SEP or IMMO) may account for differences in physiological reactions.

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Age and weight at weaning affect weaning stress and the development of stereotypy in laboratory mice

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Separation from the mother through artificial weaning is a stressful procedure for laboratory mice. In response they show increased levels of exploratory and escape behaviour, patterns of which may subsequently develop into stereotypies under barren housing conditions (Würbel, Stauffacher and von Holst, 1996, *Ethology*, 102, in press). In wild house mice (*Mus musculus domesticus*) weaning weight is known to affect offspring fitness (reviewed by Krackow, 1993, *Ethology*, 95: 76; Künig, 1994, *Behav. Ecol. Sociobiol.* 34: 275) thus, reduced weaning weight representing a risk to fitness. It was therefore investigated, whether physical condition at the moment of separation from the mother determines later stereotypy performance. Forty-eight outbred male ICR-mice were assigned to three groups. Thirty-two individuals were weaned at standard weaning age (20 days) and assigned to H (high weaning weight) and L (low weaning weight) according to whether body weight at weaning was above or below the median for the group. Besides exploiting natural variation in weaning weight we additionally manipulated physical condition at weaning by precociously weaning (17 days of age) 16 males (PW) from eight litters which were chosen at random. Weaning weight and weaning age had a significant effect on both weaning stress ($F(2,35)=5.59$, $P=0.008$) and adult stereotypy performance ($F(2,45)=6.65$, $P=0.003$). Both, PW ($P=0.012$) and L ($P=0.033$) had higher corticosterone levels 48h after weaning and also developed a higher level of stereotypic wire-gnawing (PW: $P=0.003$, L: $P=0.036$) than H. These results suggest that impaired fitness expectancy at weaning increases the stress response to separation from the mother and predisposes ICR-mice to perform higher levels of stereotypy developed from attempts to cope with this situation.

The vocal response of piglets to weaning: the effect of piglet age

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A number of experiments have established that the calls of piglets that have been temporarily isolated can provide reliable information about various aspects of piglet condition. For example, isolated piglets call more if they have missed a nursing or are cold. The aim of this experiment was to determine if the calls given by newly weaned piglets also provide information about their condition. One of the best known determinants of a piglet's ability to adapt to weaning is its age. From each of 26 litters, 3 litter-mates were weaned at 3 weeks of age, 3 at 4 weeks, and 3 at 5 weeks. Vocalizations and growth were monitored for the week after weaning. Piglets of all 3 ages called at a high rate on the day of weaning (1.1 calls/pig/min), but this call rate declined to 0.2 calls/pig/min within 4 days. There was a significant negative effect of weaning age on the number of calls produced ($P<0.001$): piglets weaned at 3 weeks produced an average of 1.2 calls/pig/min during the first 4 days after weaning, while those weaned at 4 and 5 weeks produced 1 and 0.85 calls/pig/min respectively. Younger weaning ages were associated with lower weaning weights and slower growth during the week after weaning. Lighter, slower-gaining piglets called more, but these effects were not statistically independent from that of weaning age.

Opioid peptides and dairy cows' behavioural and physiological responses to social isolation

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Endogenous opioid peptides (EOP) are involved in the neuroendocrine control of the behavioural and physiological responses of many species to social isolation. To test whether this is true for cattle, 12 Holstein cows were placed in social isolation for 15 min, either with or without naloxone treatment (an EOP blocker). Vocalizations were recorded, latency to lift the leg in response to a laser was measured to detect pain sensitivity, and blood was sampled for cortisol assays. Naloxone alone increased cortisol concentrations ($P<.05$) but did not induce vocalization or change leg-lift latencies. Social isolation increased the frequency of vocalization, cortisol concentrations at +20 min and +40 min, and leg-lift latencies while in social isolation ($P<.05$). None of these effects of social isolation was altered by prior administration of naloxone. Brief periods of social isolation appear stressful to cows, as indicated by increased HPA activity and vocalization. Isolation also reduces pain sensitivity, perhaps suggesting a stress-induced analgesia, which is the first time this has been recorded in cattle. However, in contrast to other species, EOP's do not appear to be involved in these responses.

Effect of food deprivation on crowing in the domestic cock

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Recently more research is done concerning vocalisations of animals as an indication of psychological welfare, for instance in captive baboons. Some hen sounds correlate well with aspects of the environment of the hen, i.e. hens consistently produce the laying call when they are deprived of a laying nest, and also after deprivation of a dustbath. Vocalizations can also be indicators of the physical state or condition of an animal, for instance the crow of a rooster. Analysis of the temporal structure of crow sequences shows that calls are very characteristic. A gradual increase in inter-call interval and a decrease in call duration is characteristic of each sequence. The variation in call duration is systematic and especially the last note correlated highly with the total call duration and is possibly a parameter of fatigue and thus physical condition. In an experiment roosters were deprived of food in order to influence their condition. The effect of this treatment on parameters of their crowing was investigated under the hypothesis that they crow less and for shorter duration when deprived. In the control condition (food available) roosters crowed with a mean of 24.7 ± 1.2 crows, after 0 hour deprivation a mean of 25.667 ± 2.517 was found; in the 24 hour deprivation 15.3 ± 0.6, and the 48 hour deprivation 5.0 ± 8.7 crows. The results show a general effect of the treatment on crowing (randomisation test, $P=0.0014$), food deprivation has a highly significant effect ($P=0.0021$). The effect of food deprivation was a decrease in the number of crows in a sequence. Other vocalization parameters and other ways of influencing the condition are currently under investigation.

A cross-sectional study on compulsive behaviour (stable vices) in horses

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Nine Thoroughbred, nine Standardbred and fourteen Pleasure Horse Stables in southwestern Ontario with a total of 769 horses were surveyed by personal interview in a cross-sectional study on the occurrence of compulsive behaviour. Compulsive behaviour included cribbing, stall-walking, weaving, stall kicking, aggression to self, tongue playing, and pawing. Descriptive statistical analysis, chi-square analysis and logistic regression on individual level and stable level factors were performed for each of these behaviours.

Cribbing did not occur in Standardbred operations or in operations involved in breeding. Thoroughbreds were particularly prone to cribbing. Cribbing horses were given more exercise, but were turned out singly. Stall-walking was most prevalent in Arabians. Stall-walkers got turned out more but received less forced exercise, and were kept in operations with a lower percentage of standing stalls, than controls. Stall-kicking was most commonly performed by Warmbloods and in stables where animals had physical contact with each other. Weaving was most common in Thoroughbreds, and in stallions. Weavers got more turn-out than controls. In general, the prevalence of compulsive behaviour increased with age.

This research provides the first quantitative information on compulsive behaviour of horses in Canada. Differences between breeds suggest that there are genetic predispositions for compulsive disorder in horses. The results of the analysis of stable level factors are difficult to interpret. In many cases, the identified factors may not be causally linked to the disorder, but rather represent an attempt to treat the problem. To identify causal factors for compulsive disorder, a longitudinal study would be required.

A model for the application of science to animal welfare problems

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This paper proposes that applied research into animal welfare issues commits all of the classic errors identified in industrial innovation. As a result, applications are few and have limited impact upon animal welfare. The key features of successful industrial innovation are:

* Understanding the needs of application stakeholders and giving the innovation a strong market orientation;
* Thoroughly specifying and evaluating the innovation early in its development;
* Generating many innovative solutions at a conceptual level and selecting the best against the specification;
* Matching the skills of the development team to the technical and market requirements of the application.

It is proposed that these could be achieved in applied welfare-related research by means of:

* In-depth strategic planning and extensive exploration of potential applications at a strategic level;
* The rigorous use of specifications to focus and quality control research and development;
* The commissioning of integrated programmes of multi-disciplinary research, with the given objective of delivering the specified application.

Two examples of this approach are described.

Stress in farrowing sows: evidence from behaviour, the pituitary-adrenal axis and posterior-pituitary release of oxytocin

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The aim of this work was to provide an objective assessment of the effect of close confinement in crates on the welfare of farrowing sows. Different perspectives of the sows' state were taken by measuring behaviour, 'stress physiology' (ACTH; plasma cortisol) and 'reproductive physiology' (plasma oxytocin). Previous work has shown oxytocin (OT) secretion in the sow to be sensitive to disturbance at parturition; an effect that is opioid-mediated. Thirty-one Large White x Landrace gilts with implanted jugular catheters were introduced at 5 days before expected farrowing date into either conventional farrowing crates (C; without straw bedding), or farrowing pens (P; 2.5 x 3.0 m; straw provided). Blood samples were taken remotely by catheter extension at intervals dependent on the stage of parturition. Gilts received an injection (i.v.) of the opioid-antagonist naloxone (N; 1 mg kg^{-1} body weight) or a control dose of saline (S) at 7.5 minutes after the birth of the first piglet (BFP). The proportion of scans standing rose from 24 hours before BFP, peaking at approximately 7-8 hours pre-BFP in both treatments ($P<0.001$). C gilts had higher cortisol and ACTH concentrations than P gilts over the pre-farrowing period (e.g. plasma cortisol: overall mean: 41.5 vs. 30.7 ng ml^{-1} for C vs. P gilts respectively; $P<0.05$). Gilts receiving N showed an immediate rise in OT, and had sustained higher concentrations over the first hour after BFP (Period 1; overall mean: 299.3 vs. 157.3 pg ml^{-1} for N vs. S gilts respectively; $P<0.001$). There was no effect of farrowing environment on response to drug treatment over Period 1. There was, however, a tendency for C gilts receiving S to have lower concentrations of OT during hours 2, 3, and 4 of parturition (Period 2; $P<0.05$). The results indicate that crates without bedding: (i) stimulate the pituitary-adrenal axis over the 24 hours preceding farrowing, perhaps by preventing nest-building activity; (ii) induce a mild inhibition of OT in the later stages of parturition with potential implications for uterine function.

Integration of design methodologies and applied scientific research to provide practicable solutions to animal welfare problems

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This paper explores ways in which practicable solutions to welfare problems could be developed more effectively. A systematic, market-oriented design process will be introduced, proposing the introduction of four steps prior to commissioning applied behavioural/biological research:

1. Identification of the "market pull" (or "legislative push") for welfare solutions and examination of existing knowledge of the problem via multidisciplinary sources.

2. Preparation of a comprehensive design specification providing statements of all qualitative and quantitative criteria that the welfare solution should meet, based on the demands and wishes of all "stakeholders", e.g. farmers, stockmen, animals, legislators, manufacturers, retailers, consumers etc.

3. Generation and exploration of maximum number of possible design solutions to the problem at a concept level (the level of thinking involved with general principles of design) and then systematic selection of these ideas using evaluation criteria derived from the design specification. This provides an early formal means of eliminating those potential solutions that might have harmful welfare side-effects or are either commercially or legislatively non-viable.

4. Identification of scientific research needed to refine the specification, validate concepts or deliver targeted solutions.

This approach will be explored by means of an historical review of Tauson's work on battery cages involving the application of design techniques and methodologies, e.g. product function analysis to evaluate the hierarchy of cage functions, failure modes and effects analysis (FMEA) to anticipate the trapping of birds, value analysis (VA) to analyze perches etc. This aims to illustrate how similar welfare problems could be tackled more systematically in order to speed up development, implement research results and improve the quality of applications to achieve optimum solutions within defined practical, legislative and commercial constraints.

A comparison of physical and pharmacological treatments for stereotyped behaviour in the horse

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Crib-biting and weaving are two of the most common stereotyped behaviours performed by horses. Both can cause clinical problems; strained ligaments and severe tooth wear with loss of condition, respectively. Traditional treatment has depended on anti-weave bars and the crib-strap, but research has shown that opiate antagonists may be an alternative (Dodman *et al.* 1987, *Am. J. Vet. Res.* 48: 311). The aim of this study was twofold; to compare traditional methods to the use of the opiate antagonist, naloxone, and to compare baseline levels of behavioural and physiological parameters between control, crib-biting and weaving horses. Abnormal behaviour, aspects of normal behaviour, plasma levels of beta-endorphin and heart rate were measured in 11 horses; 4 control, 4 crib-biters and 3 weavers. The treatments were Saline control (5 ml saline I.V./hr), Crib-strap (crib-strap worn, 5 ml saline I.V./hr), Anti-weave bar (anti-weave bar in stall, 5 ml saline I.V./hr), Naloxone (0.2 mg/kg naloxone I.V./hr). The treatment period was for 12 hours. Control horses received all treatments, Crib-biting horses received all except the Anti-weave bar and Weaving horses all except the Crib-strap. Both stereotyped behaviour and aspects of normal behaviour were measured using time-lapse video equipment. Plasma beta-endorphin was measured at 20 minute intervals by taking a blood sample into a glass EDTA vacutainer from the nearside jugular vein catheterised 2 hours prior to treatment. Samples were centrifuged immediately and stored at -20°C until analysis by radio-immuno assay. Heart rate was measured at 3 hourly intervals for 2 hours using a Polar Sports Tester. Naloxone was administered into a catheterised off-side jugular vein at 0.2 mg/kg/hr. Data was statistically analyzed using a paired sample t-test and one-way analysis of variance. Results showed that crib-biting was reduced by both the naloxone and the crib-strap; this was significant only for the latter ($P<0.1$). Weaving was apparently unaffected by either naloxone or the anti-weave bar. Naloxone was found to significantly increase resting in crib-biters ($P<0.05$). The crib-strap was found to significantly increase 'Non-alert' behaviour ($P<0.01$), significantly decrease 'Alert' behaviour ($P<0.1$) and significantly increase plasma levels of beta-endorphin ($P<0.05$) in control horses. Baseline levels between groups were not found to differ for any of the parameters measured.

Use of animal behaviour in equipment design and evaluation

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A survey of equipment manufacturers of pig equipment in Europe and North America indicated that many products proceed from the concept stage to marketing in less than six months. Few of those involved in equipment design have had formal training in animal behaviour, and equipment is not extensively tested before being introduced onto commercial farms. There is a need for the interpretation and dissemination of research results concerning pig biology, including ethology, during the design stage and the evaluation of prototypes. To assist manufacturers in product design, Danske Slagterier has started providing manufacturers with data regarding anatomic dimensions of different pig categories as well as relevant data on pig behaviour. Danske Slagterier also evaluates such equipment on commercial farms, but only after it is being marketed. The evaluations emphasize production parameters, but also include examination of the pigs for injuries and of the equipment for hygiene at 2-wk intervals. Behavioural observations are limited, but have revealed that if feed agitators cannot be moved, more pigs queue for feed and aggression increases. The Prairie Swine Centre has conducted a study of 12 commercial feeders, including wet/dry, dry, single and multiple space models. Pigs eat 5% more from wet/dry feeders than from dry. In preference tests, pigs prefer feeders with easy access to feed, which do not use a feed agitator. The results of these studies have been reported to the manufacturers in order that they might aid in the design of new products. As a result of these studies, manufacturers have modified the location of agitators and height of feeding shelves. There remains a need for a rapid and affordable system of testing equipment prior to marketing. Because of industrial time constraints, such evaluations are likely to rely on behavioural observations, rather than long term production studies.

Changes in thermal threshold, heart rate and plasma ß-endorphin associated with cribbing behaviour in horses

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A device for telemetric measurement of thermal stimulus perception using the forelimb withdrawal reflex has been developed. Cribbing horses (n=11) were observed in their home pens using a video system and thermal threshold measurements took place without direct visual contact before and during cribbing sequences. Heart rate was recorded continuously. Blood samples were collected in the cribbers before and after cribbing sequences as well as in age- and sex-matched control horses with no history of stereotypic behaviour (n=11) and plasma ß-endorphin was measured using radioimmunoassay.

Thermal threshold was significantly lower when horses were cribbing (Wilcoxon matched pair t-test, z=-2.93, P=0.003). The mean difference between basal and cribbing values was 4.9°C. Heart rate decreased significantly during cribbing sequences (Wilcoxon matched pair t-test, z=-2.22, P=0.026) when compared to basal values. The mean difference was 2.4 bpm. Basal plasma ß-endorphin levels in cribbers were significantly higher than those in control horses (49.5 vs. 16.2 pmol/l, Mann-Whitney U test, z=2.73, P=0.006). Within the cribbers no significant difference in ß-endorphin levels was found between basal and cribbing samples.

The decrease in thermal threshold and heart rate observed during cribbing sequences in horses supports findings in other species, whereas the higher plasma ß-endorphin level in cribbers is in contrast to previous work done in horses. However, the results reported here demonstrate that cribbing behaviour was associated with increased basal plasma ß-endorphin levels and its' performance had measurable effects on physiological parameters that could give evidence for some dearousal quality of this stereotypic behaviour pattern.

Implications of semi-intensive management on the breeding of Black Rhino (*Diceros bicornis*)

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Because of the danger of extinction it is imperative that the remaining black rhino breed successfully. This study involved a group of 7 orphaned, eight year old individuals kept on Imire Safari Ranch in Zimbabwe. The rhino were managed semi-intensively: they were penned between 1700 and 0700 and herded by armed guards whilst browsing away from the pen between 0700 and 1700. Female black rhino reach sexual maturity by seven years and although all four of the females had been showing behavioural signs of oestrous over the last year and were cycling regularly only one was pregnant. The purpose of this study was to investigate why all of the females were not breeding. Their maintenance, proximity and social behaviour was observed, both during the day and for the first hour of being penned at night in January 1996. The rhino spent 16.5% of the day standing, 19.2% walking, 22.5% browsing and 28.2% grazing. Preliminary analysis of the proximity data (1752 observations) indicates that first, there are clear associations between certain individuals and second, some individuals prefer to be further away from the other rhinos than others. Of the 1778 social interactions recorded over 405 rhino hours during the day only 7% were aggressive and 5% submissive, whilst 46 % were affiliative. A higher proportion of the interactions recorded over the 105 rhino hours observed during the first hour of penning at night were aggressive than when out during the day. Closer inspection indicates that the individuals who were not breeding were involved in many of the aggressive-submissive interactions. It is suggested that these individuals are being stressed by the current management system and have become 'psychologically infertile'.

Further analysis of the behavioural data will facilitate modification of the management of this group of rhino by taking into account the preferences and requirements of each individual.

Stereotypic behaviour in circus elephants and the effect of "anticipation" of feeding, watering and performing

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The behaviour of 17 mature elephants (14 Asian, 3 African) who performed two shows each day with a circus that travelled to at a new location (50 to 200 km from the previous day's lot) daily was studied. When not performing or working, the elephants were picketed in the traditional fashion in two separate groups of 8 and 9 elephants each. While they were picketed, a separate camera and time-lapse recorder videotaped the behaviour of four members of each group from approximately 1100 h until darkness over four days (67.25 h of observations). The behaviour of each member of the focal groups was recorded at 5 min intervals. Stereotypic weaving comprised 46, 31 (an African), 28, 23, 17 (an African), 5.3, 0.0 and 0.0 percent of the observations. During bouts of weaving, the elephants still performed a wide range of behaviours with their trunks, including eating and throwing feed or soil. Stereotypic head bobbing (the next most frequent stereotypic behaviour) was performed by the elephants who did not weave and accounted for 16% and 8.2% of the observations for those elephants. Stereotypic bumping of objects or other elephants, trunk tossing, pawing, and chain pulling accounted for 0.9% or less of any elephant's observations. Stereotypic behaviour greatly increased during the 15-min period immediately prior to feeding, watering and performing (when compared to their frequency during the three preceding 15-min periods) indicating that anticipation of certain events is a major stimulus of stereotypic behaviour in these elephants.

The birthing room: accommodation and behaviour in periparturient gilts

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Farrowing crates are designed to restrict a sow's movements in order to reduce piglet overlying (crushing); however, their effectiveness in protecting piglets has been questioned. The use of crates alters maternal behaviour and may compromise sow welfare.

A study was designed to elicit the effects of gestation and farrowing accommodation on gilts' locomotory behaviour and maternal responses. It was hypothesized that increasing available space in farrowing accommodation would allow easier movement and facilitate gilts' comfort and maternal responsiveness. Twenty-four gilts were allocated to either a stall or small group during gestation, followed by either a narrow crate (42.5 cm wide), wide crate (80 cm wide) or pen (2.4 m x 2.4 m) for farrowing and lactation. Maternal responsiveness (as measured by a simulated piglet overlying event) was variable between gilts and was not affected by accommodation. Twenty-four hour time budgets of body postures (standing; sitting; lying laterally; lying sternally) showed the major determinant of posture to be phase of gestation or lactation ($P<0.01$); farrowing accommodation also affected posture, with prepartum gilts housed in wide crates spending less time lying laterally ($P<0.05$), more time lying sternally ($P<0.01$), and displaying more bouts of lying ($P<0.01$) than other prepartum gilts. This effect was more pronounced after gestation in groups; gilts in the wide pen that had gestated in groups lay sternally for more time and in more bouts ($P<0.01$) than those previously stalled. Gilts took longer to lie down ($P<0.05$) and were less consistent in their use of the crate side during lying ($P<0.01$) in the wide crate than either the narrow crate or pen. However, time taken to lie down by gilts in the wide crate was not affected by use or non-use of the crate side during lying.

A widened farrowing crate did not facilitate movement, and appeared less comfortable before farrowing than a narrow crate or pen. The wide crate provided neither the support and apparent security of a narrow crate, nor the freedom of movement of a pen.

The use of artificial-life in the study of social and spacing behaviour of confined animals

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We are using computer generated models of animals (called animats) to gain an understanding of various problems associated with the spacing and social behaviour of confined animals. Starting 25 years ago, questions about random spacing patterns of animals in pens of different shapes led to the development of computer simulated "animals" that were simply static points (Cartesian coordinates) to represent head location and vectors to represent their orientation. As a component of these simulations, a Fortran program called DISTANGLE (an acronym from distance and angle) was developed and later used in a variety of studies, including an investigation of the influence of solar radiation on orientation of steers in winter feedlots of western Canada. Over a period of the past 5 to 6 years, Zhou has developed 2-dimensional animats with movement and selfish and goal directed behaviour. More recently, we have worked toward developing increasingly realistic animats using tools common in artificial-life and computer vision research. Time-lapse video sequence recordings of pig movements are automatically analyzed by computer to extract movement patterns of pigs in various experimental pen designs. These data are being used to train simple neural network models to behave in a manner similar to real pigs. With more sophisticated animats, we will later evaluate different experimental pen designs through simulation. Once the model reliably predicts the usefulness of novel pen designs, it will be used to assess the fitness of "genetically" defined pens in an attempt to evolve increasingly welfare positive housing for agricultural animals. We propose that artificial-life methodologies may become increasingly useful tools to researchers in applied ethology.

Individual differences and housing effects on the response of sows to weaning

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Piglets' responses to weaning have been well investigated but the reaction of sows to the sudden removal of their young has received little attention. We compared the immediate post-weaning behaviour of 40 sows which had been housed during lactation in either (1) a pen where the sow and litter were confined together, or (2) a "get-away" pen where the sow could leave the litter at will by stepping over a piglet-proof barrier. Sows in get-away pens varied greatly in the amount of time they spent away from their piglets. For analysis, get-away sows were divided into either (1) "leaver" sows which spent more than 50% of their time away from their litter, or (2) "stayers", which spent less than 50% of the time away. Stayer sows reacted most strongly to weaning, followed closely by confined sows, while the leaver sows gave the least response. All sows gave characteristic post-weaning vocalizations of long duration and low frequency. These vocalizations were more common ($P<0.05$) and of greater duration ($P<0.05$) for stayer sows. Stayers also moved more, and investigated the piglet creep area more often and for a greater duration. When played a recording of piglet vocalizations, stayer sows again gave the strongest response and leavers the least. The results suggest that there are strong individual differences between sows in maternal responsiveness; those that voluntarily spent the most time with their young appeared most distressed when the young were removed.

The influence of group size and floor area space on social organization of growing-finishing pigs

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The complexity of social organization of growing-finishing pigs housed in six group sizes and three levels of floor area space allowance was determined from observations of agonistic encounters. Group sizes (GS) were 3, 5, 6, 7, 10 and 15 pigs per pen. Space allowances (SA) were 0.030, 0.039 and 0.048 $m^2 \times BW^{0.667}$. All pens were square. Pigs were weighed (initial mean wt = 25 kg) and size of pens adjusted at 2-wk intervals, with pen adjustments made on the basis of predicted weights for the group at the mid-point of the next weigh period. Two replicates of the study were conducted. Average daily gain was reduced with increasing GS (899, 851, 868, 872, 857 and 821 g, respectively), which is consistent with results from previous studies. Agonistic behaviour (fights, bites, and head knocks) was recorded for 20 min/pen 5 days each week during the 12-week study and was used to determine the hierarchical social structure for each group of pigs. On the basis of the number of transitive relationships (TR), each hierarchy was then classified as linear (L), linear tending (LT) or complex (C), according to the following scale: L = 0; LT = 1/5, 1/6, 1/7, 2/10 or 3/15; and C ≥ 1/3, 2/5, 2/7, 3/10 or 4/15, where the numerator = TR and the denominator = GS. Using these criteria, social complexity showed a strong tendency to increase with GS and a slight tendency to increase with SA. Mean number of agonistic encounter per pig was not influenced by SA but was influenced ($P<.05$) by GS (8.1, 14.7, 18.9, 16.0, 16.3 and 12.0 encounters, respectively) with no significant interactions. A better understanding of factors related to social organization has the potential of improving efficiency of production and to enhancing the welfare of the animals.

The effect of feed type and location on the voluntary attendance to, and the behaviour in, an automatic milking system

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There are two opportunities to feed cows in an automatic milking system (AMS); 1) in the parlour during milking (concentrate), or 2) in the AMS exit area (forage or concentrate). In each case the cows have to pass through the system from the bedded area to access the food. Fourteen dairy cows were allowed to visit the system for 15 hours/day for three eight day periods. A visit to the AMS resulted in compulsory milking if the interval since last milking was greater than four hours. In period one, the cows were fed forage in the exit area and concentrate in the bedded area. In period two they were fed concentrate in the exit area and forage in the bedded area. Period three repeated period one. The cows were also divided into two groups, one was fed concentrate (1 kg) when milked, while the other was not, in each period in a cross-over design. The behaviour of these two groups during milking was recorded. Visits/cow per day increased from 4.10 to 5.96 (s.e.d=0.25, $P<0.05$) when fed forage vs. concentrate in the exit area. Milkings/cow per day were only slightly different (2.6 vs. 2.4, s.e.d=0.06, $P=0.05$). Feeding forage in the exit area reduced the number of forage feeding bouts from 7.6 to 5.1 bouts/cow per day ($P<0.02$) compared to feeding forage in the bedded area, and reduced the total forage feeding and lying time (209 vs. 289 minutes/cow per day, s.e.d=33.6, $P=0.03$; 529 vs 620 minutes/cow per day, s.e.d=43.1, $P=0.05$, respectively). There were no effects, on attendance, of feeding during milking, but it did increase the level of shuffling (6.7 vs. 3.4 shuffles/cow per attachment, s.e.d=2.07, $P=5.3\%$). Concentrate rather than forage should be fed in the exit area of an AMS, since the latter may adversely affect forage feeding behaviour. Feeding during milking did not improve attendance or behaviour in the milking stall.

Group size and anti-predator behaviour in domestic fowl

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To test the hypothesis that domestic fowl perform less anti-predator behaviour with increasing group size, we reared pullets in four replicate groups of 15, 30, 60 and 120 birds (density 5 birds per m^2). Each pen contained perches 20, 40 and 60 cm above the ground (10 cm perch space per bird, 0-12 weeks, and 20 cm, 12-18 weeks). We predicted that, with increasing group size, birds would (1) use perches less, (2) use the highest perches less, (3) preen more on the floor, (4) lie more on the floor and (5) dust bathe more. We also predicted that (6) perch use would increase with increasing age. The following significant results ($P<0.05$) were obtained by scan and focal sampling. Perch use decreased with increased group size up to 9 weeks of age. Perch use increased with perch height. The highest perch level was used most in 60-bird groups and least in 15-bird groups. Preening on the floor increased with group size. Birds in 120-bird groups spent the most time lying on the floor. Time spent dust bathing was higher in the 15- and 120- bird groups than in the other groups. Perch use increased with age. Birds in the largest groups made the most transitions between floor and perches, possibly using perches to avoid other birds. Our results are consistent with predictions 1 (up to 9 weeks), 3, 4 and 6, lending support for the hypothesis that group size influences anti-predator behaviour despite domestication and protection from predators.

Environmental requirements in mink (*Mustela vison*)

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Mink are naturally active, semi-aquatic carnivores with several nest sites. On fur-farms they are housed in wire cages with food, water and a single nestbox. The importance of other resources to mink can be assessed by imposing a cost on their acquisition. We individually housed six mink in closed economy test arenas: farm cage with access to seven compartments each containing one of seven resources. These were: a haybox; a water bath; a raised observation platform; a familiar object (same each day); a novel object (changed each day); prey-like objects; and an empty compartment. A cost was imposed on each resource by weighting the one-way indoor by 0, 250, 500, 750 or 1000g. The one-way outdoor was unweighted. Each mink's behaviour was recorded from 0800h to 1600h for each doorweight. Without weights, mink spent 30% of the observation in their home cage, 50% with the hay, 10% with both the bath and novel object, 5% with toys, 3% with the platform and less than 1% with the empty cage or the familiar object. Increasing cost had no effect on use of the home cage, but reduced the number of visits to all other cages (Regression; $P<0.05$). Total time spent with the hay, bath and novel object did not, however, decline since mink made longer visits, whilst time with toys, familiar object, platform and empty cage did decline with door weight (Regression; $P<0.001$). This suggests that the hay, bath and novel object were more important than the toys, familiar object, platform or an empty compartment. Further work will more finely discriminate between resources by increasing door weight further until the use of each resource is abandoned.

Social preferences in laying hens

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An experiment was conducted to determine if laying hens show active preferences for particular companions. Hens (N=24) housed in floor pens each containing 6 birds were used. The hens had been housed in these groups for approximately one year prior to the study. Each hen was tested 3 times (1 hr/per trial) in a six-armed preference testing apparatus, each arm of which ended in an enclosure that could contain one hen. A hen was placed in the center, and her flockmates randomly distributed among the arms. An empty arm served as a control for non-social exploration. On average, hens spent 32.1% of their time in the arms, although this decreased across the trials ($P<.001$). Almost all hens visited the empty arm, but spent significantly ($P<.05$) less time there (2.6%) than in the occupied arms (5.9% per arm). Distribution of time in the occupied arms was non-random; most hens showed clear preferences for particular individuals. There was no relationship between a hen's social rank and the time that other birds spent in her proximity, or between rank and time spent in the center or empty arm. Preferences were generally not reciprocated, since the average rank preference difference within a dyad was 2.1, a value similar to that expected by chance (2.5). Instead, one or two hens in a group were typically preferred by most hens, while one hen was rarely approached. These results will be discussed with reference to social and spacing behaviour in hens.

Effect of housing type on canine behaviour and adoptability

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Laboratory dogs were observed in three environments: 1) in runs with wood shavings as bedding (n=15), 2) in runs with no bedding (n=18), and 3) in stainless steel cages (n=13). The activity patterns and incidence of stereotypies, pacing, and circling were recorded. The dogs were videorecorded for 12 hours/day. In all cases, instantaneous sampling was done each minute. The highest levels of circling, 15 min/hr, were recorded for dogs in runs with bedding, followed by dogs in stainless steel cages, 10 min/hr, and dogs in runs without bedding, 2 min/hr ($F_{2,43}$ =19.78, $P>0.0001$). There was also a significant difference in pacing with caged dogs pacing 1 min/hr, dogs in runs without bedding pacing for 4.3 min/hr and dogs with bedding pacing 4.6 min/hr ($F_{2,43}$ =34.83, $P<0.01$). When given a one choice preference between two types of resting surfaces, a metal grate or a plastic hammock, the dogs showed no preference (paired t-test, t = 0.8, $P>0.05$).

Laboratory dogs were adopted as pets. Most dogs were adopted before they were 3 months old. The three most prominent breeds were beagles, golden retrievers and Labrador retrievers. At least six months after adoption, the owners were contacted and asked a series of questions about the dog and its behaviour problems initially or at the time the owners were contacted. The behaviours of interest were destructiveness, house-soiling and aggression. The relation of breed to the frequency and type of behaviour problem was determined. Seventy-four dogs were adopted. Of these, 67 or 90% were successful, in that the original adopters had kept the dog, and 90% of the adopters recommended a laboratory as a source of a pet. The most common initial problem was housebreaking (88%) but most (87%) were not house-soiling six months after adoption. Beagles were significantly more likely to housesoil than retrievers (χ^2 = 6.68, $P<0.05$).

Social preferences in adult female swine

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Twelve sows and 14 mature gilts were used individually as focal animals to determine if they preferred social isolation versus joining an unfamiliar social group. Subjects were trained to pass back and forth through "sow-operated gates", designed to be inoperable to untrained pigs. The preference arena was made up of 3 equal-sized compartments, separated by the gates. One compartment contained 4 pigs grouped at the start of the test, the second contained an established stable group of 4 pigs (also unfamiliar to the focal pig) and the third was empty and accessible only to the focal pig . During a 72 h period the time the focal pig spent standing, lying, drinking and fighting in each compartment was recorded. Ten of 12 sows and 10 of 14 gilts spent most time in social isolation ($P<0.05$). Gilts which showed a preference for social isolation won only 1 of 37 fights. However, the 2 gilts which spent most time with the established group won 19 of 21 fights. The remaining 2 gilts did not display a preference. Sows that remained in social isolation won 6 of 31 fights; sows which joined a group won 5 of 11 fights. Thus, the observed preference to remain in social isolation may not be solely determined by the focal pig, but could be regulated by the group pigs' ability to expel strangers. Perhaps the focal pigs were not seeking isolation, but rather freedom from aggressive attacks. Placing a sow or gilt into a group of unfamiliar animals may be as great a welfare concern as keeping her restricted in a gestation stall where she is protected from aggressive encounters.

The influence of sow lying behaviour on piglet mortality in an open farrowing system

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Research on alternatives to farrowing crates is driven by concerns about sow and piglet welfare but open systems place greater reliance on the maternal behaviour of the sow. The objectives of this experiment were to determine what behaviours of the sow influenced piglet mortality in an open farrowing system comprising five farrowing pens, with a communal passageway and an outdoor dunging area accessible only to the sows. The behaviour of 24 Large White x Landrace sows was recorded using time-lapse video for 7 days post-farrowing. All dead piglets were autopsied to determine primary cause of death. The behaviours recorded were the total time taken to lie down, the amount and type of pre-lying behaviour and the position of the sow in the pen when she lay down. A total of 1165 lying down events were analyzed. Crushing accounted for 50 of the 63 piglet deaths recorded. Percentage litter mortality was positively correlated with the proportion of times the sow lay down dangerously in the middle of the pen ($r=0.44$, $P=0.033$) and negatively correlated with the amount of rooting ($r=-0.44$, $P=0.031$) and looking ($r=-0.48$, $P=0.019$) directed at piglets before lying down. When time taken to lie down was plotted against the total amount of pre-lying behaviour and divided into four quadrants on the basis of median values, the risk of crushing was clearly least in the quadrant where the sow carried out much pre-lying behaviour then lay down quickly ($\chi^2=10.01$, $P=0.002$). These results emphasise the importance of the maternal behaviour component in the production success of this open farrowing system.

Mixed-sex rearing influences hen reproductive biology

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Domestic fowl are different from many other birds because the hens do not require male courtship to begin laying eggs. However, stimuli from males can influence hens' sexual maturation and sexual behaviour. In one study, flocks of fifty medium-hybrid hens were reared with or without roosters from one day of age. The birds received 14L:10D lighting throughout. Hens with roosters came into lay one week sooner than hens without, resulting in more eggs laid early on. Hens with roosters laid 23.4 ± 0.05 eggs/hen up to 22 weeks of age compared with 17.9 ± 0.06 eggs/hen for hens without ($P<0.05$). Comb size was also greater in hens with roosters ($P<0.05$). In our second study, groups of ten hens were reared either with roosters, adjacent to roosters or without roosters from one day of age. Hens reared with males had larger combs ($P<0.05$) and began to lay eggs earlier ($P<0.05$) than hens without. Living adjacent to males, with only visual and auditory contact, was just as effective for stimulating sexual maturation as was direct contact with roosters. Tests for sexual responsiveness toward humans indicated that over 80% of hens without males or adjacent to males assumed a sexual crouch during handling while less than 20% of hens living in direct contact with roosters crouched during these tests ($P<0.001$). The degree of contact with males has a differential effect on the hens' physiology and sexual behaviour.

Influence of unsuccessful nursings on piglets' milk intake and weight gain

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In this paper we focus on the hypothesis that unsuccessful nursing (nursings without milk ejection) stimulate the milk production. In two experiments, we investigated the effect of additional massage during unsuccessful nursings on milk intake by the piglets. In Experiment 1, it was examined whether additional udder massage accomplished on 2 teats during an unsuccessful nursing influenced the milk intake from those teats during subsequent successful nursing. Milk intake was estimated by the weigh-suckle-weigh method. At the age of 8 to 12 days, 8 sows were forced to nurse every 70 minutes three times. Between the nursings, 2 piglets had an additional possibility to massage their teats for 10 minutes. These piglets massaged their teats 7 min during the first unsuccessful nursing and 8 min after the second unsuccessful nursing. However, the additional massage on the two teats had no influence on milk output from those teats on subsequent nursings. The change in milk output between the first and the two following nursings was not significantly different in teats which had received the additional massage from that in teats without this manipulation (Wilcoxon matched-pairs signed-rank test, n.s.). However, there was a trend for the milk output to increase in the teats which received additional massaging. In Experiment 2, we tested whether additional udder stimulation by the whole litter during repeated unsuccessful nursings affects milk production over a period of 24 hours. On day 7 or 8 post partum sows were forced to nurse every 70 min for a period of 24 hours. In half of the sows, additional unsuccessful nursings were induced 15 minutes after each successful one. The total duration of udder massage was considerably longer in group MIN70+15 (median 259 min vs. 165 min, Mann-Whitney U-test, $P=0.005$). Nevertheless, the weight gain during the whole 24-hour-period was the same in both groups (140 g vs. 144 g, t-test, n.s.). Both groups had nearly the same decrease in weight gain during the 24-hour manipulation of nursing rhythm in comparison with the weight gain during a unmanipulated period 24 h one day before (group MIN70+15 decreased 28% and group MIN70 decreased 32%, t-test, n.s.). Our results suggest that additional massage provided during unsuccessful nursings does not induce higher milk output per milk ejection, either locally or systemically. This conclusion brings us back to the initial intriguing question: Why do piglets perform and why do sows allow this time- and energy consuming, but seemingly unproductive, behaviour? Several answers are suggested in the discussion.

Using video images to study social recognition in laying hens

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Video images have previously been used successfully as social stimuli in fowl; to elicit social facilitation of feeding (Keeling and Hurnik, 1993, *Appl. Anim. Behav. Sci.* 36: 223) and as audiences to elicit alarm calling with an overhead model predator (Evans and Marler, 1991, *Anim. Behav.* 41: 17). In this study, the suitability of video images for studying discrimination between flockmates and unfamiliar birds in the domestic hen (*Gallus domesticus*) was investigated. With live birds behind clear perspex as stimuli, hens showed higher latencies to begin feeding near unfamiliar conspecifics than flockmates (medians: familiar 149.7 s, unfamiliar 300 s), and also discriminated between dominant and subordinate flockmates (median feeding latency: high rank 113.1 s, low rank 13.8 s). When life-size colour video sequences of the same birds were substituted however, there was no discrimination on the basis of either familiarity (medians: familiar 43.6 s, unfamiliar 53.5 s) or rank (medians: high rank 19.6 s, low rank 16.2 s), although hens took longer to begin feeding near to videos showing hens with a threat-like posture than hens with normal posture (medians: normal 46.5 s, threat-like 300 s). In a second video experiment, hens again failed to discriminate flockmates from unfamiliar birds (feeding latency medians: familiar 45.3 s, unfamiliar 41.6 s). Behavioural observations showed that in early trials, subjects appeared to attend to the stimulus and occasionally moved in synchrony with the video bird or pecked at its head. In later trials these responses were never seen, and hens approached the screen more readily. Despite these behavioural changes, discrimination of flockmates from unfamiliar birds was not found at any stage. Various possible reasons for the hens failure to discriminate between familiar and unfamiliar conspecifics on video are discussed, and the findings contrasted with other published work in which videos were shown to be adequate substitutes for social stimuli in fowl (*Gallus sp.*).

Control of the thermal environment: influences of operant heat on the well-being of weaned pigs

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An ability to exert control over the environment is thought to enhance well-being. The current study aimed to improve our understanding of the effects of providing control over temperature on intensively housed pigs. A yoked-design experiment (n = 6 pairs per treatment) was conducted. Treatment group (O) controlled the arrival of 5 minutes of heat reinforcement, while a second group (Y) was yoked to O and received identical reinforcement non-contingently. A third treatment group (C) acted as the control and received continuous heat. Experimental conditions were imposed for two weeks, during which time behaviour in each group was recorded. The percentage of time spent engaged in aggressive, locomotory (run, walk, stand, sit), redirected (belly-nose, root, tail/ear-chew), play and maintenance behaviours did not differ significantly between treatments. However, O appeared to be in more thermal discomfort, spending longer lying in a sternal posture (52.4 ± 5.4 cf. 33.5 ± 4.4 per cent, $P=0.0038$) and huddled while lying (70.6 ± 2.3 cf. 29.8 ± 7.7 per cent, $P=0.0061$) when compared to C. Individual pigs were tested in an open-field arena both before and after experiencing the experimental condition. There was no evidence to suggest that experience with control ameliorated the stress experienced during this procedure. Activity level, response to a novel object, defecation, vocalization and heart rate were all non-significant between treatments. The provision of control in the current experiment thus appeared neither to enhance nor compromise well-being. There were no detectable beneficial effects on behaviour attributed to control per se.

Assessment in pig conflicts

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The most potent stimulus for eliciting aggressive behaviour in pigs is an unfamiliar individual. What kind of information does a pig need about a stranger in order to stop fighting? In two experiments, the role of asymmetries and pre-exposure to strangers were investigated in light of the Sequential Assessment Game (SAG). The experiments were performed on pigs aged from five to eight weeks. Altogether about 150 paired encounters were analyzed. In accordance with SAG, asymmetries were important for the outcome of the conflicts. More than 90% of all encounters were won by the resident in a resident-intruder set-up. In a neutral arena, more than 90% of the meetings were won by the larger pig. Also in consistence with SAG, 24 h of visual, auditory and olfactory pre-exposure reduced the initial nosing phase in the following encounter and hence shortened the latency till full fight, as well as the total contest length. However, contrary to the predictions of SAG, a weight difference of about 20% did not shorten the contest length. We conclude that stranger-induced fighting can be explained by a need in pigs to assess relative fighting capacity. However, information that does not involve physical contact seems not to be effective in such assessment in pigs.

Using observation, strain gauges and load cells to objectively measure the behavioural response of cattle to a routine management procedure (branding)

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Three hundred feedlot steers (320±2 kg) were assigned to freeze-brand (F), hot-iron brand (H), or control branding (C) treatments according to a randomized branding order. Behaviours believed to be indicative of pain (tail-flicking, kicking, falling and vocalizing) were recorded during branding. Escape behaviour, measured as the amount and duration of force exerted on the headgate and squeeze by the animals during restraint, was obtained using load cells and strain gauges. Subsequent handling-ease was also tested every second day for 10 d by recording the time and handling pressure required to move animals into the chute. H steers had higher tail-flick, kick, fall and vocalization frequencies than F or C animals ($P<0.005$), while F animals only had higher tail-flick frequencies than controls ($P<0.005$). The average and maximum exertion forces as well as the duration of force were greater in H than F and C steers ($P<0.001$); F steers had greater values than controls ($P<0.001$). No treatment differences in handling-ease were observed. However, all steers required more handling pressure up to d 6, indicating handling, in itself, was aversive. Results indicate that H steers experienced more discomfort at the time of branding than F and C steers, while F steers experienced more than controls. This objective method of quantifying the behavioural responses of animals during branding could be a valuable tool for the comparison and assessment of other routine management procedures such as castration and dehorning.

Dynamics of aggression in the domestic fowl

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To investigate aggressive competition for food, layer pullets were reared in groups of 15, 30, 60 and 120 in four replicate pens/group size (GS). Pens were 3, 6, 12 and 24 m^2, respectively (5 birds/m_2). At 11, 19 and 21 weeks (Experiments 1-3, respectively), birds were offered an attractive food in two cups, one in the pen centre (Cup C) and one by the wall (Cup W), and the number of agonistic interactions occurring in a 0.5 x 0.5 m area around each cup was recorded for 15 minutes. In Experiment 1, controlling density (D), birds were tested in their home pen. In Experiment 2, controlling pen size (PS) and social experience (SE), the 120-bird groups were temporarily divided into groups of 15, 30 and 60 (on 1 day only) and tested in their home pen. In Experiment 3, controlling GS, PS and D, groups of 15 birds from each pen were tested in a 24 m_2 pen. More aggressive pecks occurred around the central than the peripheral food cup in Experiment 1 (Cup C, 2.5 ± 0.56; Cup W, 2.1 ± 0.58; $P<0.05$) and Experiment 3 (Cup C, 6.4 ± 1.05; Cup W, 2.9 ± 0.57; $P<0.01$) although not in Experiment 2 ($P>0.05$). In Experiment 3, there were also more threats given at Cup C (11.8 ± 1.63) than Cup W (6.7 ± 1.24, $P<0.05$). Previous SE in different group sizes did not affect the level of aggression in 15-bird groups (Experiment 3; $P>0.05$). The relationship between GS and aggressive interactions was complex. Aggressive pecks decreased with increasing GS in Experiment 1 (3.3 ± 0.60, 3.5 ± 1.04, 0.7 ± 0.44, 1.7 ± 0.17, for groups of 15, 30, 60 and 120 birds, respectively; $P<0.05$) and increased with increasing GS in Experiment 2 (1.4 ± 0.38, 5.8 ± 1.30, 8.125 ± 2.83, for groups of 15, 30 and 60 birds respectively; $P<0.05$). The total frequency of aggression (pecks, threats, chases and avoidances combined) also increased with increasing GS in Experiment 2 (8.0 ± 2.70, 17.8 ± 2.83, 20.8 ± 4.48, for groups of 15, 30, and 60 birds, respectively; $P<0.05$). However, a per minute analysis for Experiments 2 and 3 indicated that the frequency of agonistic interactions tended to be inversely related to the actual number of birds around the cup independent of the GS in the pen (Pearson Correlation Coefficients - Experiment 2: Cup C (n=60), threats, r=-0.503, $P<0.001$; avoidances, r=-0.330, $P<0.01$, Experiment 3: Cup C (n=225), threats, r=-0.138, $P<0.05$, avoidances, r=-0.158, $P<0.05$. The results suggest that aggression in the domestic fowl is a dynamic process involving bird assessment of the cost-benefit balance.

Training Antelope to Cooperate with Veterinary Procedures

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Traditional methods of manual restraint or immobilization of antelopes with pharmaceuticals result in both behavioral and physiological signs of stress. Nyala and bongo antelope at the Denver Zoological Garden have been successfully trained to cooperate with veterinary procedures. Highly palatable treats which were not part of the animal's diet were used to entice the animals to enter a plywood box equipped with remote controlled vertical slide gates on each end. After the bongo were trained, very low cortisol levels near baseline were obtained. For three animals, the levels were 6, 8.5 and 4.5 ng/ml after they had stood in the box for 20 min. These crate conditioned bongos had much lower cortisol levels than those reported in the literature for restrained deer or cattle (values for manually restrained and deer darted with ketamine, 45.3 ng/ml and 55.6 ng/ml, respectively; domestic cattle restrained in squeeze chutes, 25 to 63 ng/ml). The cortisol levels in crate conditioned bongo were at almost the baseline values reported for cattle (2 to 9 ng/ml) and bighorn sheep (5 ng/ml). Creatine phosphokinase (CPK) levels for four bongos averaged 71 I.U. in trained animals and 288 I.U. in immobilized animals. Comparisons of crate conditioned glucose levels to glucose levels obtained from the bongos' medical records indicated that crate conditioned animals had much lower values (61 mg/dl in crate conditioned and 166 mg/dl in immobilized). The glucose and CPK levels in crate conditioned animals were also much lower than values reported in the International Species Inventory System. These values have probably been obtained in immobilized or manually restrained animals. ISIS average values for bongos are: CPK in males-395 I.U., females—655 I.U.; glucose in males—105 mg/dl, in females—118 mg/dl.

Since antelope are a prey species, great care was taken to avoid triggering a massive flight reaction. These animals are likely to panic if they are suddenly confronted with novelty. The first step was to slowly habituate the animals to the box by placing treats in it. The most critical step was careful desensitization to the sound of the sliding doors. On the first day the door was moved only 2 cm. Over a period of two and one-half months, the animals were trained to tolerate being locked in the box. It then took another month to habituate them to having their hind leg accessed through a hole in the box for blood sampling. There was a critical point where food treats were switched from motivating the animals to enter the box to rewarding them for standing still. For blood testing or injections, they were trained to tolerate increasingly hard pinches. Antelope are sensitive to small changes in their surroundings; therefore, each change in the procedure must be done slowly.

Forced copulations by broiler breeder males

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An experiment was designed in response to concerns raised by the broiler breeder industry regarding increased aggression in particular strains of males. Such males have been reported to have been savaging females and even killing them. A 3x2 factorial was used to compare 3 genetic strains of male (2 broiler breeder lines and 1 commercial laying strain) at 2 feeding levels (restricted or ad libitum) during the breeding phase. All birds were reared according to the management guidelines for each strain. At 22 weeks of age, pairs of males were penned with 20 hens of a broiler breeder strain and behaviour was sampled from each pen for six 10-minute periods at weeks 25, 27, 29, 33 and 37. Results indicate that broiler breeder males show significantly less courtship behaviour than laying strain males. Mean incidence of courtship behaviour per 10 minute period were 3.62 ± 0.12, 1.12 ± 0.07 and 0.97 ± 0.06 for the laying strain and broiler breeder strains A and B respectively ($P<0.0001$). Full fed males performed significantly more courtship behaviour than restricted males. Mean incidence of courtship behaviour per 10 minute period were 2.29 ± 0.10 and 1.51 ± 0.08 for the full-fed and restricted males, respectively ($P<0.0001$). Hens approached displaying males of the laying strain three times as often as they did broiler breeder males ($P<0.0001$). The number of overall successful copulations was not affected by strain or feed restriction. Of these successful copulations, only 12.5% were forced copulations for the laying strain in comparison to 47.8% and 50.0% for the broiler breeder strains A and B, respectively ($P<0.0001$). Chasing behaviour was performed most often by broiler breeder males ($P<0.0001$) particularly those receiving full feed. Similarly, fleeing or escape behaviour was exhibited by hens most often during interactions with full-fed broiler breeder males ($P<0.0001$).

In conclusion, pronounced differences were found to exist in aggressive and sexual behaviour of modern broiler breeder and commercial laying male strains. Few differences were found between the two broiler breeder strains. Deficiencies in courtship behaviour of broiler breeder males may result in a lack of arousal and hence crouching in hens, predisposing these males to adopt forced copulation as a mating strategy.

Reduction in fear reactions of isolated ewes and lambs by photographic images of conspecifics.

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We investigated the effectiveness of projected slide images of conspecifics in reducing fear reactions of isolated adult sheep and lambs. Thirty ewes and 17 three-week-old dam-reared lambs were successively isolated and tested in the presence of an image of an unfamiliar ewe of their same breed (all subjects), and when exposed to the image of either an unfamiliar object (18 ewes) or a geometric form (12 ewes, 17 lambs).

Fear reactions of adult ewes were reduced during the tests with a conspecific image as compared to their responses to the object or the form. Fearfulness scores (positively correlated with fear) were respectively: 17.0 vs. 20.0 ($P<.01$) for tests with ewe/object slides, and 10.0 vs. 15.0 ($P<.002$) for animals tested with the image of a ewe vs. a form. Lambs displayed significantly more interest in the slide of a sheep than to a projected geometric form; they also appeared to be less distressed in the presence of the sheep slide, as indicated by the lower number of attempts to escape this condition.

In subsequent experiments, we investigated the responses of adult ewes (n=24) and one-month-old lambs (n=24) to the images of unfamiliar sheep of their own vs. a different breed. A projected image of a ewe of the subjects' breed was associated with lower fear reactions than was the other breed slide among adults (scores: 22.7 vs. 26.3, $P<.003$), but not in lambs, suggesting that breed recognition may not yet be developed at one-month of age.

Factors modulating aggression received by pigs mixed individually into groups

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Twenty-four pigs of approximately 90 kg body weight were individually housed remote from 24 unfamiliar groups of 3 pigs of similar body weight for 5 days prior to mixing. During this period, 8 groups experienced live sound from the individual with whom they were to be mixed via a microphone, amplifier and speaker link (audio treatment), 8 groups received approximately 3 kg of faeces and urine soaked bedding from the individual pig daily (olfactory treatment), and 8 control groups received no such treatment. After this period each individual pig was mixed into its corresponding group, and behaviour recorded by time-lapse videography for 48 hours. Video tapes were subsequently analyzed over 6 hours following mixing, and over a further 6 hours on the day after mixing. Data were analyzed by Mann-Whitney U test; control groups vs. audio treatment groups, and control groups vs. olfactory treatment groups. Individuals mixed into audio treatment groups received less total aggression (bites, knocks and threats combined) than individuals mixed into control groups ($P<0.05$, $U=15837.5$). Individuals mixed into olfactory treatment groups also received less total aggression than individuals mixed into control groups ($P<0.01$, $U=15025$). Both audio and olfactory factors may therefore have been involved in the reduction of aggression reported in the pre-exposure mixing experiments previously reported by these authors (28th International Congress of the ISAE, 1994).

The effect of presence of a stockperson on behaviour of livestock under distress

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We observed 52 Japanese Black cows on 6 commercial farms that time spent tongue-playing correlated negatively with the length of stockperson's stay in each farm ($r=-0.467$, $P<0.01$). Then we did 3 experiments to ascertain if the staying itself suppresses performance of tongue-playing. Subjects were 20 ewe tegs. Half of them were handled gently for 5 weeks from about 6 months old (H sheep). Remainders got only routine husbandry (NH sheep). After handling treatment, behaviours were compared between with and without a stockperson as follows; Test 1: the conflict test (sheep, having learned feed and buzzer associatively 15 times, were observed for 1h each of 3 times), Test 2: the surprise test (sheep being presented with a moving, noisy, hanging novel object, were observed for 3 min) and Test 3: the isolation test (sheep being separated from pen mates and left in a single pen, were observed for 3 min). In Test 1, the time-budget (means$\pm$SE%) for biting fences as an indicator of severe distress was performed less with a person (NH, 0.2 ± 0.1^a, 3.0 ± 1.1^b and 0.4 ± 0.1^a at an unconflict situation, a conflict situation with out and with a person, respectively; H, 0.8 ± 0.3^a, 4.3 ± 0.7^b and 4.4 ± 1.1^b, $P<0.05$). Rumination as an indicator of mild distress was more performed with a person than control and without a person (NH, 6.7 ± 1.9^b, 0.7 ± 0.4^a and 19.3 ± 3.9^c: H, 4.4 ± 1.5^b, 1.8 ± 0.7^a and 14.8 ± 2.7^c). In Test 2, escape attempts from a pen without a person decreased significantly to half with a person (NH, 6.7 ± 1.3 and 3.9 ± 0.8; H, 5.6 ± 2.4, 2.5 ± 1.2, $P<0.05$). In Test 3, escape attempts and vocalization decreased significantly with a person (escape: NH, 6.8 ± 1.6 and 3.6 ± 1.1*; H, 9.2 ± 2.8, 2.9 ± 0.8*; vocalization: NH, 60.2 ± 6.1 and 47.9 ± 5.0*; H, 50.9 ± 3.6, 34.6 ± 2.6*). A stockperson might be able to be an alternative to conspecifics.

Assessing behavioural demand functions: issues

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Behavioural demand functions have proved useful in quantifying the importance of various environmental features or behaviour to pigs, hens and other animals. Typically, animals are trained to work (e.g. lever press) to gain access to a commodity, and then the work requirement ("price") is gradually increased. The demand function describes the change in rate of "consumption" of the commodity with "price" increases. With hens the slope of the demand function (elasticity) varies with the type of litter substrate made available. In accordance with convention, in these studies price was calculated as the number of responses required for each reward. Other research with rats has indicated that price may be better described as a cost/benefit ratio, which includes consideration of both the effort of the work and the value of the commodity purchased. This study compared the usefulness of these two ways for measuring price. Individual hens (n = 6) obtained their daily food requirements by working on fixed ratio schedules (increasing from FR5 to FR200) at each of two reward magnitudes (3 sec and 9 sec access to food pellets). The numbers of responses made, reinforcers obtained and amount of food consumed each day were recorded by computer. The slopes of the food demand functions (best fit straight lines) when calculated using the conventional measure of price were significantly ($P<0.01$) steeper for the 3 sec reward (mean slopes of -0.89 and -0.39 for the 3 sec and 9 sec reinforcers, respectively). When food consumption was plotted as a function of unit price (responses/g of food obtained) the data from both reward durations conformed to a single underlying demand function of the form $y = c + bx - a10^x$ where elasticity increased as a function of unit price. These results show that the appropriate independent variable that accounts for changes in "consumption" is unit price, and that demand elasticity [illegible] necessarily a constant for a given commodity as price varies.

Reduction in pain: its effect on lamb behaviour and plasma cortisol

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Animals cannot communicate their pain using verbal language. However, in response to painful stimuli, they show behavioural and physiological changes similar to those produced by procedures painful to man. Selection pressures have modified the outward expression of pain in farm animals compared to man, except when its intensity exceeds their ability to suppress it. To assess the acute effect of different levels of the same painful stimulus, behavioural and physiological responses of 5 to 6 day old lambs (group n = 7) were recorded for 180 min following a range of procedures. The procedures, decreasing in severity as assessed by the degree of tissue damaged, were bilateral castration and tail docking, bilateral, unilateral, short scrotum castration without and with local anaesthetic, tail docking, all using rubber rings, down to a non-painful procedure (handled). Blood samples were taken for plasma cortisol analysis at -20, 0, 12, 24, 36, 48, 60, 72, 96, 132, 180 min. after treatment. Active behaviours e.g. head turning, foot stamping were recorded continuously, while postures were recorded every 2 min for 96 min then every 6 min for a further 84 min. An analysis of variance on a summation of the incidence of restlessness, rolling, jumping, foot stamping, kicking and easing quarters (REQ) was significant ($P<0.001$) and mean REQ scores ranged from 339 for castration and tail docking, 248 for bilateral castration, 171 for unilateral castration, 178 for short scrotum castration without local anaesthetic and 57 with local anaesthetic, down to 19 for handled controls. Ventral lying with full extension of the hindlegs (V4) and lateral lying were postures commonly adopted by lambs subjected to the most severe procedures, while abnormal standing was a more sensitive measure of the less severe procedures. Plasma cortisol responses provided a useful measure of moderate pain. Multivariate analysis (Discriminant analysis with validation) was used to find the combination of indices (V4 and REQ) which most economically and accurately separated the lambs into their treatment groups. From this analysis and multiple regression a composite index will be developed for detecting different degrees of this type of pain in this age and species of animal.

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In search of the motivation underlying feather pecking behaviour

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Both hypotheses proposed in the literature for the causation of feather pecking in domestic fowl suggest that feather pecking is redirected ground pecking, but one suggests that it is related to feeding motivation and the other to dust-bathing motivation. The experiment described here was designed to discriminate between these hypotheses.

Fifty-three individually marked laying hens were housed in a litter floor pen and each bird observed (4x5 min) using a randomised design. Ten birds showing a high rate of feather pecking were selected and observed again to give a total of 70 min observation time per feather pecking bird. A sequence analysis was then carried out to determine the frequencies of transitions to and from this behaviour.

A total of 1053 feather pecks was observed. A feather peck was significantly more likely than expected to be preceded by a feather peck ($\chi^2=582$; d.f.$=1$; $P<0.001$). Correcting for these bouts, we found that birds were significantly more likely to be walking and less likely to be ground pecking, feeding, drinking or preening before giving a feather peck and significantly less likely to preen immediately afterwards. Extending this analysis to the five behaviours before and the five after giving a feather peck showed that birds were significantly ($P<0.05$) less likely to be:- feeding, ground pecking, drinking, standing, and preening on 6, 5, 4, 4 and 3 occasions respectively out of these 10 lag positions. We therefore suggest that feather pecking is more likely to be associated with a food searching or consummatory motivation, perhaps as a substitute behaviour, than with a comfort behaviour.

A pain assay to measure the nociceptive response in cows

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With the purpose of producing a pain assay to measure the nociceptive response in the cow, and to find the minimum morphine dose to elevate it 10 - 15%, a pain threshold measurer (PTM) apparatus was developed and tested with 12 dry, non-pregnant, culled cows. The cows received a cumulative dose (from 0.00 to 0.40 mg/kg B.W.) of morphine sulphate through a catheter in the jugular vein. Interval between dose was 20 min, and a nociceptive test was performed 15 min after each injection. The PTM consists of a 60 watts halogen bulb built in a 15 cm PVC tube, with a 0.6 sec response time probe attached at its end and connected to a thermocouple. The probe measured the temperature where the heat was applied: the cranial part of the forefoot, on the metacarpal region. At the foot lift response of the animal the radiating heat stimuli from the bulb was instantaneously turned off, preventing any suffering. Each nociceptive test value consisted of the average of three consecutive measurements of the temperature. The 0.00 mg/kg dose test was the baseline, and the subsequent measurements were considered in percentage difference from it. Data were analyzed in GLM procedure, with cow nested within dose. A fast response (FR) and a slow response (SR) group were noticed, with different slopes ($P<0.002$) and intercepts ($P<0.02$). A regression of pain response on dose for each group produced the equations: FR dose$=0.0044+0.0076X$, and SR dose$=0.0997+0.0070X$, X being the enhancement in the pain tolerance. The lines were parallel, but with different intercepts ($P<0.001$). Thus, a two step dose should be given to achieve a certain enhancement in the pain tolerance of the cow.

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Quantity of milk in the udder, the level of hunger, and sucking behaviour of the nursing calf

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Twelve dairy calves were allowed to suckle their cow twice a day, two hours after each milking. The sucking behaviour of the calves was video recorded when the cow had different amounts of milk in the udder. The amount of milk consumed by the calf was determined by weighing the calf before and after nursing. A nursing was considered to have ended when the calf left the udder for more than 10 s. To vary the amount of milk in their udder, cows were either partially or totally milked either 2 h or 30 min before the nursing. When cows were partially milked 2 h before, the total duration of sucking during a nursing was shorter (442 s vs 541 s, $P<0.004$), the frequency of butting (12.6 vs 20.0, $P<0.01$) was lower but the milk intake of the calf was the same as when the cows were completely milked. When milk availability was minimized by milking 30 min before, sucking duration was longer (835 s vs 478 s, $P<0.001$), butting frequency (40.2 vs 7.7, $P<0.01$) was higher but the milk intake of the calf was not affected. The sucking behaviour of the calves was also recorded when they were hungry (fed only 50% at the previous meal) or pre-fed (tube-fed 4l of milk, 10 min before nursing). If the calf was hungry, it sucked for longer (747 s vs 491 s, $P<0.01$), did not butt more (31.9 vs 19.1, $P=0.18$) and drank more milk (6.8l vs 4.9l, $P<0.001$). If the calf was satisfied, it sucked for a shorter time (178 s vs 437 s, $P=0.03$), there was no effect on butting (8.8 vs 13.2, $P=0.22$) and the calf drank less milk (1.1l vs 3.7l, $P<0.01$). Consequently, the sucking behaviour of calves is not always a good indicator of the amount of milk ingested as it also reflects the ease at which the milk is obtained. If milk is plentiful, it will be ingested rapidly and with little butting and if milk is limited, it will be ingested slowly with much butting. The calves level of satiation will directly effect the meal duration and milk intake but not the butting behaviour.

Genetic variability of psychobiological reactivity in lambs reared under open-range management

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In order to develop extensive rearing systems in harsh environments in Europe, it is necessary to improve the production of local breeds by introducing more prolific breeds. However, those breeds can only be introduced if they are able to adapt to extensive rearing systems. A study of the genetic variability of reactivity and social attachment has been conducted on four genetic types of sheep reared under open-range management: Lacaune (local breed mainly used for milk production), Romanov (breed characterized by high prolificacy of ewes), and the two respective crossbreeds. The first part of the study aimed to measure the general reactivity and maternal qualities of 300 ewes at lambing by observing licking activities and mother-young distance, and by testing reactions to brief separations from offspring and to exposure to human beings. Results show that Romanov ewes, primarily bred for intensive management and known to have a well-developed maternal aptitude, present in extensive rearing conditions stress reactions (particularly towards human) that are likely to alter their maternal behaviour. Romanov ewes react more strongly than Lacaune ewes in response to a brief separation from their lambs (frequency of high bleating, 53 12 vs. 45 11, $P<0.05$). They spend less time near their lambs than Lacaune ewes when a human is nearby the lambs (153s 18 vs. 176s 23; $P<0.01$).

The second part of the study aimed to study the social reactivity of 1350 lambs tested after weaning (2 months of age) in a series of short trials inducing social isolation and proximity to human beings. In addition to the four genotypes, we tested lambs from crossing between males of a third breed (Berrichon-du-cher) and females of one of the previous genotypes. Results show that the breeds differ in their reactions. The crossbred Berrichon and Romanov are more reactive than Lacaune to social separation (number of high bleats, 59 18 and 47 12 vs. 38 7, $P<0.01$). Nevertheless when a human is close to the conspecifics, the crossbred Berrichon spend more time than Lacaune near the pen of conspecifics (161s 84 vs. 96s 43; $P<0.01$). These results give evidence too that stress responses are under genetic control (direct, maternal and heterosis effects). They further suggest that simple and objective measures of adaptation can be used in future selection programs for a better adaptation of flocks to extensive breeding.

An increase in nutritive sucking duration reduces, but does not eliminate non-nutritive sucking by the calf

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To investigate the effect of nutritive sucking duration on post-meal non-nutritive sucking we developed a model whereby calves sucked their milk from an artificial teat. We used washers with holes of different sizes to manipulate milk flow rate and nutritive sucking duration. Twelve male Holstein calves at 12 weeks of age received 5l of whole milk on consecutive days, at each of four flow rates: Fast (1.33 l/min), Medium (0.70 l/min), Slow (0.34 l/min), Very Slow (0.14 l/min). Behaviour was observed continuously throughout the meal and for 20 minutes after. Meal duration with the Very Slow flow rate was longer than the Fast, Medium and Slow treatments (14.4 min vs. 4.8, 4.5, 6.5 min $P<0.01$). The Very Slow treatment resulted in less non-nutritive sucking than the Fast, Medium and Slow treatments (2.1 min vs. 5.0, 5.0, 3.7 min $P<0.01$). Although the duration of nutritive sucking with the Very Slow flow was longer than the combined duration of nutritive and non-nutritive sucking on the other treatments, calves still performed some non-nutritive sucking. Whereas a longer nutritive sucking period reduces post-meal non-nutritive sucking it does not eliminate it.

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Dust-bathing in modified cages

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This study aimed to determine the extent to which conventional (control) and five designs of modified battery cages for laying hens meet the birds' behavioural needs to dust-bathe. Only the "Edinburgh Modified Cage" provided a dust bath, but hens were able to perform sham dust-bathing on the wire floors or in the nest boxes of other designs.

The mean dust-bathing frequency differed significantly ($P=0.0001$) between cage types, with the highest frequency in the conventional cages (mean 4.1 bouts/hen/day) and the lowest in the "Elevated Trough" modified cage (mean 1.1 bouts/hen/day). Dust-bathing bouts were significantly shorter at low density (mean 374 25s, high density mean 311 26s; $P=0.0114$). There was little difference between modified cages in mean bout duration (overall mean 375 21s), but bout duration was shorter in conventional cages (214 21s; $P=0.0001$).

Conventional cages appeared not to reduce the birds' motivation to dust-bathe, but did affect the mean bout duration. In modified cages, surprisingly little dust-bathing occurred in dust baths and nest boxes. I suggest that the hens require more space to perform this behaviour than previously thought and that the enclosed dust baths, nest boxes and (small) conventional cages were perceived as insufficiently spacious. The 'open plan' layout of nest boxes in the "Bristol Modified Cage" attracted a high proportion of dust-bathing, while dust-bathing in other modified cages usually occurred in the main cage area.

Effects of bulky diets on feed motivation and hunger of sows

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We determined if high-fibre diets decrease feed motivation and hunger of sows. Forty gilts were fed either a concentrate diet (CONC) or high-fibre diets balanced for energy (HF1: wheat bran and corn cobs; HF2: oat hulls and oat) or lower energy (HF2LE). Daily intake of major nutrients was calculated to be the same in the CONC, HF1 and HF2. Duration of eating was increased by all three bulky diets ($P<0.01$), due to an increase in the mean duration of eating bouts for HF2 and HF2LE. Before meals, the total duration of chain manipulation was reduced by HF2, compared to CONC. Sows fed HF2LE performed more chain manipulation than those fed HF2. After meals, less stereotypies occurred in HF2 and HF2LE than in CONC, with a tendency for the same result with HF1. When eating time and the diet were included in a multiple regression model to predict the duration of chain manipulation after the meal, only time spent eating was significant ($P<0.01$). During an operant conditioning test, more rewards were received by CONC sows than by HF1 ($P=0.06$) and both HF2 diets ($P=0.03$), but both HF2 diets reduced operant performance after meals more than did CONC. In conclusion, bulky diets reduce hunger and post-feeding stereotypies. Low energy diets increase pre-feeding stereotypies.

Manipulating familiar lamb-associated odour cues facilitates add-on fostering in sheep

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Manipulating lamb odour cues has been used to facilitate fostering a second lamb on ewes with a single natural offspring (add-on condition). In Experiment 1, neatsfoot oil was smeared on own and alien lambs within 12 h of birth to establish a common artificial odorant. Fosterings were initiated 15 hr later. Nine of 18 ewes (50%) met the criteria for accepting both own and alien lambs in 72 h and 7 of these 9 ewes (78%) adopted alien lambs immediately (upon initial exposure). In Experiment 2, neatsfoot oil was again used to establish a common artificial odorant on own and alien lambs and, in addition, individual lamb odors were transferred (exchanged) between own and alien lambs via cloth stockinette jackets. Twenty-four of 30 ewes (80%) accepted both own and alien lambs using these combined techniques and 20 of the 24 adoptions (83%) were immediate. Experiment 3 followed the procedure used in Experiment 2 except that alien-lamb odour was eliminated by washing the alien lamb with a non-ionic detergent prior to fostering. The results did not differ from Experiment 2; 11 of 19 ewes (58%) adopted both own and alien lambs and 8 of 11 ewes (73%) showed immediate acceptance. It was concluded that the use of a common odorant and odour transfer to facilitate fostering provide complementary and additive effects when used together. Eliminating alien-lamb odour by washing does not provide any added benefit. The success of add-on fostering may be limited only by an inability to match familiar lamb-associated odour cues on own and alien lambs.

Environmental temperature, radiant heat and illumination affect occurrence of dust-bathing in hens

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Although dust-bathing in hens is motivated by internal factors, external cues, such as the sight of a dusty substrate, can also stimulate this behaviour. Two studies investigated the effects of other environmental factors on the occurrence of dust-bathing in hens. In one study, six groups of ten medium-hybrid hens were kept in temperature-regulated chambers at 10° or 22°C and offered either peat or sand in addition to a litter floor. Frequencies of dust-bathing were greater when hens were held at 22°C than at 10°C ($P<0.01$) regardless of the substrate available. For a given temperature, the overall level of dust-bathing was similar whether sand or peat was provided ($P>0.10$). However, when sand was provided, more dust-bathing took place in the litter than when peat was provided. In another study, twelve groups of three hens were exposed to one-hour periods of either radiant heat with no light or bright, photo-flood light for four consecutive days. Radiant heat emissions at hen level were balanced for the two sources. Four consecutive days of no heat or light stimulus served as control periods. Both the radiant heat source and the photo-flood light stimulated dust-bathing and sun-bathing behaviour. Squatting, a behaviour pattern observed during sun-bathing and dust-bathing, was observed more frequently during periods of radiant heat ($P<0.05$) and photo-floods ($P<0.05$) when compared to identical time periods on control days. Active dust-bathing was also observed more often during radiant heat ($P<0.06$) and photo-floods ($P<0.05$) than during control periods. The highest frequencies of squatting and dust-bathing were observed under photo-floods. Dust-bathing in hens appears to be motivated by a complex combination of internal and environmental factors.

The consequences of nose-ringing for the behaviour and welfare of pigs maintained on pasture

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Nose-ringing of pigs on outdoor units limits land damage by suppressing rooting behaviour. This project assessed the effect of different methods of nose-ringing on both rooting behaviour and other behavioural indicators of welfare. Three groups of 10 gestating sows were randomly assigned to one of three conditions: unringed controls (UR); ringed with three small, copper clip-rings in the top rim of the snout (CR) or with a single "bull" ring through the nasal septum (BR). They were maintained in adjacent paddocks on undamaged pasture at a stocking rate of 38 sows/ha. Behavioural observations were carried out during weeks 1, 3, 4, 21 and 22 after ringing, using a combination of focal sampling of individual sows and scan sampling of each paddock. For a month after ringing, dig-rooting was totally abolished in CR and BR. Hard ground in the 3-4 week period reduced rooting even in UR, but 5 months later, in soft winter conditions, ringed pigs still rooted significantly less than UR (0.49, 0.12, 0.05 sows/scan; $P<0.05$). CR and BR sows palpated the ground with the snout less in the first month, but no difference were observed in the extent of sniffing at the ground. Grazing was also inhibited in BR sows on the two days after ringing. Both groups of ringed pigs spent more time standing inactive in the first week (5.0, 14.5, 30.1 sec/10 min), but BR sows maintained higher levels of inactivity throughout. At 5 months, all CR pigs had lost at least one ring, with no sign of injury; two bull-rings were missing, with one BR sow sustaining snout damage. In conclusion, rooting is most effectively reduced with a bull-ring, but other behavioural changes suggest that the welfare of BR sows is more compromised.

Wallowing behaviour in fattening pigs

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Although wallows are usually not provided for fattening pigs, wallowing behaviour is an efficient way for pigs to control their deep-body temperature during warm periods. In this study we examined the use of wallows in 22 groups of 4 male and 4 female pigs. All groups were kept in identical "straw-flow" pens (0.78 m^2 per pig). The temperature in the house could be controlled by means of a computerized heating and ventilation system. In the first, batch 8 of the 12 groups were given wallows (100 x 40 x 5 cm, filled with water). The pigs were placed in the pens at 12 weeks of age and their wallowing behaviour was observed from 13 to 24 weeks. Wallowing was defined as rooting followed by laying down on the side. All pigs were observed on 5 days with elevated temperature (31°C) and on 3 days with the usual temperature (18°C). In the second batch, 5 groups of litter-mates and 5 groups of mixed litters were placed in the pens and all given wallows at 6 weeks and observed during week 7, 10, 13, 16 and 19 on days with normal temperature (18°C) and days with elevated temperature (27°C). Data were analyzed by means of the GLM procedure.

In the first batch, wallowing behaviour was about 8 times more frequent in the groups with wallows ($P<0.001$) and, generally, 3 times more frequent at elevated temperature ($P<0.001$). Wallowing increased with body weight, but decreased with number of exposures to elevated temperature. In the second batch, wallowing increased with age ($P<0.0001$) and was about 3 times more frequent during elevated temperatures ($P<0.001$). The pigs also wallowed more after they had been forced to move for 3 minutes ($P<0.01$). Finally, pigs in groups of litter-mates wallowed less that those in mixed groups ($P<0.05$). This study reveals that wallows are used by fattening pigs and that wallowing is influenced by a number of environmental factors.

Behaviour of male laboratory rabbits given environmental enrichment in a preference test and in an individual cage

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The aim of this study was to test the behavioural effects of giving individually caged male laboratory rabbits access to hay, grass-cubes, gnawing sticks or a box either in a preference test or in their home cage.

In the preference test 12, male New Zealand White rabbits were tested individually in the apparatus in a random order with one object at a time in a random order. The preference apparatus consisted of one starting box with four alleys each ending in a goal box where the object was placed in a random order between boxes. Behavioural observations were done instantaneously at 15-s intervals during 15 min three times/object. The recordings were analyzed by Wilcoxon Signed Rank test.

In the home cage, 60 (2 x 30) male New Zealand White rabbits were randomly assigned to one of the four objects or to a control group (n=12/treatment). Behavioural observations were done instantaneously at two min-intervals on 10 rabbits at a time during one h during a total of 16 days. The recordings were analyzed by Wilcoxon Rank Sum test.

In the preference test, rabbits interacted more with hay than with gnawing sticks ($P<0.001$) or grass-cubes ($P<0.01$) and more with a box than with gnawing sticks ($P<0.01$). The rabbits were recorded to stay more in the goal box with hay ($P<0.05$) or a box ($P<0.01$) than in the goal box with gnawing sticks. The most common behaviours performed in the preference test was sniffing the apparatus, being alert, different movements and chin-marking the entrances to goal boxes.

Rabbits given the objects in their home cage interacted more often with hay than with any of the other objects ($P<0.0001$), and significantly more often with the grass-cubes than with gnawing sticks ($P<0.001$) or a box ($P<0.01$). Rabbits performed fewer abnormal behaviours when given hay ($P<0.01$) or grass-cubes ($P<0.001$) than control rabbits. Rabbits given hay performed less of other behaviours ($P<0.001$), less lying ($P<0.05$), less rearing ($P<0.01$) and more sitting ($P<0.01$) than control rabbits. Rabbits given grass-cubes had a higher weight gain ($P<0.001$) than control rabbits. It is concluded that giving individually caged male rabbits hay may improve their welfare.

Comparing the importance of environmental enrichments: strength of motivation for a running-wheel, complex tunnel system and loop tunnel by laboratory mice.

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It may be possible to improve the environments of laboratory mice by providing simple, artificial resources which allow increased locomotion. To determine which of several such resources is perceived by the animals as most important, an initial approach is to ascertain whether use is maintained when the cost of gaining access is increased. This study investigated the responses of individually housed laboratory mice to increased cost (switch presses) of gaining access to 3 simultaneously available resources (a running-wheel, a complex tunnel system and a loop tunnel). As the cost of gaining access increased, visits to the loop rapidly decreased and ceased at the highest cost. Increased cost also resulted in decreased visits to the tunnel system and some mice ceased visiting this resource. The frequency of visits to the running-wheel decreased less rapidly and became consistently greater than visits to the other 2 resources. In addition, cost of access had no significant effect on the time spent in the running-wheel or on the number of revolutions each 24h. Responses to the three resources differed, indicating they are not directly substitutable. The results indicate that under conditions of increasing cost, the mice perceived a running-wheel to be more important than a complex tunnel system or a simple loop tunnel. Therefore, in practical terms, it may be of more benefit to provide laboratory mice with a running-wheel rather than a large, complex tunnel environment.

Responses of mice to increased cost of gaining access to a running-wheel, complex tunnel system and loop tunnel. Values are means of 24h.

Required presses	Duration of use (s) Wheel/Tunnels/Loop	Visits Wheel/Tunnels/Loop	Activity score Wheel/Tunnels/Loop
1	7905 / 7031 / 296	13.7 / 14.5 / 4.7	1935 / 453 / 117.1
10	9005 / 5418 / 51	11.6 / 8.3 / 0.7	2761 / 192 / 13.9
20	10269 / 4168 / 31	11.2 / 4.8 / 0.2	3364 / 135 / 11.1
40	7246 / 2537 / 19	6.5 / 3.7 / 0.1	2517 / 88 / 4.3
80	4974 / 1703 / 0	3.7 / 1.7 / 0.0	2032 / 53 / 0.0
P-values	N.S. / N.S. / <0.0001	<0.05 / <0.001 / <0.001	N.S./<0.001/<0.001

Significant differences within columns due to the effect of increased cost of access were determined by ANOVA. Activity scores were number of revolutions by the wheel, or breaks of light beams within the tunnels or loop.

The effect of housing with or without substrate on responsiveness to novelty in growing pigs

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It has been suggested that farm animals housed in environments lacking substrates show decreased responsiveness to novelty, but few 'enrichment' studies have investigated the interactive behaviour of the animals in detail. This study examines the responsiveness of two groups of differentially housed growing pigs to a novel situation. Twenty-six female pigs were housed individually from 10 weeks of age for five months in pens which were either substrate-provisioned (SP; concrete-floored pens with straw, bark and branches, n=13), or non-substrate- provisioned (NSP; concrete-floored pens, n=13). On one day each month, the response of each pig to 1) a novel arena attached to its home pen and 2) the addition of a novel object to that arena, was recorded. Results indicate that SP pigs moved back and forth between their home pen and the novel arena more frequently than NSP pigs ($P<0.001$). They also scampered more frequently ($P<0.05$) and interacted more often with walls ($P<0.01$), gate ($P<0.05$) and other fixtures ($P<0.05$) of the arena. NSP pigs on the other hand showed longer bouts of chewing the novel object than SP pigs ($P<0.01$), and spent a higher proportion of their time chewing the object ($P<0.05$). Calculation of a relative diversity index R indicated that SP pigs showed a higher behavioural diversity during the tests than NSP pigs ($P<0.001$). These results indicate that a lack of substrate for interaction not only reduces behavioural diversity in the home pen, but also has a longer-term effect on the diversification of behaviour under novel conditions.

Poster Presentations

Effects of microwaves, as a source of supplemental heat, on growth, reproduction and behaviour of young pigs

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It has been shown that microwave radiation can provide supplemental heat to young domesticated animals. To determine the effects of microwaves on growth and behaviour, 72 recently weaned pigs (60 females, 12 males) were exposed to either 2,450 MHz radiation at an average power density of 17.9 mW/cm^2 (Microwave), or two 250-Watt infra-red heat lamps (Control) for 23.5 hours per day for 4 weeks. Each experimental unit consisted of 6 pigs. Analysis of the slopes and intercepts of weight gain, feed consumption and feed:gain ratio indicated no significant treatment effects over the duration of the exposure period ($P>0.05$). No significant differences between the treatments were found for the age or the body weight of the females at first estrus ($P>0.05$). In order to determine whether the microwave radiation had an effect on activity levels, the pigs were videotaped during the first three days and then every fourth day of the experiment. The tapes were analyzed to determine the average percent of time each pig spent lying huddled in a group, lying alone, standing at the feeder, and standing but not at the feeder. No significant treatment effects were found for these behaviour variables ($P>0.05$). These results suggest that microwave radiation may be a suitable source of supplemental heat for small pigs. Furthermore, the animals would not be dependent on warm air as a heat source, so the ventilation rate in the pig rooms could be increased to reduce the levels of harmful gases and dust.

Towards a consensus definition of animal welfare

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A view is emerging that there are two approaches to the definition of welfare. One emphasises that welfare is concerned with what animals feel, while the other is more broadly concerned with biological functioning. However, the dichotomy may be more apparent than real: feelings are affected by the state of the animal and they are also an important aspect of its functioning. Some degree of unification of the approaches is implicit in the widespread use of the Five Freedoms and in commonly used definitions such as "A wide term that embraces both the physical and mental well-being of the animal". We propose the following definition, which makes the unification explicit, as a basis for discussion. It is based on the Five Freedoms but groups mental aspects into one category.

"Animal welfare has different aspects, as indicated by the following list of problems for welfare; it can be safeguarded or improved by avoiding or reducing physical problems (categories 1 to 4) which will achieve the primary aim of avoiding or reducing suffering (category 5).

1. Water restriction, undernutrition, malnutrition;
2. Environmental challenge;
3. Disease, injury, functional impairment;
4. Behavioural or interactional restriction;
5. Anxiety, fear, pain, distress."

This is not meant to be restrictive. For example, although we know less about pleasure in animals than about suffering, increasingly welfare is considered to be more than simply the absence of suffering. Nevertheless, such a definition may be used in practical contexts. It arises from a scheme now being used in New Zealand and elsewhere for predicting the impact of procedures on experimental animals. An increased consensus on such a definition would also help to answer those who resist improvements to welfare on the grounds that no-one agrees what welfare is.

Riddle's Elephant Breeding Farm and Wildlife Sanctuary and Hendrix College - people helping animals and people

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Scott and Heidi Riddle run an elephant sanctuary in central Arkansas, 25 miles from Hendrix College. The sanctuary accepts unwanted or injured elephants and has housed 4 Asians (female) and 9 Africans (2 female, 6 male) since 1990. The Riddles, having circus and zoo backgrounds, manage the elephants "hands-on" and a bull barn ("hands-off") is available. Hendrix College, a small liberal arts school, and the Riddles have formed a mutually beneficial relationship. Biology, Chemistry, and Psychology faculty investigate elephant anatomy, biochemistry, and behaviour: anatomical research has confirmed suspected pathology in some animals; biochemical research has monitored progesterone in tracking estrous cycles; behavioural research has observed fewer stereotypies in most animals when penned rather than chained. Students conduct research through independent study projects and class laboratories, and are involved through voluntarism and an incoming student orientation program. Student groups assist with routine chores, the annual "Elephant Oiling," preparation for the annual "Elephant Handling School," and have even exhumed an elephant skeleton. The Riddles benefit by having free physical labourers and by applying the knowledge gained from the research projects. Hendrix benefits by having access to a unique research and teaching opportunity and by having the Riddles and visiting elephant experts speak on campus. The Riddles invite interested parties to contact them about visiting and conducting research at their sanctuary.

The behavioural development of group housed New Zealand White laboratory rabbits

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The housing of 'laboratory rabbits' on floor pens in groups has been shown to be a real alternative to solitary caging of this species. The increased floor area, provision of significant and suitable environmental enrichment and social interaction add considerably to the quality of life of these animals and is therefore a positive welfare refinement.

However, there appears to be a lack of information regarding the behaviour of this species generally and certainly animals of different strains and ages. Therefore, a behavioural assessment of New Zealand White (NZW) rabbits at four age periods, 8 weeks, 17 weeks, 26 weeks and 52 weeks of age, was undertaken in an attempt to demonstrate the changes that occur in their behaviour as they age. The allocation of floor area using bodyweight in isolation is surely erroneous and takes no account of the activity of the animal, which to some extent will be age-related. A form of age-related activity paradigm has been shown for laboratory rats, which demonstrate their most active phase when they are about 90 days old, after which they activity levels gradually decline. A similar pattern of activity may occur in the rabbit although, of course, at a different age. A preliminary, gross measure of activity has shown that a group of five NZW rabbits had a mean 24 hour percentage activity of 39.5% at seven weeks of age, which increased to a mean of 49.5% at 14 weeks of age.

Noise and vibration on a poultry transporter

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The poultry industry transports by road approximately 2 million broiler per day in the UK. Vehicles carry about 5000 birds in 18 modules each having 12 containers with 24 birds, and may have curtain sides to maintain temperature in cold weather. When transferred from the broiler farm to the processing factory the birds are subjected to a high degree of handling and transportation that may reduce their welfare.

This study shows the results of measurements of vibration, acceleration and noise on a typical broiler chicken transporter. Vibration measurements were made using triaxial accelerometers mounted in the bird container with the vehicle both laden and unladen. In the dominant vertical axis the fundamental vibration frequency is between 3 and 4 Hz with a secondary peak at 12 Hz in the container of the laden transporter. The magnitude of vibration acceleration occurring in the bird container would be uncomfortable for the human and might also compromise bird welfare.

The dominant sounds on a laden transporter are the vehicle engine (63 - 80 Hz), the wind and the road noise (400 Hz - 6.3 kHz), the banging of the curtains (2.5 kHz) and bouncing of the modules (1 - 2.5 kHz). The intensity of these sounds of around 79 to 82 dB (A) or around 100 dB linear is just below the harmful level for humans.

The combination of noise and vibration might affect the birds more than the application of noise or vibration alone.

On a different journey the behaviour of the birds in the container was recorded on video. The birds try to maintain postural stability in the containers by crouching and wing flapping and moving as little as possible. They also crowd to the warmer regions in an attempt to avoid drafts and wind chill.

The effects of age and stocking density on light-choice by broilers

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Popular lighting programs for broilers are 23 h light and 1 h dark or 24 h light. The aim of continuous light is the improvement of feed intake during a 24 h day. However, a number of investigators have reported that shorter lighting periods improve bird health and reduce stress. In addition, it also results in a slower growth rate than continuous light. Dark periods are however demanded to improve the wellbeing of broilers.

In an experiment repeated three times, Ross broilers were given the choice to use a dark or light compartment (3.1 x 2.9 m). Stocking densities were 12.0 or 16.0 birds/m^2 if all animals were in one compartment. In the experiment a total of 140 or 142 broilers were used. Water and a standard broiler diet were provided ad libitum. The light intensity was 20 lx in one compartment and 0.05 lx in the other one. Light intensity was switched between both compartments daily at 1000 h in order to prevent the animals getting used to a certain compartment. In both compartments perches were fixed at a height of 20 and 40 cm stepwise. Behavioural parameters were registered by video recorders for 23 h throughout a 6 week period. Activities observed were the number of animals found in each compartment and the use of perches during the fattening period. Furthermore, weekly body weight, daily feed intake and mortality were recorded. The experiments were analyzed using time sampling in 5 min. intervals. Data were analyzed using analysis of variance (SAS) and expressed as a percentage of total number of animals.

The results showed that broilers given the choice frequented a dark room significantly more often with rising age and body weight ($P<0.001$). The average percentage of animals observed in the dark compartment increased from 1.58% to 38.89% during the experiments. Perches were used after 1 week of age (1.04%) until the end of the experiments (2.43%). The maximum was reached at 4 weeks of age (4.03%, $P<0.001$). The results showed that animals preferred perches with a height of 20 cm in the light compartment.

In conclusion, needs of broilers on light change during the fattening period. For this reason an adaption of light regimes is necessary for the wellbeing of broilers.

Individual variation in eating speed of dry sows

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The aim of this experiment was to investigate the individual variation in eating speed of dry sows and the influence of wet and dry feed. Nineteen dry sows, in the middle of the gestation period, were used in the experiment. They were kept in ordinary gestation stalls and fed 2.2 kg of a standard concentrate once a day (in the morning). In the first period the sows were offered the concentrate without water (DF), in the second period the concentrate was mixed with water at a ratio of 1:4 (WF1) and in the third period the concentrate was mixed with water at a ratio of 1:8 (WF2). Before feeding the sows, access to the troughs was blocked, the water supply to the drinkers over the troughs was closed and the troughs were emptied of water. The feed ration (weighed on an electronic balance) was then placed in the trough and the sows given access to the trough. At Day 1, the sows were allowed to eat for 12.5 min. before access to the trough again was blocked. The residual feed in the troughs was then weighed on an electronic balance. At Day 2, the time before the access to the trough was blocked was reduced to 10.0 min., at Day 3 to 7.5 min., at Day 4 to 5.0 min. and at Day 5 to 2.5 min. The same procedure was applied with the wet feed in periods 2 and 3.

The average eating speed increased when water was added to the diet, and was highest for the ration with the highest water content, WF2. However, since the volume of WF2 also was higher, the sows finished the WF1 ration faster than WF2. The calculated coefficient of variation was 25.3%, 14.8% and 20.6% at 5.0 min. and 26.6%, 5.3% and 17.7% at 10.0 min. for DF, WF1 and WF2 respectively. This indicates that adding water to the diet reduces the individual variation, but that the feed:water ratio should be kept lower than 1:8.

A model on the influence of frustration on the behaviour, heart rate and immune function of pigs

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To evaluate the influence of food deprivation on behaviour, heart rate and immunity, four pigs (weighing 35-40 kg) with jugular catheters and implanted heart rate transmitters were either fed between 0800 and 0900 h, or denied access to a filled feeder with a clear plexiglass window. Food deprived pigs were fed between 0900 and 1000 h. Treatments were reversed after 3 days. The individually confined pigs were housed in two pairs of raised pens in an environmentally controlled room, where food deprived pigs were always adjacent to neighbouring pigs that were fed at the same time. Heart rate (beats per min.) and behavioural activity (min. spent standing) were monitored between 0800 and 1000 h. Natural killer cell activity (NK; lytic units), a stress sensitive immune parameter which is vital for antiviral activity, was measured in whole blood taken via jugular catheter at 0900 and 1500 h. Time spent standing was greater for pigs fed between 0800 and 0900 h than for food deprived pigs (42.6 ± 7.8 min vs 19.4 ± 6.3 min; $P<0.05$). Between 0900 and 1000 h, previously fed pigs decreased their activity (5.6 ± 3.3 min standing), while previously food deprived pigs almost reached the activity level of the neighbouring pigs that were fed between 0800 and 0900 h (35.1 ± 8.2 min). Heart rate was not influenced by treatments. Pigs that were fed between 0800 and 0900 h exhibited a numerically higher heart rate than food deprived pigs in their neighbouring pens (147.6 ± 23.6 vs 115.2 ± 8.0; $P>0.05$). Also, heart rate was not different between satiated pigs and those that were fed after being food deprived between 0900 and 1000 h (152.2 ± 19.2 vs 131.8 ± 12.9 beats/min; $P>0.05$). NK activity was influenced by daytime, with activity (lytic units) greater in the morning than afternoon ($P<0.01$). Lytic activity was numerically reduced in food deprived pigs at 0900 h, but, presumably due to the low number of animals, not different from the controls that were fed ($P=0.26$). The data of this frustration model indicate that heart rate, as measured in beats/min, is not a suitable indicator for the possible psychophysiological impact during food deprivation. Other factors (i.e., arousal around feeding time) seem to influence heart rate as well, although physical activity does not seem to correlate well with heart rate. NK activity tends to be influenced by food deprivation in that lytic activity was reduced by 60% in the morning after treatments were imposed. The model should be expanded with a greater number of animals in future studies to include endocrine measurements of sympathetic activation and specific behaviours that would be indicative of frustration during food deprivation.

Tonic immobility in domestic fowl is not easily modified by the behaviour of the predator after induction

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In domestic fowl, tonic immobility (TI) is regarded to be the last defense alternative after being caught by a predator (Ratner, 1967 In: J.E. Gordon (Ed.) *Handbook of Clinical and Experimental Hypnosis*. McMillan, New York. p. 550). A large number of factors prior to induction of TI are reported to affect the duration of TI (Jones, 1986, *World's Poultry Science Journal* 42: 82). If TI is an adaptive antipredator response, the bird should monitor the environment while in TI, escape when the predator is gone and remain longer in TI if the predator still watches its prey. These predictions were tested with human predators.

Thirty-seven laying hens (35 weeks old) were each exposed to six TI tests each with a different stimulus regime (S1-S6) after TI induction in random order. S1: Human hidden; S2: Human left hide after 15 s in stage 1 and walked to the hen; S3: Human left the hen after 15 s in stage 1 and walked into hide; S4: Same as S2, but after 15 s in stage 2 (after first alert head movements); S5: Same as S3, but after 15 s in stage 2; S6: Human 30 cm from the bird and watching it. Delay between tests was at least two days.

No habituation to the TI test was detected. TI duration until righting (637 ± 403s) did not differ between stimulus regimes (Wilcoxon paired-sample tests).

The results indicate that even if laying hens easily get into tonic immobility when being held firmly by a human, the duration of TI is not easily affected by the position or behaviour of the predator during TI. A possible conclusion is that the tonic immobility is an inflexible antipredator response in domestic fowl which might be non-adaptive.

Modelling animal welfare by structural decomposition

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The problem of assessing animal welfare has been widely discussed and disputed. In an attempt to overcome the dispute-phase and move on to the application-phase an expert information system on animal welfare is being developed at the IMAG-DLO institute in the Netherlands. In order to obtain multi-disciplinary standardisation of animal welfare assessment a specifically suitable procedure from system science is being used. The starting point of this approach is the MSE (multifacetted structured entity) model. In this model the entity 'animal welfare' is decomposed according to its aspects into subentities, which again may be decomposed and so on. The result is a tree-like graph with 'animal welfare' as root and its parameters (component entities) as leaves. Validation of this MSE model (in the information technology sense) must originate from consensus gained during interviews with experts in the field of animal welfare. Starting from the MSE model an expert system will be developed in which the impact of single (or groups of) parameters on the welfare status of the animals can be assessed.

Effects of exposure to excessive dose UV-light on space behaviour and performance of dairy calves

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This trial was conducted to investigate the effects of the exposure of calves to excessive doses of ultraviolet radiation.

The behaviour of 10 calves divided into two equal groups was studied for 36 hours. The average age of animals in the experimental group was 32.8 days and in the control group 33.8 days. The calves of the experimental group were exposed to ultraviolet radiation with the spectrum of 280-320 nm for 12 hours without interruption. The average dose of radiation per m^2 of the pen was 1.794 Er.h. The total irradiation dose represented 179.10^{-10} $J/h.m^{-2}$ on average per calf. The experiment was performed in a pen which was divided into 9 equal parts (squares) by lines. We noted the length of stay of animals in individual parts of the pen, number of grid crossings, and direction of the body when lying and standing. The number of grid crossings was not statistically different between the groups during the irradiation. The calves of both groups stayed for the most time in square S_1 with the feeder with hay and starter mix, and in the neighbouring S_2 square. The S_3 square was also quite preferred. The S_5 square, above which the UV-light emitter was placed, was occupied in the fourth place. The bodies of animals in both groups were orientated towards the perimeter of the pen significantly longer than towards its centre.

The live-weight growth and feed consumption were studied in the period from UV-light exposure to the 44th day. The results showed that an overdose of radiation substantially inhibited the live-weight growth of the calves. The difference in the average daily weight gain for the period from the third to seventh day of the experiment was statistically significant: 0.26 kg in the experimental group, 0.84 kg in the control group. An exposure to excessive doses of ultraviolet radiation reduced appetite.

Fear as a cause of aggressive pecking in laying hens

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Fifty-four 50-week-old laying hens were selected from three aviary systems. Eighteen of these hens had been previously identified as 'victims' (frequently being chased and head pecked), 18 as 'aggressors' (performing aggressive pecks) and a further 18 were selected at random (controls). A test arena (3 x 3 m) was placed in an adjacent room and two concentric squares were drawn on the floor to label areas as outer, middle and inner with respect to a fear inducing object in the centre. Hens were individually captured and placed in one corner of the arena facing the novel object. Behavioural data were recorded over a 10 min period. We hypothesized that if fear is a mechanism underlying aggressive pecking, the fear responses of aggressors and victims (the latter being predisposed to being frightened by virtue of their victim status) should be similar and both these categories should be more responsive to a fearful stimulus than the controls. Hens spent most (>90%) time in the outer area. A Kruskal-Wallis analysis showed victims had a significantly greater latency to vocalise than aggressors ($P<0.015$) and spent more time attempting to escape than both aggressors and control ($P<0.015$). Aggressors and victims spent less time standing ($P<0.015$) and performed displacement pecking more frequently ($P<0.01$) than the controls. These results show: (1) victims were the most frightened; (2) aggressors and victims shared some responses which were different from the responses of the controls. This suggests fear may play at least a partial role in predisposing hens to commit aggressive pecking.

Reducing animal numbers in experiments

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Commonly, when we wish to carry out an experiment, we decide on the number of subjects to use based on (a) how many subjects there are available, (b) the cost to us or to them of the test procedure, and (c) some gut feeling about how many we need in order to make the sort of decision that we hope to make. In many situations it is desirable to keep the number of subjects used as low as possible, especially when the test procedures are stressful or painful. The "gut-feeling" estimation method usually greatly overestimates the number of subjects needed.

If you both (1) know the mean and variability of your population, and magnitude of effect of interest and (2) are able to test your subjects one at a time, then you can more economically carry out experiments using many fewer subjects. From prior research or from control group data, we often have an estimate of mean and variance, and can estimate an important magnitude of effect.

Sequential sampling techniques were developed for quality control engineers and are rarely used by behavioural scientists. Sequential sampling is preferable to commonly-used procedures as it is more powerful in that fewer subjects (around 50%) are required in order to arrive at a decision with the same degree of certainty.

Sequential sampling involves collecting data from single subjects in succession, plotting the subjects' scores on a predetermined graph, and then stopping the study when that plot exceeds a set level.

The technique is simple to use, readily available in computer statistics packages (e.g., STATISTICA by StatSoft), makes statistical analysis simpler, is more powerful, and uses fewer subjects. It is a more ethical alternative in contentious experiments, and it should be more widely known and used.

Evaluation of sound to enrich the environment of piglets during stressful procedures

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Farmers are often advised to provide music or other background sound as environmental enrichment for farm animals or to mask sudden disruptive noises, but the effects of this practice have rarely been evaluated. We played different sound recordings to piglets in two stressful situations: when the animals were held for 5 min as if for castration, and during the first 24 h after weaning. We used counts of the vocalizations given by the piglets as an indication of their level of distress. The sound treatments included pulsed white noise, music, white noise or music with a sub-rhythm used to induce relaxation in humans, sounds given by other sows and piglets in stressful situations (during actual castrations, or after weaning), or silence. In the short-term restraint, none of the sound treatments reduced the piglets' level of calling below that of silence, and some treatments led to significantly more calling. In the 24 h post-weaning period, some treatments led to significantly more calling in the first hours following separation from the mother.

Effects of journey length, space allowance during transport, and lairage during and after road transport on the behaviour of sheep

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The effects of journey length, feeding, watering and resting intervals, and space allowance during road journeys were investigated in a series of experiments. Direct behavioural observations of sheep were made before, during and after transport. Sheep lay down during the journey if provided with adequate space. After 3 h of transport the proportion of scans during which the sheep (35 kg) were lying was less at a space allowance of 0.22 m^2/sheep (0.08 of scans) than at space allowances of 0.27, 0.31, and the 0.41 m^2/sheep (0.33 of scans) ($P<0.001$). The frequency of losses of balance and slips due to vehicle movements was less at a space allowance of 0.22 m^2/sheep (median 2.5/h) than at higher space allowances (median 4.0/h) ($P<0.01$), although the frequency of either falls or collisions with the vehicle walls arising from these events was low (median <0.1/h). There was no significant effect of providing either a 3 h or a 12 h lairage period during a 24 h journey compared with a continuous 24 h journey with no lairage, on the lying behaviour during both the remainder of the journey (proportion of scans spent lying after 12 h lairage 0.41, after 3 h lairage 0.52, and after no lairage 0.55 of scans) and during the first 12 h post-transport (proportion of scans spent lying after 12 h lairage 0.76, after 3 h lairage 0.74, and after no lairage 0.73 of scans). If the sheep did not have adequate space to lie down during the journey they laid down more after the journey than those that were able to lie down during the journey. After journeys of either 12 or 24 h, but not after a journey of 8 h, the immediate behaviour of most sheep was to stand and eat hay (0.80 of scans were spent eating hay during the first hour post-transport) rather than to lie down. The results suggest that if sheep are able to lie down during the journey, a break in the journey to provide rest may not be necessary. However, the behaviour after the journey suggests that sheep would benefit from feed and water at 12 h intervals.

Bar-biting and slat-chewing in experimental sheep are not equivalent responses to dietary deficiencies

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The term stereotypy is a descriptive tool, and should not imply either causal or functional equivalence between all aimless, repetitive behaviour. Experimental sheep in slatted, unbedded pens, for example, commonly perform two similar oral stereotypies, bar-biting and slat-chewing. We recorded the development of these stereotypies in Suffolk lambs that were individually housed in experimental pens (1m x 2m) at eight weeks of age and fed one of three low fibre diets: a conventional high energy feed *ad lib* (AL, n=63); a restricted quantity of this feed (R, n=28); and a high energy, low protein feed *ad lib* (HELP, n=27). From 33 weeks all lambs also received a handful of hay (about 100g) every day. Initially, bar-biting was rare for each diet (2% of scans). It did not increase in AL or HELP lambs with age, but rose to 10% of scans in R lambs by 32 weeks ($P<0.001$). The provision of hay had no effect on bar-biting. R and HELP lambs initially performed more slat-chewing (both 10%) than AL lambs (5%; $P<0.01$). Slat-chewing rose with age (AL, 9%; R, 19%; HELP, 24%: $P<0.001$) and was reduced by hay (AL, 6%; R, 14%; HELP, 18%: $P<0.001$) in all three diets. These differences in the effect of diet indicate that bar-biting and slat-chewing are not equivalent. Slat-chewing was readily performed by lambs and appeared be a relatively natural response which may compensate for dietary deficiencies. Bar-biting arose only in R lambs, bore little resemblance to other feeding behaviour, served no obvious purpose and was harder to disrupt once established.

Housing laboratory pigeons

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Pigeons frequently serve as subjects in biology and psychology studies. Traditional housing consists of individual cages where the birds can observe other birds but not interact with them and are fed restricted rations. Birds used in operant conditioning experiments are usually maintained at 15-20% below their *ad lib* feeding body weight. During a series of operant experiments investigating foraging, different methods of housing were established. Birds were maintained in indoor aviaries or in a loft with a flight area on a roof. Few problems were encountered maintaining operant performance under these conditions. Following the change in housing, overall activity, time spent in plumage care, and muscle volume increased. Body weight initially decreased then increased over the succeeding weeks. There was little aggression after the first few days, routine husbandry took less time and any health problems were easier to detect. Housing pigeons in aviaries, indoor or outdoor, allows expression of a greater range of behaviour and has welfare benefits for the birds.

Behavioural responses of broiler chickens to whole-body vertical vibration

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Vibration is one of the factors which might reduce broiler welfare during transportation. The objective of this study was to assess which specific frequencies of vertical vibration, occurring on a transporter, were aversive to broiler chickens.

An operant conditioning, passive avoidance technique was used to assess aversion. The response of birds was obtained over a 2 h session using a variable-ratio 20 schedule of food reinforcement. Concurrently, each bird was exposed to 30 seconds random narrow band vertical motion following every 20th peck. In a completely randomised design, each bird was exposed to one frequency (0.5, 1, 2, 5, 10 Hz) at one of three acceleration magnitudes. Four birds were assessed at each of the fifteen combinations. Birds had to trade off the benefit of responding for food against the cost of exposure to vibration.

Results showed significant suppression in the total number of pecks recorded during the 2 h session ($P<0.05$). At each frequency, a fitted curve of mean number of pecks against acceleration magnitude was used to construct contours of equal numbers of pecks (i.e. levels of aversion) in the frequency / acceleration magnitude plane. These contours were essentially parallel. Results indicated that for frequencies of 0.5 Hz to 2 Hz there was no change in aversion with increasing acceleration magnitude. However, at frequencies beyond 2 Hz aversion increased linearly with acceleration magnitude.

Parallel studies of vertical vibration on poultry transporters show that peak accelerations occur below 4 Hz (Randall, Streader and Meehan, 1993, *British Poultry Science* 34: 635) which, from the current study, are those vibrations that birds find most aversive. Aversion may be due to discomfort, fatigue or fear, however this work suggests that current design of poultry transporters require improvement to their suspension.

Courtship behaviour of wild boars (*Sus scrofa leucomystax*) under captive conditions

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The courtship behaviour of wild boars was observed and compared with that of domestic pigs in order to clarify the variance of behaviour that accompanies domestication. Two groups under captive conditions were used in this experiment. Each group consisted of one male and five or six females. The statistical sequence of male courtship behaviour was determined. The sequences of following to sniffing, sniffing to chin-resting and leaving, and chin-resting to mounting were positively significant ($P<0.001$). Sniffing determines whether male wild boars continue courtship behaviour or not. There were some differences between the courtship behaviour of wild boars and that of domestic pigs. In domestic pigs, nosing was located in the centre of the courtship behaviour pattern, and there were significant behavioural transitions from nosing to all other courtship behaviour and vice versa. On the other hand, only two patterns of behavioural transition, from nosing to head to head and from mounting to following, were observed in wild boars. It is likely that the courtship behaviour of wild boars is, therefore, more fixed than that of domestic pigs. Courtship behaviour of male wild boars focused significantly more on the left hand side of females than on the right hand side ($P<0.01$). Behaviour such as flehmen after vulva-sniffing, urine-sniffing and dung-sniffing was observed. It continued 2-25 s each time.

Natural and synchronized heat in Nellore (*Bos taurus indicus*) cows and heifers

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Artificial insemination of Zebu females is based on the same schedule established for european breeds. However, the high return rates observed are discouraging its use. This problem can be related to the time of occurrence and duration of estrus. The objective of this work was to investigate the heat behaviour of Nellore females from the National Beef Cattle Research Centre (EMBRAPA), during two breeding seasons. In the first breeding season, 12 cows were observed during two consecutive heats. The first heat was synchronized with Sincro-Mate-B. In the second breeding season, 14 heifers were synchronized. After implant removal, estrus behaviour was looked for over five days. Duration of synchronized and natural heats for cows were 11.2 ± 2.6 h and 10.7 ± 2.3 h, respectively. In heifers, heat lasted 10.3 ± 3.6 h. Time of ovulation for cows was 11.6 ± 3.7 h and 18.0 ± 3.6h after the end of natural and synchronized heat, respectively. Fifty-eight percent of cows and 50% of heifers showed first signs of heat between 1800 and 2400 h. Due to the short duration and the large number of animals showing heat at night, the effectiveness of detecting heat in the morning and at night is questioned. These observations suggest: (a) cattle detected in heat in the morning must be inseminated in the same morning. For those animals remaining in heat, re-insemination should be performed in the same afternoon; b) females detected in heat during the afternoon should be inseminated the next morning.

Social facilitation and exploration

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The effect of a drinking companion on the behaviour of domestic hens (*Gallus gallus domesticus*) was investigated. The two aims of the investigation were (1) to see if drinking was sensitive to social facilitation, and (2) to see if differences in the degree to which birds were influenced by a drinking companion correlated with one or more social or non-social traits. The social facilitation was studied using a focal animal with a thirsty/non-thirsty companion and measuring the intake of the focal animal. Each hen was used as its own control in a balanced design (n=12). Other traits were also measured: the rank within each pair in a competitive feeding situation, the social dependence/fear as measured by the distance they were prepared to stray from a caged flock mate, the latency to approach a novel object, and finally the body-weight (as a crude measure of the overall rank of the birds, i.e. their rank in the group).

The focal animals drank on average 4.2 ml when with a thirsty companion and 0.5 ml when with a non-thirsty companion, showing that social facilitation of drinking did occur (P=0.001; Wilcoxon Matched-Pairs). In each pair, body-weight was a good predictor of rank, with the heaviest bird the most dominant ($P<0.05$; Wilcoxon Matched-Pairs, one-tailed). It was discovered that the lightest birds were the ones most influenced by the drinking companion (r_s=0.73, P=0.006). Furthermore, the heaviest, and probably most dominant, individuals kept the shortest social distance (r_s=0.74, P=0.006) and had the longest latency to approach a novel object (r_s= 0.66 P=0.02).

These results mean that the birds that were most influenced by a drinking companion were also the individuals that were least fearful and that showed the highest degree of exploration. The individuals that showed a high degree of social dependency, on the other hand, were not as influenced by the behaviour of the companion. This supports the exploration hypothesis of social facilitation in domestic poultry.

Thermoregulatory behaviour and metabolic responses in dry sows housed in an uninsulated building

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Behavioural, physical, and physiological responses of pregnant sows to cold exposure were investigated. Ten groups of six pregnant sows were housed in an uninsulated building during winter. There were two pens in the house, each containing kennels with straw bedding and individual feeding stalls. General activity (standing, sitting, movement, manipulating straw), lying posture, degree of huddling and the use of kennels were continuously recorded by four videocameras. Instantaneous sampling with 10 min intervals was used. Social rank order was decided by using a food competition test. Groups 7 and 8 (12 sows) were used to measure core temperature and skin temperature on seven different areas of the body. Blood samples were taken from the same sows in order to measure the level of plasma glucose, free fatty acids and thyroxine. From January 20 to March 11, 1995 the average, minimum and maximum temperature difference outside and inside the house was 3.0, 0.5 and 9.5°C, respectively. The average temperature difference outdoor and inside the kennels was 12.0°C, the minimum being 8.0°C and the maximum 19.0°C. Preliminary results from the behavioural studies showed that with decreasing temperature outside, the sows spent more time lying on the belly close to each other than with higher temperatures (R_s = 0.8, $P<0.05$). On the other hand, if temperatures were high, the sows spent more time lying on their side without physical contact (R_s = 0.6, $P<0,05$). There was a negative correlation between outdoor temperature and time spent in the kennels (R_s = -0.4, $P<0.05$) and manipulation of straw in the huts (R_s = -0.4, $P<0.05$). The oldest and biggest sows spent more time in the huts than the younger and smaller ones (R_s = 0.5, $P<0.05$). Individuals with a low social rank order showed more activity in general than high-ranked animals (R_s = 0.4, $P<0.05$). The main thermoregulatory strategies used by sows were huddling and changes in lying posture. The activity levels were not so influenced by decreasing temperature. This was in great contrast to sheep, which mainly reduced their lying time and thereby increased their heat production.

Behavioural responses of pigs to two challenge tests

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There are often substantial individual differences in behaviour performed by pigs. We wished to ascertain the consistency of behavioural responses of pigs to two different 'challenge' tests. In our study, 50 groups of four pigs (two gilts and two castrates) were tested at 15 and 21 weeks of age.

In the open-door test, the passageway next to the pen was blocked by two solid boards, creating a corridor-shaped area of 7 x 1m. The length of the corridor was divided into seven equal sections. After the door of the pen was opened, behaviour was recorded on videotape for 8 min. Variables scored were latency of time to leave the pen and number of sections crossed. Mean latency time was significantly lower ($P<0.001$) at 21 weeks (36 ± 6 s) than at 15 weeks (77 ± 9 s), suggesting some habituation to an initial fear response. Latency times at two ages did not correlate significantly ($r=0.10$, ns). At 21 weeks of age the mean number of sections crossed (94 ± 4) was significantly lower ($P<0.05$) than at 15 weeks (105 ± 4). There was a significant correlation between number of sections crossed at 15 and 21 weeks of age ($r=0.35$, $P<0.001$), which may be explained by the fact that gilts crossed more sections than castrates at both ages ($P<0.001$).

In the food-competition test, the single-space feeder in the home pen was closed for 20 h, after which it was opened at 1000 h. The following parameters were then scored for 15 min: duration of feeding, frequency of aggressive behaviour, and frequency of attempts to displace the pig at the feeder. Duration of feeding did not differ between ages (15 weeks: 239 ± 5 s; 21 weeks: 238 ± 4 s; ns). Pigs showed a lower frequency of aggressive behaviour at 21 weeks of age (8.5 ± 0.7) than at 15 weeks of age (12.5 ± 1.1) ($P<0.01$), but displayed more attempts to displace (15 weeks: 8.2 ± 0.8; 21 weeks: 13.1 ± 0.8; $P<0.001$). All the variables correlated significantly between pigs at 15 and 21 weeks of age (duration of feeding, $r=0.47$, $P<0.001$; aggressive behaviour $r=0.28$, $P<0.05$; attempts to displace $r=0.24$, $P<0.01$).

Behaviour in the open-door test did not significantly correlate with behaviour recorded in the food-competition test. We conclude that the hypothesis that stable individual differences amongst pigs exist, is supported mainly by results of the food-competition test.

Boar taint and pheromones

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The purpose of this presentation is to elucidate the pheromonal aspects of the substances responsible for boar taint in pig meat. These substances are androstenone, skatole and indole. Androstenone is a male pheromone produced in the testes, stored in adipose tissue and released to the surroundings via saliva. Skatole and indole are produced from microbial activity in the hind gut, and are likewise taken up by adipose tissue.

The investigation comprised 4 replicates of 100 pigs (half intact males, half females), randomly allocated to 10 pens of 10 pigs each. Data from 90-110 kg liveweight included repetitive recordings of aggressive interactions and dominance rank in connection with competitive feeding; determination of androstenone, indole and skatole levels; and assessment of sexual maturity at slaughter. Results (ANOVA) showed that rank was significantly related to the level of androstenone ($P=0.0001$), regardless of the sex of the dominant pig in the pen. High ranking animals also had the largest bulbo-urethral glands ($P=0.0001$), highest levels of skatole and indole in plasma ($P=0.0005$ and 0.03 respectively), whereas this was not the case for levels in faeces. Instead, pigs subjected to least aggression tended to have lowest levels of skatole in faeces ($P=0.09$). The higher the maximum level of androstenone was in a given pen, the higher was the level in the remaining animals ($P=0.0003$), i.e. there was a stimulating effect. Likewise, a high pen maximum was associated with a higher level of aggression ($P=0.003$).

The pheromonal messages conveyed by boar taint substances are not quite clear, but must be related to the social structure, behaviour and ecology of the pig.

The demand for straw and feathers as litter substrates by layer hens

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Consumer demand theory has been applied to investigate the behavioural demands and the environmental requirements of farm animals. Typically, animals are given the opportunity to work for items, and the amount of a particular commodity that is obtained ("consumed") is measured when the work requirement ("price") is varied. The elasticity of demand is calculated from the slope of the function relating consumption to price.

Our recent research with layers has shown that the demand for various floor litters (peat, sand, wood-shavings) is inelastic. Other litters (eg straw and feathers) are available to hens in some housing systems. Inadequate litters have been suggested as a risk factor in the development of feather pecking. This study aimed to determine the importance of straw and feathers to hens by measuring demand functions for these items. In one hour sessions, individual hens (n=6) were given the opportunity every second day to work on fixed ratio schedules (FR5 to FR200) for access to either straw or feathers. The number of responses made and reinforcers delivered were recorded by computer. The behaviour performed during each session was recorded on video. Although the hens did not dust-bathe in straw or feathers, straw (but not feathers) functioned effectively as a reinforcer and the demand for it was inelastic (-0.48). This implies that even if a substrate does not support dust-bathing, caged hens have a high demand for a suitable litter substrate. Methods to establish the level of demand for particular behaviours rather than for different environments need to be developed. Such techniques might be more useful for quantifying differences in demand for substrates that elicit different types of behaviour.

What makes a calf butt?

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During normal nursing, the young of many ungulate species butt against the dam's udder with their head. It has been suggested that butting stimulates milk ejection and so might occur when milk flow slows or stops, but there is no direct evidence to support this. Bucket-fed dairy calves sucking a non-nutritive teat also butt. We developed a model to test hypotheses about the proximate causation of butting. Twelve male Holstein calves were fed milk from an artificial teat system which permitted us to change the rate of milk flow both between and during meals. We fed calves with four different flow rates: Fast (1.33 l/min), Medium (0.70 l/min), Slow (0.34 l/min), Very Slow (0.14 l/min). Butting rate tended to be greater on slower flow rates, with the least butting occurring on the fastest rate (0.6 butts/min) and the most butting occurring on the slowest rate (1.3 butts/min) ($P<0.01$). On all four flow rates calves butted more during the first minute than during either the middle or final minutes of their meal ($P<0.01$). Switching between two flow rates at 30s intervals during a meal produced more butting in periods after a decrease in flow rate versus periods after an increase in flow rate ($P<0.01$). Stopping the milk flow for 30s also dramatically increased the butting rate (0.2 vs. 5.2 butts/min; $P<0.01$). Butting rate was relatively low with a constant flow rate. We conclude that a decrease and a stoppage of milk flow are proximate causes of butting behaviour by the calf.

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The effect of an operant foraging device (The modified "Edinburgh Foodball") on the performance of stereotypic behaviour in the stabled horse

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The "Edinburgh Foodball" is an operant foraging device, providing small food rewards relatively randomly in space, time and quantity (Young *et al.* 1994, *Appl. Anim. Behav. Sci.* 39: 237). Winskill *et al.* (1995, *Appl. Anim. Behav. Sci.* in press) found that it increased species-typical behaviour in stabled horses, and suggested that the device may reduce stereotypic behaviour. This study aimed to investigate the influence of the foodball on the performance of equine stereotypies.

Six horses exhibiting stereotypic behaviour (2 weaving, 2 crib-biting, 1 windsucking, 1 box-walking) were subjected to the following treatments: Baseline (Days 1-3), normal management practices followed and known quantities of concentrates and hay fed; Enrichment (days 4-8), baseline evening concentrated feed replaced by introduction of the foodball which was left in the stable. The horses were videotaped continuously, and behavioural data collected by 2 min instantaneous scan sampling.

During baseline, horses spent an average 5.27% ($\pm$ 8.17 SD) of time in the stable performing stereotypy. During enrichment, horses used the foodball 6.3% ($\pm$ 9.23 SD) of the time in the stable. Significant individual variation in foodball use was found (Kendalls Concordance, $W=0.497$, $P<0.05$). Most horses used the ball as soon as it was filled, and foodball use generally declined overnight. During enrichment, there was a trend for stereotypic behaviour to decrease (Wilcoxon Matched Pairs, $N=6$, $W=2$, $P<0.1$). A reduction in stereotypic behaviour was seen in five horses, and an increase in stereotypy in one horse (crib-biter). Increased overnight crib-biting was observed during enrichment.

The "Edinburgh Foodball" appears to have potential for reduction of certain equine stereotypies (especially food-related locomotory stereotypies). In conjunction with other measures such as behavioural therapy and increased exercise, the foodball may help prevent the development of stereotypies, and has the additional benefit of facilitating increased horse-owner contact.

Designing trials to evaluate treatments for behavioural problems in companion animals

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Companion animal behaviour is becoming better understood, and undesirable behaviour is being treated with drugs or behavioural modification or both. In most cases, evidence for the efficacy of these treatments is anecdotal. Scientific evaluation is needed and may be done with a clinical trial. The trial, in turn, must have certain features if the results are to be valid and generalizable. This presentation highlights basic issues in the design and conduct of clinical trials. Examples of these issues will be drawn from an ongoing trial that evaluates the drug clomipramine as a treatment for canine compulsive disorder. A clinical trial may be considered under the following headings: (i) objectives (research hypothesis) (ii) treatment (administration; dose) (iii) ethics (informed consent of the owner; use of placebo or other control treatment) (iv) design (there is considerable variability between pets, which may make the crossover design more appropriate for some problems) (v) randomization and blind design (vi) study population (vii) eligibility criteria (viii) recruitment (ix) diagnosis of cases (x) choice of outcome(s) and how to measure it (them) (xi) protocol deviations (xii) follow-up (xiii) statistical analysis (xiv) generalization of the results. All of the above points should be considered when evaluating treatments for behaviour problems in companion animals.

The nature, purpose and development of rooting in pigs

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Rooting is a pervasive activity in pigs that occupies 20-30% of the day in natural conditions. It is assumed that its main function is to search out, identify and harvest food. Yet it occurs in commercial pigs housed on bare concrete and fed ad libitum, and in piglets within two days of birth, when their nutrient intake is supplied by suckling, suggesting that rooting is a basic behavioural need. Piglets direct a similar action at the sow's udder during suckling. Perhaps massaging the udder is the same activity that piglets gradually redirect from one target (the udder) to another (the ground) during the course of weaning. Rooting appears to involve three distinct activities: (i) passing the snout over the ground without touching it, apparently sniffing, (ii) a similar action with the nasal plate palpating the surface, (iii) digging the upper rim of the snout into the ground and shovelling it forward. Each of these involves some combination of a number of component micro-actions. In order to determine the specific actions serving the different purposes and the relation between them, video-recordings were made of rooting by adult pigs, and of both rooting and massaging at the udder by suckling pigs at various ages. Head and snout movements, point of contact and use of the nasal plate varied systematically with the different functional activities in adults. In piglets, the micro-actions of massaging resembled those of digging, with the upper rim of the nasal plate forming the main pressure point. The time spent rooting increased with age (piglets in crated farrowing pens, with a peat-filled rooting tray, spent 0.6, 4.1 and 7.0 mins per hour rooting at 2-5, 14-15 and 22-30 days of age, respectively, during morning observations: $P<0.001$), while that devoted to massaging declined (spending 5.4, 4.8 and 3.1 mins per hour massaging at 2-5, 14-15 and 22-30 days respectively: $P<0.001$). Rooting constitutes a complex and adaptive skill, with both sensory and effector capacities, and serves many purposes. This multiple capability facilitates weaning by enabling the same action to be used for acquiring food both before and after.

The impact of nose-rings on the micro-actions of rooting in pigs

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Pigs kept on pasture are commonly given nose-rings in order to suppress rooting and hence reduce pasture damage. Video-recordings were made of rooting in unringed sows (UR) and in those ringed either with three copper-wire rings clipped through the upper rim of the snout (CR) or with a single rigid steel 'bull' ring through the nasal septum (BR), to enable analysis of the precise component actions of rooting. When ringed sows did attempt to root, they did so much more tentatively, with less apparent force and velocity. They also used quite different actions. Unringed sows palpate the ground with the flat end of the snout; they dig in with the top rim and push forward, using the snout as a shovel. BR pigs pushed at the soil with the lower edge of the snout, keeping the flat plate at an angle and the ring clear of the ground; some dug in with the lower jaw only, biting at the ground. CR pigs used the lower edge and plate of the snout, but did not dig with the upper rim. During the week after ringing, proportion of time rooting with upper rim, flat end, lower rim and lower jaw in contact with the ground was respectively 73, 11, 2 and 0% in control pigs, but 0, 8, 22 and 44% in CR and 0, 1, 11 and 68% in BR pigs ($P<0.0001$). Proportion of time with snout not in contact with the ground at all was 14, 26 and 20% respectively. Three weeks later, differences were reduced, largely because a heatwave had hardened the ground and UR pigs dug with the tip of the snout much less. Differences were still statistically significant 22 weeks later in soft November soil.

The organization of behavioural responses to novel arena tests in dairy calves

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The organization of behaviour during novel arena testing in calves was investigated using principal component analysis. Two experiments are reported here. In the first experiment 31 dairy calves (six months old) were subjected to a 10 minute test in a novel arena containing a novel object (a chair). The duration of sniffing, walking, immobility and the latency to sniff the wall and the novel object were recorded. After 10 minutes a person entered and latency to sniff this person was recorded. In the second experiment 27 dairy calves (three months old) were tested in an arena with an unfamiliar, restrained calf present. Latency to sniff this calf was recorded. Subsequently, the calves were subjected to a 10 minute novel arena test. Latency to sniff the wall, duration of sniffing, immobility and time spent in the centre of the arena were recorded. All variables were log transformed and analyzed by principal component analysis. In the first experiment three principal components with eigenvalues 2.6, 1.2 and 0.9 explained 81% of the variation. The first principal component (44%) had a high positive coefficient for immobility and a high negative coefficient for sniffing. The second principal component (22%) had high positive coefficients for latency to sniff the wall and the person while the third principal component (16%) had a high positive coefficient for latency to sniff the chair. In the second experiment three principal components with eigenvalues of 2.0, 1.4 and 1.0 explained 87% of the variation. As in the first experiment, the first principal component (39%) contrasted immobility and sniffing. The second principal component (27%) had a high positive coefficient for latency to sniff the calf, and the third principal component (20%) had a high positive coefficient for time in the centre of the arena. In both experiments the first principal component is interpreted as representing exploratory motivation. Responses to people and novel objects, respectively (experiment one) and to a conspecific (experiment two) appeared to be uncorrelated to this first component. This suggests that reactions are specific and that we have to be cautious using results of novel arena tests to predict individual calves' general ability to adapt to husbandry practice.

Behavioural adaptation of pigs to the irritant effects of atmospheric ammonia

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Symptoms of ammonia exposure can be both immediate and delayed. Irritation of ocular, nasal and respiratory tract membranes is observed after brief exposure to the highest ammonia concentrations recorded in piggeries. Passive avoidance operant conditioning was applied to compare the motivation of pigs to avoid acute exposures to peak ($\approx$100ppm) and background ($\approx$40ppm) ammonia concentrations, with their motivation to feed.

Twelve gilts, of between 30kg and 70kg and fed to 80% free-feeding level, were trained to manipulate an operant conditioning paddle functioning under a VI30 schedule. Fresh air was continuously ventilated through the paddle at approximately 3.1m^3/s. Paddle manipulation was reinforced with approximately 14g of pelleted food delivered to the paddle base. The food was removed automatically after 20s. Ammonia was released over this food, peaking in concentration at 15s. Each daily experimental session lasted for 90-minutes. The results were analyzed by ANOVA, using a repeated measure design.

When 100ppm was vented through the paddle, significantly fewer responses were initially made (240.5$\pm$36.1 vs 344.9$\pm$37.7; 100ppm vs control; $P<0.05$) and fewer food reinforcers were received (37.4$\pm$2.5 vs 43.4$\pm$1.6; 100ppm vs control; $P<0.05$) during a session. This difference disappeared over eight consecutive experimental sessions ($P<0.001$). The behaviour of the pigs when 40ppm ammonia was vented through the paddle did not differ from the fresh air control (364.6$\pm$37.0 responses, $P>0.05$). The ammonia did not influence the proportion of the delivered food consumed (59.0%$\pm$1.0 vs 60.9$\pm$0.6% vs 60.9$\pm$0.2%; 100ppm vs 40ppm vs control; $P>0.05$).

Avoidance of 100ppm but not 40ppm ammonia suggests that pigs initially perceive higher concentrations of ammonia as irritating rather than novel. This aversion was not sustained. Other studies have shown that 40ppm ammonia only becomes aversive (perhaps nauseating) after prolonged exposure (Jones, Wathes and Webster, 1995, *Proc. ISAE UK Winter Meeting*, London; Jones *et al.* 1996, *An. Sci.*, in press).

Cow strategies in relation to visits to an automatic milking visit in a free cow traffic situation

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Milking without human interference in an automatic milking system (AMS) is starting to be introduced. However, it is still not clear how cows adapt themselves to different AMS situations. The behaviour of 18 Holstein-Friesian x Friesian-Dutch dairy cows, kept in a cubicle house with an AMS, was studied over eight 24 h periods by means of computer registrations and over three 24 h periods by means of video observations in an AMS situation in which the cows were left a free choice whether to visit the AMS or not. The AMS was positioned in the cow-shed with its entrance in the lying area and its exit in the feeding area. During milking visits to the AMS, cows received concentrates. During non-milking visits they were immediately sent out of the system without receiving concentrates. Roughage mixed with some concentrate was available ad libitum at 8 feeding gates with individual cow recognition. Visiting patterns of cows were analyzed in relation to previous AMS visits. Moreover, the time budget of the cows and the occurrence of aggression in front of the AMS entrance was analyzed in combination with the chosen strategy. The results show significant differences in the cows' behaviour after milking visits and non-milking visits ($P<0.05$). After a non-milking visit, when the cows did not receive any concentrates, they seemed to prefer the feeding area to eat roughage and after a milking visit, when the cows got concentrates, they seemed to prefer the lying area to lie down. Besides, after a non-milking visit, the time elapsing until the next AMS visit was shorter and the incidence that the cows passed the feeding area and the lying area only once until the next AMS visit were more frequent. The cows spent on the average 42.9 ± 2.7% of their time lying and 15.1 ± 0.5 % of their time at the feeding gate. Aggression in front of the AMS was hardly observed. First analyses of another experiment with 24 cows in the same AMS situation showed comparable results.

The use of foraging substrates by two groups of behaviourally different brown layers

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Under some circumstances hens will choose to forage rather than eat identical feed that is freely available, but there is little information about the characteristics of foraging substrates that hens prefer. This study investigated the use of various foraging substrates by 24 ISA Brown hens aged 32 weeks, kept in groups of four at 1.2 birds/m^2. Twelve hens (group A) were previously kept in groups of eight, at 2.3 birds/m^2, and had not been observed to feather peck. The other 12 hens (group B) were previously kept in a group of 168, at 14 birds/m^2, and were known to feather peck. Initially group B hens were more aggressive and restless but settled after five weeks. When presented with either meal mixed with coloured gravel (m&g), meal with multicoloured balls (m&b) or mixed corn with coloured gravel (c&g), group B preferred m&g and m&b (98.8 and 114.9 pecks/bird/h respectively) compared with c&g (14.3 pecks/bird/h). Group A used all far less than group B (10.3 pecks/bird/h vs 76.0 pecks/bird/h) and had an equal preference for all substrates. Groups preferred food in the foraging substrate (80.0 pecks/bird/h), but they still foraged significantly more in the inedible substrate compared to an empty trough (1.7 pecks/bird/h vs 0.25 pecks/bird/h). Birds reduced time spent feeding when they used the foraging substrate. Time to habituate to gravel substrates was also investigated.

Behaviour and welfare of semi-wild Scottish Highland cattle in nature-reserves

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In the Netherlands, large grazing mammals are used for the management of the vegetation in nature reserves. Occasionally, cattle or horses are allowed to grow and live with minor intervention by man. Population growth is then limited by the carrying capacity of the area. However, under circumstances of extreme population growth some animals have to be removed from the herd. The necessary selection of animals can cause effects on the welfare of individuals within the herd, for instance due to removal of calf/mother, leading cow (i.e. experience) or due to destruction of social structure. The impact of this selection could be minimized when it is based on behavioural knowledge of the relations between animals. Observations started in September 1994 and were done on a semi-wild Scottish Highland cattle herd in 'National Park Veluwezoom' (Eastern Netherlands). The social organization consisted of groups of variable size, whose membership varied from day to day. Association indices between adult individuals were low from March to June but high from September to December. During movements between groups most animals had variable positions, although there were at least three 'leading' cows present (on the first position for more than 75% of the recordings). Time-budgets of bulls during the rut were dominated by aggressive and sexual behaviour. Young bulls were often found in the neighbourhood of dominant bulls, the impression that the young bulls learned to tend cows in this way is currently being investigated. New-born calves stayed mainly within 1 m of their mother; 1 year olds stayed within 5 m. The study produced many more results that are being used for the management of this herd of free-ranging cattle.

Vocalizations of Scottish Highland bulls during the rut

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Scottish Highland bulls utter a number of vocalization during the rut. We discerned at least ten vocalizations already partly described in the literature under varied labels. Vocalization, behaviour and context were recorded with the Observer software to investigate the function and causation of the vocalization and dependency on the context. Video recordings were made to record the vocalizations in their precise context. Calls were analyzed with the Signal sound analysis system allowing for detailed analysis of the time and frequency structure of the sounds. Vocalizations were uttered mainly in the morning and evening when most interactions between bulls occurred. Bulls could be approached within 2 m, so very soft vocalizations could be recorded; nine were aimed at other bulls, one aimed at cows. A number of vocalizations occurred in specific contexts; others were more specific for the individual and could be used for individual recognition. For example, loud calls - named bellows - were specific for bulls, and also specific for individuals (frequency and duration were significantly different between all bulls). Recognition and presence of bulls on certain locations could be verified based on this vocalization. Another example is the in literature described 'Cri du combat'. This vocalization occurs only in bulls that are losing or have lost a fight. The structure of the call shows specific characteristics of approach-avoidance conflict (see the motivational-structural rules developed by Morton). The two highest ranking bulls vocalized more and longer than lower ranking bulls. The hypothesis that the condition of the bulls may be reflected in their vocalizations is current investigated.

Spacing behaviour of mares and foals in a herd of Hokkaido native horses kept outdoors all year round

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Hokkaido native horses weigh about 350 kg and stand about 130 cm at the withers when mature, and have been used for packing horses on the island of Hokkaido in northernmost Japan, since the last century. The population of these horses now is less than 2,000. In the Livestock Farm of Hokkaido University, a herd of 20-30 mares and their offspring have been kept outdoors all year round. In this herd, spatial behaviour between dams and foals and between the dams were studied through the suckling period. On a 4.8 ha pasture, the behaviour of four pairs of dams and foals including two male and two female foals was observed from 0600 to 1800 h once a month from June through November. The distances from each dam to her own foal and to other horses were estimated by the scale-unit of each dam's body length at 15 min intervals. Thus, the distance between animals were expressed as less than 1, 2, 3, 4 and 5, then between 5-10, 10-20 and more than 20 units of body length. Suckling, grazing, lying and other social behaviour of foals was observed continuously through observations. Up to 4 months of age, each foal was frequently observed nearby each dam, and distributions of distance between dam-foal were significantly different from those between dam-dam distributions ($P<0.05$, Kolmogorov-Smirnov test). These significant differences of spatial behaviour between dam-foal and dam-dam disappeared after 6 months of age in female foals, while it disappeared at 5 months of age in male foals. Through the suckling period for both male and female foals, there seemed to be tendencies that time budget of suckling and lying were decreasing, while time budget of grazing and the mean distance between dam-foal increased. As suckling behaviour decreased, social grooming and affiliative behaviour between dams and foals tended to increase ($r=-0.79$ and -0.55, both NS). In this herd, 5 focal dams and their nearest neighbour dams were observed. Three of 5 dams showed specific pair-behaviour to certain other dams ($P<0.05$, Chi-square test), and in only one of these pairs was the relationship dam-daughter.

The effects of early housing and handling of dairy calves on the subsequent man-animal relationship

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The aim of this study was to examine the effect of different housing and handling of calves during early life on man-animal relations about two years later. During the first 3 months of life, 80 Danish Holstein-Friesian female calves were housed in either: (1) Open single boxes, (2) Closed single boxes (no visual and tactile contact to other animals), (3) Group boxes (5 calves/box) or (4) Group boxes (calves and cows together). Calves on treatment (4) could suckle their mothers during the whole period. At 3 months of age, all calves were tethered and treated equally.

When these animals were heifers, 15-18 months old and pregnant, they were pastured for 6 months during the summer. During the last 3 months of this grazing period, the heifers' fearfulness to humans was examined five times. In the field, it was examined how close a man could approach each animal using the following method and scale.

1. Possible to touch the animal without problems
2. Sniffing to the hand, but not possible to touch
3. Keeping a distance below 2 m
4. Keeping a distance over 2 m

The average score for the four groups was 2.2^b, 1.4^a, 2.4^b, and 3.2^c ($P<0.01$, Kruskal-Wallis) with a replication coefficient between observation days of $r=0.86$.

The results show that the isolated situation in the closed single box (group 2) during the first 3 months of life has a significant effect on the fearfulness towards humans. The reason must be that the only social contact the isolated calves have had is from a human. On the other hand, calves which were reared together with their mother during the first 3 months of life (group 4) were very reserved towards humans, even though they has seen man as much as the other group (the cows were machine milked twice a day in the pen). There were no differences between open single box (group 1) and group box (group 3).

The results indicate that calves have a sensitive period for imprinting during the first 3 months of life. The effects of this early imprinting may be assessed by a simple approach test 2 years later.

A preliminary study examining the effects of testosterone (T) or dihydrotestosterone (DHT) implants on the activity of female Red-Eared Slider turtles (*Pseudemys scripta troostii*)

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Red-Eared Slider turtles produce offspring whose sex is temperature dependent and thought to be associated with the amount of T deposited in their eggs at laying. Aromatase is a temperature-dependent enzyme which converts T to estrogen and thus can alter genetic sex and behaviour. The objective of this experiment was to determine if exogenously administered T (aromatizable androgen) or DHT (non-aromatizable androgen) affected turtle activity or mating behaviour.

Twelve female turtles were randomly assigned by weight to one of three implantation treatments: control, C (n = 3); T (n = 4), or DHT (n = 4). Female turtles were implanted with vehicle (C), T (5 mg), or DHT (5 mg). Both controls and treatment animals (T or DHT) were housed together in 1136 l tanks with males. Each tank was videotaped, using time-lapse photography, every 3 days (0700 to 1900 h). Tapes from all days and treatments were viewed through the entire 12-hour observation to record mating behaviour. To analyze the tape for duration of activity, 15 min observations were taken every 2 h, five times daily. The C, DHT, and T turtles gained 0.10, 0.22, and 0.18 kg respectively ($P<0.12$). Mating behaviour was not observed during the month of study. Duration of activity during the entire period of observations did not differ between treatments ($P<0.5$; 2.25 ± 0.3 min/15 min observation), nor when analyzed by day ($P<0.4$) or time of day ($P<0.3$). The slider turtle adapts readily to laboratory conditions and is an excellent model for examining temperature-dependent sex determination. However, little is known about this species including a fully observed account of courtship and mating. The preliminary data from this study indicate that T and DHT may influence weight gain but not activity.

A validated test to assess the temperament of dogs

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This study describes a standardized, validated and workable sequence of behavioural temperament tests for assessing dogs in a rescue shelter. The development of this test was described in Ledger, Baxter and McNicholas (1994, *Proc. 29th International Congress of the ISAE*, Exeter, U.K.). Twenty-six temperament tests were performed on 56 dogs in an RSPCA rescue shelter. Behavioural responses to each test were observed. Forty of these dogs were eventually placed in homes. Their new owners completed questionnaires about their dog's behaviour. Principal components analysis was used to cluster questionnaire responses and these responses were found to correspond with commonly defined personality traits. The behaviours observed in the temperament tests correlated with trait scores and certain key behaviours significantly differentiated the dogs' trait scores, (Mann-Whitney, $P<0.05$). The best predictor of trait was, however, found to be how many of these key behaviours were displayed.

1. An unfamiliar tester standing in a kennel with a dog, ignoring it: The behavioural response to this test was significantly correlated with excitability, (rho=0.640, $P<0.001$).
2. Grooming a dog in its kennel: The behavioural response to this test was also significantly correlated with excitability, (rho=0.659, $P<0.001$).
3. Showing a kennelled dog its leash and chain and saying 'walkies': The behavioural response to this test was significantly correlated with obedience, (rho=0.724, $P<0.001$) and aggression, (rho=0.821, $P<0.001$).
4. Walking a dog outside on a lead: The behavioural response to this test was significantly correlated with timidity, (rho=0.679, $P<0.001$).
5. Approaching a kennelled dog with a titbit: The behavioural response to this test was significantly correlated with separation-related problems, (rho=0.724, $P<0.01$) and with timidity, (rho=0.793, $P<0.001$).
6. Playing 'tug-of-war' with the dog and a toy rope: The behavioural response to this test was significantly correlated with aggression, (rho=0.815, $P<0.001$).

Assessing dogs in rescue shelters may improve owner-dog compatibility. Assessing breeding dogs and puppies required for particular tasks, such as, laboratory dogs, police dogs and assistance dogs may lead to improved training success.

Factors influencing the reactions of cats to humans and novel objects

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Individual differences between animals are of increasing interest to today's applied ethologists and those who work closely with animals. Particular personality types may be better suited to particular environments (e.g. being kept under laboratory conditions). The welfare of laboratory cats might therefore be improved by manipulating breeding selection and early experience to give rise to desirable personality traits.

This study aimed to identify temperament differences in kittens and factors which influenced their behavioural responses to an unfamiliar person, handling, an alarm clock and a clockwork mouse. Suggestions to improve the adaptability and suitability of cats for specific uses are concluded. The behavioural responses of 29 litters of pedigree British Shorthair kittens (84 kittens) and their parents, were scored to these tests. Spearman rank-order correlation coefficients were calculated to measure the association between kitten and adult scores. There was a significant positive correlation between the responses of kittens and their mothers to a clockwork mouse, (rho=0.441, $P<0.01$). The most fearful mothers had the most fearful kittens. Kittens which had received least handling from their owners and were housed in the most isolated living areas, struggled more when handled by an unfamiliar person ($P<0.01$) and showed more fear of an alarm clock ($P<0.05$). Their latency to approach an unfamiliar person was also significantly greater, ($P<0.001$). Kittens with red or cream coat colour (indicating the presence of the red coat colour gene), made the most escape attempts when handled by an unfamiliar person and struggled for a longer time compared to kittens which did not carry the red coat gene, (Mann Whitney U-test, $P<0.05$). There were no significant correlations between the behavioural responses of fathers and their kittens to any of the four tests.

Selective breeding of cats which show the least fearful responses in behavioural tests will produce kittens which are more suitable to being handled in laboratories. Cats without red coats are less fearful and more handleable than cats with red coats. The degree of socialization they receive when they are young is fundamental to the level of fear that they show to handling when adult.

The effect of the level of barking on the behaviour of kennelled dogs

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Studies have found that barking is the main source of noise in dog kennels. The level of noise recorded in some dog kennels reaches 80-90 dB. This can have severe physiological effects on human hearing and therefore it may have an even worse effect on dogs whose hearing is far more sensitive. Since there are a large number of dogs kept in kennels, in rescue shelters, laboratories and in training establishments, hearing damage could pose a significant welfare problem.

The first part of this study aims to assess which factors stimulate dogs to bark in a rescue shelter. Instantaneous sampling was used to measure the relationship between the number of dogs which barked in response to five stimuli which presented themselves daily, (no disturbance, visitor only, visitor and kennel staff, kennel staff only and kennel staff and another dog). Kruskal-Wallis analysis showed that the number of people present in a kennel block had a significant effect on the number of dogs which barked, (n=887, $P<0.001$). In a second kennel block, the dogs which barked most were removed and the effect of their removal on the remaining dogs was studied. Using the same observation methods and analysis, this treatment was found to significantly reduce the incidence of barking: there was a reduction in the level of barking in the test kennel when there were no visitors in the kennel, visitors only, and a kennel maid only, (Kruskal-Wallis analysis, $P<0.05$).

The second part of this study aimed to assess the effect that the greater noise level had on the behaviour of dogs as a possible indicator of their welfare. A sample of 16 dogs were randomly selected from both the control 'noisy' kennel from the 'quiet' test kennel. The behaviour of these dogs were observed. Data will also be presented on the behavioural responses of dogs in both kennels to the five stimuli.

A circular test for the effects of environment on the orientation of peri-farrowing sows

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The orientation preferences of sows was investigated. A total of 32 pre-and post-partum Yorkshire sows were tested in two types of testing apparatus - a circular crate and an oval crate. A mean vector was introduced to express both the concentration and direction of the sow's orientation. The orientations of sows were compared between crates, between farrowing stages and between postures. One-sample test of frequency distribution showed an overall dispersion patterns of the sows' orientation along the circular ring of the crate ($P<0.05$). Such a dispersion pattern was less clearly manifested in the oval crate than in the round crate. In both crates, the sow's orientation varied either in the direction or in concentration when sows were in different postures ($P<0.05$). Among four main sow postures - lateral lying, ventral lying, sitting, and standing, preference was most evident in the circular crate when the sow was in a standing position ($P<0.05$). The oval crate clearly directed sows to lie in its long axis while the circular crate allowed the sow to lie more or less randomly in all directions. However, the sow was not significantly influenced by the presence of piglets.

Social effects on nesting in hens

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In the wild, a hen will usually move away from flockmates and find a secluded place in which to nest. Several factors influence the hen's decision where to lay her egg. In addition to the quality and safety of the nest, she may also consider social factors. Under commercial conditions, there are more potential nest sites but hens have no opportunity to move away from flockmates and social factors could become especially important. The aim of this experiment was to study the effects of competition and disturbances on nest site selection in commercial laying hens.

Hens were housed in 16 litter pens (15, 30, 60 and 120 hens per group x 4 replicates) and the levels of aggression and disturbances were compared between nestboxes and pen corners. The number of hens per nestbox area was the same for all group sizes but since all pens were rectangular the number of hens per corner area was higher in larger groups. Despite a higher level of disturbances in the corners ($P<0.001$) and a higher level of aggression directed towards nesting birds ($P=0.01$), most hens chose to lay their egg in the corners ($P<0.001$). However, the time a hen stayed at the nesting site correlated to the level of aggression; the more pecks a hen received the shorter time she stayed ($P<0.01$) and the more pecks she gave the longer time she stayed ($P<0.001$). Therefore, social factors had a greater effect on time at the nest site than selection of the nest site.

Differences in sow maternal behaviour and degree of success: cause or effect?

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In a natural farrowing environment, sow maternal behaviour greatly influences litter performance. The objectives of this study were to determine retrospectively, any differences in sow behaviour in an open farrowing system, on the basis of litter survival. The behaviour of 24 Large White x Landrace sows was continuously recorded for 7 days after farrowing in a communal farrowing system comprising five farrowing pens, with a communal passageway and an outdoor dunging area accessible only to the sows. Piglet survival to 7 days post-farrowing was recorded. An arbitrary division of the sows into 'successful' (n=10) and 'unsuccessful' mothers (n=14) was made on the basis of litter mortality being below or above 17% (range 0-54%). After farrowing, successful mothers spent longer away from the piglets (19.6% vs. 12.0% of total time, P=0.037) and less time lying with udders exposed (65.0% vs. 71.6% of total time, P=0.040). Successful mothers tended to lie down; (1) facing the passageway more, (2) away from the creep more, (3) dangerously in the middle of the pen less. Successful mothers carried out significantly more rooting actions (4.0 vs. 3.3 per lying event, P=0.024) and looking at the piglets (2.2 vs. 1.8 per lying event, P=0.002) before lying down, reducing the risk of crushing. The results indicate that there were behavioural differences between successful and unsuccessful mothers. However, whereas differences in behaviour associated with lying down are likely to be a cause of maternal success, differences in time budgets are likely to be an effect.

Expression of the social situation by vocalization in chickens

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Young chickens need social support to establish their social bond by imprinting. Social deficits in the early development of chickens may effect the later behaviour of the animal. In the last years we started searching for information about the social situation of chickens by analyzing their vocalization. In this study we compared the distress calls of animals from three breeds in a test with stepwise reduction of the number of social partners.

Fifteen to 20 chickens of each breed (Silky Hens, Chabos and White Leghorn) were housed in commercial rearing boxes. The Step-Isolation-Test was executed in a soundproof chamber with a start group of 5 animals and 6 repetitions per breed. The vocalizations of the animals were recorded with a calibrated recording system on a DAT-Recorder. The distress calls were processed by numeric analysis of sound signals.

The calibrated recordings of calls enabled us to measure the exact sound pressure level for each call. The level o distress calls uttered by a single chicken was between 89.4 and 95.9 dB. White Leghorn chickens gave shorter calls with lower call energy than Silky Hens or Chabos chickens. Within the Step-Isolation-Test we found comparable reaction in call duration and call energy for each breed. The single point parameters of calls give us a deeper insight into the reactions of the breeds. For example, White Leghorn shows the highest value of peak energy in calls by the five-animal group, but Silky Hens or Chabos single animals show the highest peak energy. Chabos show only high peak energy when isolated as single animal but the calls of Silky Hens have also a higher level of energy in three-animal groups.

The call features and other behaviour in the open field (pecking or walking) show differences between the three breeds, too. White Leghorn chickens from a commercial breed show a higher reaction after the transfer to a new environment than after reduction of group size. This may be a sign for the reduction of social facilities in these animals. Chabos, which are described to be highly intelligent, give the same low reactions in activity and in call parameters in a five- and three-animal group.

Measurement of monoamine levels in canine saliva - advantages and limitations of a non-invasive technique for behaviour research

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The measurement of monoamines, including 5-hydroxytryptamine (5HT), 5-hydroxyindolacetic acid (5HIAA), homovanillic acid (HVA), vanillymandelic acid (VMA) is finding increased attention in the field of animal behaviour, especially for the understanding of mechanisms underlying behavioural problems related to anxiety, aggression, obsessive-compulsive disorder (OCD), and their pharmacological treatment. For avoidance of frequent cerebrospinal fluid (CSF) and blood sample collection, we evaluated advantages and disadvantages of canine saliva samples for analysis of 5HT, 5HIAA, HVA and VMA with high performance liquid chromatography, comparing central (CSF) and peripheral (serum and saliva) levels, as well as potential influences of flow rate on saliva monoamine concentrations.

The study was divided into three steps. First, CSF and serum samples collected during routine surgical and diagnostic procedures from canine patients (n=12) were examined. Secondly, saliva and serum samples were collected from male and female laboratory Beagles (n=50), comparing 5HT, 5HIAA, HVA and VMA concentrations. Finally, saliva samples were taken from Beagles (n=8), with sterile cotton buds, followed by saliva collection with cotton buds prepared with citric acid (20 and 40 mg) for determination of potential influences of saliva flow rate on monoamine concentrations.

Measurement of monoamines in canine CSF have shown that concentrations relate closely to serum levels, although anaesthesia, breed, age and other factors might influence our results. A comparison of serum and saliva concentrations indicates a statistically significant correlation. Analysis of saliva samples collected with and without citric acid shows that saliva flow rate has no significant influence on monoamine concentration.

Although further investigations regarding the comparison of central and peripheral monoamine levels are needed to confirm our preliminary data, it is evident that this method presents a reliable and stress-reduced non-invasive technique.

The concept of behavioural abnormality and its relevance to animal welfare

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Much welfare legislation and literature refers to the need for an animal to perform normal behaviour. In defining this concept, a statistical approach is commonly used e.g. Broom and Johnson (1993, *Stress and Animal Welfare*, Chapman and Hall, London). Here, normality is considered to be that which is exhibited by a majority of members within the population or species. This approach is of limited value when considering matters relating to animal welfare. It does not relate to the functional significance of the behaviour in the specific context concerned. Behaviours defined as abnormal by such an approach may, in fact, reflect fully functional adaptations by an animal to its current environment, for example when the context of concern is different to that in which the norm has been calculated. Alternatively, environmental conditions may be such that a behaviour indicative of poor welfare is shown by the majority.

Clarification of the concept is therefore necessary. This is possible through a recognition of its various dimensions, (see Rosenhan and Seligman, 1984, *Abnormal Psychology*, W.W. Norton, New York). Thus a behaviour may be considered abnormal if it: involves suffering, is maladaptive, is inexplicable, deviates from that which is shown by the majority, is unpredictable, is unacceptable in the social context of the animal, or causes observer discomfort. The welfare implications of each criterion relevant to a given behaviour must then be assessed.

Evaluation of the Hurnik-Morris (HM) housing system for the well-being of breeding gestating swine

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A group housing system for sows, the Hurnik-Morris (HM) System, was developed which addresses several of the perceived animal welfare limitations of existing housing methods. HM sows were observed to lie less frequently in sternal recumbency (31 vs. 21%; P=0.004), exhibit less stereotypy behaviour (0.10 vs. 0.56%; P=0.034) and participate in more social activities (1.4 vs. 0.19; P=0.0007) than gestation stall (GS) sows. HM sows revealed a significantly longer latent period to postprandial lying than GS sows (64 vs. 32 min.; P=0.0001). The order of sow entry into the feeding compartments tended to be more consistent than the order of feeding compartments being entered (W=0.57 vs. 0.41; P=0.06). Possibly, social factors appeared to be more important than spacial ones in determining the order of feeder entry behaviour.

A multiparous study revealed that the HM sows attained comparable numbers of piglets weaned and litter weaning weights to gestating sows reared in individual gestation crates (GS). HM sows were leaner than GS sows at prefarrowing time (18.6 mm and 21.3 mm respectively; P=0.0001). Significantly higher lifetime parity of HM sows (3.1 vs. 2.6; P=0.046) suggested that the HM system supports greater longevity. The higher levels of life-time productivity for the HM sows (27.2 vs. 21.5 piglets weaned/sow; P=0.045) also reflects on the superior impact of this housing system on animal well-being. Attrition profiles and the causes of attrition on sows varied between housing systems and further indicates that the HM system provides a better welfare housing situation than gestation stalls.

Improving stress coping capacity in pigs by temperament evaluation

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Stress in pigs results in considerable variation in welfare conditions and in production traits, partly explained by individual differences in adaptability to prevalent production conditions. In some species, the mode of adaptation to stress, the coping pattern, can be divided in an active or a passive mode. In order to examine if this dichotomy also exists in pigs, piglet responses were evaluated during behavioural tests in relation to their growth rate.

In the second and third week after birth 3868 piglets underwent a back-test (BT2 and BT3): they were put in a supine position and latency to first escape attempt was recorded. Behaviour in an open field test (OFT) (latency to leave the starting square and to reach one of the central squares, number of grid lines crossed, time spent in the central and peripheral squares) and the reaction to a novel object and to a human (latency to first interaction, number of interactions and total time interacting) were noted after weaning in 716 piglets.

The distributions of the latency time of both back-tests were not normal nor bimodal. The correlation coefficient between BT2 and BT3 was 0.45 ($P<0.0001$). Sixty-nine percent of the animals reacted twice in the same manner, i.e. twice faster or twice slower than the mean. The daily weight gain between the second and third week in the responders which reacted twice faster was higher than in those responders which reacted twice slower (215.4 vs. 207.2 g/day, $P<0.05$). When the population was divided based on the number of grid lines crossed during the OFT, a strong consistency existed in other behavioural traits: the most active piglets showed shorter latency times, longer total interaction times and interacted more with the novel object and the person ($P<0.05$), but had lower growth rate between the third and fifth week (216.1 vs. 229.2 g/day, $P<0.05$). Hence, a tendency for consistent behavioural strategies in relation to growth rate was found. Additional behavioural tests and reproduction recordings of sows will be evaluated in the future to confirm this conclusion for adult animals.

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Laboratory mice show a lack of direction during wheel-running with respect to resources

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It has been suggested that wheel-running by caged animals is a re-directed form of searching behaviour and that the animal is attempting to increase the probability of encountering resources which are not attainable in its cage. It might be expected then, that if unattainable resources are placed outside the wheel, animals will run toward the stimulus resource. This experiment determined the tendency of laboratory mice to direct wheel-running toward resources, specifically, cagemates or bedding material. The wheel-running activity of four mice was video-recorded for three days in the absence of a stimulus resource. For the following three days, a transparent cage containing cagemates was placed on one side of the wheel, and on the opposite side for a further three days. This was repeated for another group of four mice using bedding material as the stimulus resource. Video-tapes of each 24 h period were scanned at 5-min intervals and the direction of wheel-running determined (Table 1). Three-way ANOVA showed that proportion of total scans when the mouse was wheel-running was not significantly affected by the position of the stimulus resources (P=0.23) or the mouse (P=1.0), but was significantly affected by the direction i.e. left or right (P=0.0094). These preliminary results indicate that the direction of wheel-running by mice was not significantly influenced by resources in the immediate vicinity of the wheel, but overall, there was a tendency to run in one direction.

Table 1. The direction of wheel-running in relation to resources outside the wheel, or in relation to left or right.

		Percentage of total scans when mouse was recorded as wheel-running			
Mouse	Resource	Toward	Away	Left	Right
1	Cagemates	53.2	46.7	40.1	59.9
2	Cagemates	35.6	64.3	26.9	73.1
3	Cagemates	41.6	58.5	41.0	59.1
4	Cagemates	53.1	46.8	26.5	73.5
5	Bedding	54.5	45.4	43.5	56.5
6	Bedding	55.5	44.4	59.7	40.2
7	Bedding	43.1	56.8	55.4	44.5
8	Bedding	46.1	53.8	76.7	23.2
	Overall	47.7	52.3	45.1	54.9

The relationship between livestock distribution channels and animal welfare

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Technological advances, legislative controls and social and economic pressures have precipitated major changes in the nature and structure of slaughter livestock distribution channels in the U.K. These factors are dynamic and will continue to cause shifts in the levels of utilization of livestock auction markets, electronic auctions and direct farm to abattoir sales.

The distribution channel from farm to abattoir can take a variety of forms, largely dictated by the marketing system used. For example, livestock marketed through live auction markets may experience handling operations and transportation structure very different from those marketed directly from farm to abattoir. As a consequence of these differences, the welfare of livestock is likely to vary between channels. The effect of handling and transportation variables on animal welfare have been investigated and the aim of this study is to present a conceptualized model of the various distribution channels and the implications of each channel for animal welfare.

Determination of the effect of distribution channel on animal welfare and identification of best practice will assist in improving the welfare of slaughter livestock between farm and abattoir and enhance consumer confidence in welfare-assured production and distribution systems.

The effect of origin, pre-slaughter handling and time from farm to slaughter on the welfare and meat quality of lambs

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Live auction markets are perceived to be more stressful than sales direct from farms to abattoirs. Increased handling, mixing of unfamiliar animals and additional transportation necessitated by the live auction system are among the key variables known to affect welfare.

This paper presents the results of a preliminary investigation of the effect of origin, pre-slaughter handling and time from farm to slaughter of 2327 lambs arriving at one abattoir on carcass pH measured 5 hours post slaughter. Ultimate carcass pH of 242 of these lambs was also measured 24 hours post slaughter. The aim was to measure the rate and extent of post mortem glycolysis which can influence meat quality and give some indication of the aggregate effects of pre-slaughter handling practices on animal welfare.

Results indicated that there was no significant difference in ultimate carcass pH between lambs arriving directly from farms and via livestock auction markets. Significant relationships were, however, found between other variables in the distribution processes and carcass pH (for example intra-market and intra-haulier differences ($P<0.001$), suggesting that handling and transportation practices may have a greater impact on animal welfare than the marketing system per se.

Monitoring feeding behaviour of cattle by detection of acoustic emission induced by forage-chewing

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Feeding behaviour is considered to be affected by quality of forage. However, the relationship between feeding behaviour and forage quality such as hardness, moisture and nutritional content, is still obscure. Recently, acoustic emission (AE), the sound induced from distortion or breaking of solid material, is frequently used in medical diagnosis such as joint movement, blood circulation and teeth occlusion. We examined the possibility of using AE to differentiate the chewing sounds and frequency caused by different forage resources. Chewing sounds of cattle were recorded by the finely tuned sound level sensor, covering the range of from 0 to 1 kHz. The sound was analyzed with the Fast Fourier Transform Analyzer at ten-second intervals after A/D conversion. The AE profile during chewing of forage had a major peak in the range under 10 Hz and two other peaks were observed around 100 Hz and 300 Hz. The AE from chewing changed according to forage quality. The strength of the peaks was related to the moisture content of the forage. The AE induced by forage-chewing had a tendency to become smaller when the moisture of forage was higher. The chewing frequency also changed with the quality of forage. These results suggest the possibility of using AE analysis for monitoring feeding behaviour of cattle.

Allonursing and weight gain in water buffalo calves (*Bubalus bubalis*)

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Allonursing is part of the behavioural repertoire of water buffalo cows. The effects of this behaviour on the weight gain of calves were investigated in a dairy herd at an experimental station in the state of Sao Paulo, Brazil. Twenty nine cows and their calves were observed on range from birth to weaning (10 months), 3 days per month. These observations were carried out while the calves were in a pasture together with their mothers, from 1000 to 1600 h each day. Sucking behaviour was recorded as follows: recording began when the calves succeeded in getting a teat into its mouth for, at least, 3 seconds, ending when the teats were set free. All animals were weighed monthly. Daily average of time spend sucking was estimated when calves sucked on their own mothers (TM= alone and TMC = collective) and on any other cows than their own mothers (TO = alone and TOC = collective). Two periods were considered: first four months of age (U4) and first eight months of age (U8). The averages were compared by t-test and the Pearson's correlation coefficients were estimated. Males (n = 14) presented higher means than females (n = 15) for weight gain per day (WG), TM and TOC (U8 only), as follows: WG U4 = 0.49±0.13 kg and 0.39±0.11 kg ($P<0.01$); WG U8 = 0.43±0.09 kg and 0.33±0.08 kg ($P<0.01$); TM U4 = 5.03±2.67 min and 1.70±2.15 min ($P<0.001$); TM U8 = 2.96±1.38 min and 0.98±1.09 min ($P<0.001$); TOC U8 = 6.80±4.23 min and 3.64±3.23 min ($P<0.05$), respectively for males and females. Correlation coefficients were significant between TM and WG for males (r=0.610 and 0.719, for U4 and U8 respectively; $P<0.05$), while for females there were significant correlations between TOC and WG (r=0.526 and 0.644, for U4 and U8 respectively; $P<0.05$) and between TMC and WG for U4 (r=-0.518, $P<0.05$). It was concluded that allonursing affected the weight gain of calves, but in a different way for each sex.

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Attraction of the parturient cow towards placenta and amniotic fluid

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The attraction of the parturient cow towards donor placenta and donor amniotic fluid was studied using 13 Holstein cows. Nine preference tests (PT) were video recorded: at six months of pregnancy, at 48, 24, 12, and 6 h before expected parturition, and at 1, 4, 12, and 24 h after parturition. PT were: 6 min choice between a trough containing silage (SC) or silage plus donor placental material, and a 4 min choice of silage plus donor amniotic fluid. Donor placentas and amniotic fluid were collected from cows at parturition. Each cow was used as a focal animal, with the following events recorded: inspecting SC (INSC); inspecting contaminated trough (INST); eating or licking SC (EALC); eating or licking in contaminated trough (EALT); not at the troughs (OUTT); care-giving to calf (CAGC). Relative times of each behaviour in each test were statistically analyzed using the GLM procedure. Across the placenta PT the relative time INSC and EALC decreased linearly ($P<0.003$), whereas EALT increased linearly ($P<0.002$). A contrast comparison between tests before vs after parturition was significant ($P<0.001$) for both EALC and EALT. In the PT with amniotic fluid, the only significant change across tests was the linear decrease ($P<0.006$) in the relative time OUTT. However, a contrast comparison between the PT with amniotic fluid at 48 and 24 h before parturition vs the subsequent tests, showed the cows spending more time EALT in the later tests ($P<0.05$). The results revealed that the attraction to placenta and to amniotic fluid by the parturient cow is not exclusively specific to the cow's own afterbirth, and can occur (in the case of amniotic fluid) even before parturition.

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Social hierarchy and feeding learning in pigs

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Feeding behaviour was studied in 8 groups of 12 Large White boars (starting weight 30 kg), during the training period to use an electronic computerized feeder, to assess the relationship between social hierarchy and the learning processes. Animals were fed ad libitum and the average initial weight was 30 kg. Pigs were observed by continuous video recording during the first six hours of training. Feeding activity was controlled during the following six weeks from data collected by the computerized system: identity of the pig, feeder entry and exit times, amount of food consumed. Dominance order was based on competitive feeding test before the observations began.

During the first six hours, dominant pigs showed the lowest entrance latency to the feeder system (7 vs. 90 min in subordinate pigs). The feeding activity was significantly affected by social rank during the three first weeks; compared to subordinate pigs the dominant ones were characterized by two peaks of activity as early as the first week, higher number of meals (+2), lower feed consumption by meal (-30%) and higher meal duration (+20%). The feed intake per day was also higher (+100 g) while the average rate of feed intake was lower (2 g/min). Similar results were obtained during the three following weeks, but differences were not significant. The results suggest relationships between individual feeding strategies and social rank during the training period, but limited over time when feed supply is not restricted.

Reinforcing properties of milking vs. feeding for high and low yielding dairy cows in a y-maze and an automatic milking system

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In Experiments 1 and 2, six high yielding (HY, 33.9l/day s.d 5.4l) and six low yielding (LY,13.8l/day s.d. 1.6l) dairy cows were given the choice to be milked or not in a Y-maze five times/day every 3.5 h. The cows were divided into two groups of three, each of which was milked in opposite spurs of the maze. (Cows were milked a minimum of twice/day). After nine days, the treatment positions were swapped to the alternative spur, to accommodate any spur preference, for a further nine days. Prior to each phase, the cows were trained to associate each spur with its particular treatment. Milking motivation was categorized as motivated (>24 milkings), aversive (<10 milkings) and indifferent over the last three days of each phase (max 30 milkings). Three HY's were motivated, one aversive and two indifferent. Two of the LY's were motivated, one indifferent and three aversive.

In Experiment 3, six HY's (35.2l/day s.d=3.1) were given the choice between being milked or fed 1kg of pelleted food. At every opportunity the cows chose to be fed. In Experiment 4, 12 cows (6 high and 6 low yielders, 27.52 s.d= 3.36: 13.63 s.d=1.35 respectively) were allowed voluntary attendance to an automatic milking system for 15 h/day. One HY cow was motivated (>6 milkings/cow over final three days), one aversive (0 milkings/cow over final three days) and four indifferent. One LY cow was motivated, three aversive and one indifferent. When fed concentrate (HY's 4kg/day, LY's 2kg/day) in the AMS, all the HY's and two LY's were motivated to enter the system. Three LY's were aversive and one indifferent. Individual cows may find milking either positively or negatively reinforcing. Food is significantly more reinforcing than milking for HY's and LY's. Motivation to be milked is unlikely to be a sufficient stimulus to attract cows into the AMS, whereas motivation to be fed will be.

Heart rate and behaviour of primiparous dairy cows during milking

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We examined heart rate, behaviour and inhibition of milk let-down during 3 afternoon milkings in 23 primiparous dairy cows. For the first 30-42 hours after parturition, cows were not machine-milked and permanently stayed with their calf in a separate pen. Each animal was observed during milking on day 2 of lactation, when they were machine-milked for the very first time, and on days 4 and 130 of lactation. Heart rate (HR) was monitored continuously during a 20 minute baseline recording before milking and from entry into the milking parlour until exit. Behaviours recorded, included the number of flinch, step and kick (FSK) responses performed during udder washing, cluster attachment and milking. After cluster removal, residual milk was assessed by injecting 10 IU of oxytocin intravenously and machine milking the cow again. On average, the total number of FSK responses did not differ between milkings ($P>0.20$). Compared to days 2 and 4, mean HR during milking (both absolute and expressed as increase to baseline), baseline HR and residual milk (expressed as % of total milk yield) were significantly decreased ($P<0.01$) on day 130 of lactation. Only during the first two milkings observed, was HR increase during udder washing significantly correlated with both the number of kicks during udder washing and residual milk ($P<0.05$). Individual differences in FSK responses, residual milk and HR were consistent ($P<0.05$) only between early lactation milkings. Our results suggest that mechanisms underlying FSK responses may differ according to stage of lactation.

Effect of the distance between feeder and drinker on behaviour and leg disorders of broilers

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The incidence of leg problems is influenced by genotype, nutrition and management factors (Riddel, 1992, In: *Bone Biology and Skeletal Disorders in Poultry*, (Ed. C.C. Whitehead), Carfax Co., Abingdon, U.K., p. 119). Previous experiments have shown that higher locomotor activity not only improved the walking ability but also influenced the bone development (Reiter and Bessei, 1995, *Proc. 29th Congress of the ISAE*, Exeter, U.K., p. 211). A possibility to stimulate locomotor activity under practical conditions may be the increase of the distance between feeder and drinker.

In this experiment, 600 commercial broiler chicks per group were reared in deep litter compartments (15 birds/m^2) under a continuous light program. Two distances, 2 and 12 metres, were tested from the 2 to 5 weeks of age. The frequency of changing between feeder and drinker and the behaviour was observed. The torsional and angular deformity of tibia and femur were measured by a special device. Once a week the incidence of leg disorders was scored subjectively. Data were analyzed using analysis of variance and Mann-Whitney U-test.

Body weight development and feed efficiency were not influenced by the distance between feeder and drinker. The locomotor activity was higher, the percentage of birds which died from sudden death syndrome and which had to be culled for leg problems were lower in groups with greater distance. Higher locomotor activity reduced the angular and torsional deformity of the bones.

Surgical versus non-surgical castration in domestic sheep: behavioral and physiological responses

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Frequently, surgical procedures are performed on livestock without administration of anesthetics or analgesics. Of these procedures, castration is one of the most commonly performed surgical manipulations. As an alternative to surgical castration, non-surgical methods are available. Application of rubber rings (elastrator rings) around the spermatic cord results in ischemia, local necrosis and subsequent loss of the testicular tissue. To determine whether a non-surgical method of castration was preferable to a surgical method of castration, we evaluated the behaviour and physiology of 7-day old lambs castrated by either method. Fifteen lambs were randomly assigned to one of three treatments: surgical castration (SC, n=5), non-surgical castration (NC, n=5) and sham-castration (S, n=5). After treatment, blood samples were withdrawn, analyzed for cortisol and behaviour was videotaped. All data were analyzed by ANOVA. Cortisol levels were greater ($P<.05$) in both castrated groups (SC and NC) versus shams. Peak cortisol levels were observed within 40 min of castration although the magnitude of the response was apparently higher in SC (100.1 ± 15.1 ng/ml) versus NC (78.1 ± 8.2 ng/ml). The frequency and inventory of normal behaviours decreased in both castrated groups (SC and NC) versus the shams. Alternatively, both castrated groups (SC and NC) replaced normal behaviours with abnormal behaviours or behaviours indicative of restlessness. Interestingly, there were no differences in the frequency or inventory of behaviours, normal or abnormal, between the non-surgically and surgically castrated lambs. Thus the non-surgical method of castration does not appear to be more humane than the surgical method of castration.

Dust-bathing by layers in the sand-bath of large enriched cages

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Observations were taken to investigate whether the presence of a sand-bath in a large enriched cage really results in improved hen well-being. To minimize negative effects only a thin (0.5 cm) sand layer was present in the bath. To avoid egg laying in the bath, accessibility was limited to three hours at the end of the light period (hens prefer to bathe during the middle of the light period). During the period of accessibility a closing grid rested on this sand layer, to enable removal of hens (and eventual eggs) from the bath at closing time.

There was no bathing in the dust-bath for only 8.75 ± 5.25 min per day (mean value of 5 days). Each day more than 80% of the hens bathed in the bath. All 40 hens bathed in the bath within 5 days. The frequency was extremely high: more than 50% of the hens dust-bathed in the bath on each of five successive days. The presence of the dust-bath had no significant influence on the amount of feather lipids found. Most dust-bathes in the bath were of a short duration. Incidently, rubbing was observed in the bath.

In earlier research at this Institute it was found that hens postponed dust-bathes till the bath was open. Therefore, it is concluded that with respect to bathing in the sand-bath the level of well-being is probably higher than in battery cages.

Why can't dairy heifers eat clover quicker than grass?

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This paper reports an experiment to characterize the ingestive behaviour of dairy heifers grazing monocultures of either grass or clover (two core groups of three heifers on each herbage species). Two different types of jaw movements were characterized: prehensions (i.e. when herbage is gathered in to the mouth and then severed with a bite) and mastications (when herbage previously severed by a prehension bite is chewed before swallowing). The heifers had a total jaw movement rate (i.e. prehensions + mastications) of between 70 - 80 min^{-1}. Of these, 80-90% were prehensions, with bite mass varying between 0.15 - 0.3 g DM $bite^{-1}$. There were no significant differences between bite masses and DM intake rates of grass or clover. These results show that the grazing behaviour of heifers was very different to that previously reported in sheep (Penning, Parsons, Orr and Hooper, 1994, *Grass and Forage Science* 49: 476; Penning, Parsons, Orr, Harvey and Champion, 1995, *Appl. Anim. Behav. Sci.* 45:63). Sheep had a total jaw movement rate of approximately 150-160 min^{-1}. At low bite masses (30 mg DM $bite^{-1}$), approximately half of the jaw movements were prehensions when grazing either grass or clover. However, at higher bite masses (>100 mg DM bite-1), the proportion of prehensions was reduced to one third when grazing grass, but remained approximately one half when grazing clover. This ability to maintain a relatively constant proportion of prehensions when bite mass increased resulted in a lower total handling time per bite for sheep grazing clover. This ability to alter the ratio of prehensions and mastications allowed the sheep to achieve greater total DM intake when grazing clover compared to grass. In contrast, the fact that the majority of the jaw movements shown by the heifers were prehensions meant that the heifers had much less ability to alter the ratio of prehensions and mastications. Consequently, the heifers could not eat clover quicker than grass.

Correlation between behaviours in open-field test and reaction to ACTH injection in calves

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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 cows to various environmental stresses. In this experiment, 7 Holstein calves (3 females and 4 males, aged 1 month) were subjected to 6.0 $IU/W^{0.75}$ ACTH trial after a 24 h fast. Cortisol and metabolite concentrations in plasma were analyzed. For measuring fearfulness in calves, an open-field test was performed in a 4.5 x 4.5 m pen one or two months after the ACTH trial. The floor of pen was divided into nine equal squares by white lines. The behaviour recorded was the number of lines passed across, vocalizations, etc. All the calves were ranked separately according to the levels in each physiological and behavioral character. High rank correlation coefficients were observed between reactions and behaviours. Cortisol and urinary nitrogen levels, in particular, revealed high correlations with behavioural characters.

Is there a role for corticosterone in expression of oral stereotypies in restricted-fed fowls?

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Growing parent stock (breeders) of meat type chickens (broilers), subjected routinely to chronic food restriction, show increased drinking and pecking at non-food objects (oral stereotypies) after a single daily meal. Expression of these activities is correlated positively with the level of restriction imposed, and is thought to be controlled mainly by central dopaminergic mechanisms. There is published evidence that glucocorticoids amplify the activity of dopaminergic pathways thought to mediate behavioural responses to psychostimulant drugs and certain environmental stimuli. This poster describes four experiments examining the relationship between corticosterone and behaviour in individually caged broiler breeders.

In Experiment 1, birds were fed either the recommended daily ration (severe restriction), twice that amount (mild restriction), or ad libitum. Plasma corticosterone concentration was correlated positively with the level of restriction (and hence with expression of oral stereotypies) when blood samples were taken in the morning, at 6 and 10 weeks of age, but not when they were taken in the afternoon, at 10 weeks (treatment $P<0.001$, day $P=0.002$, interaction $P=0.155$). In Experiment 2 (severe restriction only), plasma corticosterone level did not change significantly with time of day ($P=0.173$), and mean values of individual birds were not correlated with their observed times spent in oral stereotypies ($r=0.094$). Corticosterone level may decline from morning to afternoon with mild but not severe restriction. In Experiment 3 (severe restriction), object pecking increased in a dose-related way after systemic injection of 1-4 mg/kg corticosterone ($P=0.022$) and 7.5-30 IU/kg ACTH ($P=0.226$), and 10-40 mg/kg metyrapone (corticosterone synthesis inhibitor) had no effect. In Experiment 4 (severe restriction), 180 mg/day metyrapone administered in food for 5 days reduced ($P=0.003$) the plasma corticosterone response to injection of 15 IU/kg ACTH on the fourth day, but otherwise had no effect. Significant increases in drinker directed activity ($P=0.025$) after injection of ACTH on the fourth day and 4 mg/kg corticosterone on the fifth day coincided with greatly elevated plasma levels of corticosterone.

It is concluded that the oral stereotypies of restricted-fed broiler breeders do respond to induced increases in plasma corticosterone concentration that are supra-physiological, but there may be only a weak association between behaviour and corticosterone within the physiological range.

Effects of stereotypies on sympatho-adrenal- and hypothalamic-pituitary-adrenal-axes change with parity in tethered sows

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In tethered sows, the amount of stereotypies (SS) increases with parity. A survey in a commercial herd revealed that sows with high levels of SS during their 1st to 3rd parity were more likely to reach higher parity then sows with low levels. SS might partly help the sows to cope with tethering. Evidence for this hypothesis is found in the high negative correlation between SS and post-feeding heart rate (HR) and the decrease in HR during bouts of SS followed by an increase during successive bouts of non-SS. However this effect disappears after long term tethering. Cortisol levels of tethered sows with low (1-3) and high (4-7) parity number were measured before and after feeding. No differences were found between low and high parity sows. However, a significant negative correlation between SS and pre- and post-feeding cortisol levels, as well as maximum cortisol level post-feeding were found in high parity but not in low parity sows. The level of post-feeding SS did not significantly differ between low and high parity sows (63.2% vs 69.0% one hour post-feeding). Low(1-3)and high(4-7) parity sows that had been tethered during all parities were loose housed in large individual straw-bedded pens. High parity sows showed significant more post-feeding SS than low parity sows (39.2% vs 73.6% one hour post-feeding). Pre- and post-feeding cortisol levels tended to be higher in high parity sows than in low parity ones (pre-feed, 14.1 vs 34.9 ng/ml; post-feed, 16.4 vs 37.2 ng/ml). No correlations between SS and pre- or post-feeding cortisol levels were found. These findings show that in tethered sows, SS suppress stress-induced physiological reactions by decreasing the sympatho-adrenal-axis response during the early stages of tethering and by decreasing the hypothalamic-pituitary-adrenal-axis response after long-term tethering.

Using applied behaviour experiments to develop a "high-welfare" perchery system for laying hens

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Several alternative systems exist for commercial egg production in the U.K., especially since the 1970's. The perchery system is one of these alternative systems. Several perchery designs exist, including custom-built systems. However, birds' ability to use the system has mostly been ignored. These systems, promoted as an improvement to bird welfare, often increase the risk of injury and bone breakage during the production period, compared to birds in cages. There may also be higher levels of feather pulling and cannibalism. The degree of injuries and expression of vices may be linked to poorly designed systems. Staff at SAC have investigated how easily birds jump from perch to perch, both in the horizontal plane and when perches are arranged at different heights, separated by different angles. Restricted-fed birds were required to jump between perches to a food reward. In general, birds were not able to jump easily between perches separated by 1.00 m or more ($P<0.001$). Birds were able to jump upward more easily than they could jump down between perches ($P<0.001$). The birds could not easily jump between perches at 45 degrees or more.

Ergonomic studies have revealed poor working postures for caretakers in some systems. Improved working postures have been included in the studies, in the belief that improving the environment for the humans in the system could improve bird welfare, particularly during depopulation of the system. These results have been incorporated in a set of design criteria and a new design of perchery system, which aims to improve bird welfare in alternative systems.

Bull exposure has no effect on estrous behaviour in dairy cattle

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Bull exposure has previously been shown to hasten the onset of estrous cyclicity in postpartum beef cattle but has not been examined in high producing dairy cattle. This investigation was carried out to examine the effect of bull presence on postpartum reproductive characteristics in dairy cattle. Forty-five multiparous dairy cattle (mean=9764 kg milk/lactation) were randomly allocated into three groups at the time of calving. Treatments consisted of no bull exposure (NBE), twice daily exposure (2xdBE) and continuous exposure (CBE). Estrus detection was carried out for all groups for a period of 0.5 h twice daily following milking. Blood samples were collected every other day from day 10 postpartum until the time of the first AI service or until day 100 postpartum, whichever occurred first. Systemic progesterone concentrations were used to determine ovulation occurring without associated estrous behaviour. Intensity of estrous behaviour was scored on a scale of zero to four where zero indicated no estrous behaviour associated with ovulation and four indicated primary signs of estrus for at least two consecutive observation periods. Bull exposure had no effect on time to first behavioral estrus ($P>0.30$), behaviour score at first ovulation ($P>0.60$), or score at first behavioral estrus ($P>0.80$). Energy status was similar in all treatment groups ($P>0.50$). Bull exposure did not affect long term reproductive outcome in these dairy cattle.

Evaluation of the provision of a forage box to increase the normal behaviour shown by captive *Papio hamadrayas* baboons within the optimal exhibit area of their enclosure

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The effect of introducing a wooden box (126 x 110 x 13 cm) containing 0.1 m^3 of woodchips and a small amount of hidden food, into the front of a 120 m^2 outdoor enclosure containing four female *Papio hamadrayas* baboons was examined. Ten minute intermittent scan samples were used over a six hour period on ten occasions covering a 36 day period to record the time spent in a 2.86 m wide strip at the front of the enclosure.

There was a consistent and significant ($P<0.05$) increase in the proportion of time spent outdoors in this area during the observation period by all individuals, when the forage box was included. The level of effect was not related to rank position as determined by precedence during competition for food. The majority of food was removed within three hours of its introduction. Significantly more ($P<0.05$) time was spent in the designated area prior to exhaustion. These effects continued in the presence of visitors. The weather variable, wind, was most important in influencing the amount of activity outdoors. It is concluded that the forage box may prove to be a useful tool in captive primate collections. It increases the use of space available within the enclosure, through the encouragement of normal behaviour, in areas which improve the exhibit value of the collection.

The influence of intervals between nursings and udder massage on hormone levels in the domestic sow

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Milk production in the sow is strongly affected by frequency of nursings and probably also by the piglet teat massaging. We investigated whether these effects may be mediated by altered prolactin, somatotropin, or insulin levels.

Seven sows were forced to nurse every 35 minutes (group MIN35) and 6 sows every 70 minutes (group MIN70) for a period of 27 hours. During the last 3 nursings, blood was collected every 5 minutes and udder massage duration was recorded. The dynamics of hormone levels were analyzed in samples obtained immediately before and 30 minutes after each milk ejection. Prolactin increased in all but one sows after milk ejection ($P=0.002$), whereas somatotropin and insulin levels responded variably, and more often negatively, to nursing. The prolactin increase (measured as area under the prolactin curve) tended to be larger in MIN70 than in MIN35 sows ($P=0.08$), and somatotropin peak values tended to be lower in MIN70 sows than in MIN35 sows ($P=0.08$), but there were no other differences in either baseline hormone levels or their changes after milk ejection between the MIN35 and the MIN70 sows. In within-sow comparisons, duration of udder massage was related to prolactin increase ($r_s=0.49$, $P=0.02$) and insulin increase ($r_s=0.36$, $P=0.10$) and to somatotropin decrease ($r_s=-0.47$, $P=0.03$). We conclude that when frequency of nursing is altered, the hormonal changes which follow each nursing remain unaffected. The total prolactin secretion is higher in frequently nursing sows due to higher number of prolactin peaks which might support the enhanced milk production. The length of udder massage influences hormone levels, but it is unclear whether this is reflected in modified milk production.

The behavioural changes of young layers during the first week in perched cages

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The objective of the present study was to clarify how hens adjust their behaviour to a change in rearing conditions, from conventional cages to cages with perches. An experimental cage (420 x 800 x 530 mm) with a wooden perch was made by modifying a commercial cage. The perch was installed in the centre of the cage (400 mm from the front). Two birds were housed in the cage and their behaviour was videotaped for 24 h on the first, third, fifth and seventh days using an infrared camera and a time-lapse video recorder. Sixteen birds were used in total. The illumination cycle was 15 h of light (0500-0530 h and 1930-2000 h, 20 lux; 0530-0600 h and 1900-1930 h, 150 lux; 0600-1900 h, 250 lux) and 9 h of darkness. Some birds moved from the floor to the perch and prepared for resting or sleeping during the dusk period (1900-2000 h). The primary activities of birds on the perch were resting (sleeping) and preening. The rate of perch utilization increased as the experiment progressed, and stabilized by the fifth day. The difference between the rate of perch utilization in the first half (first and third days) and in the second half (fifth and seventh days) of the experimental period was significant ($P<0.01$). This tendency was observed in both light and dark periods. Hens might be able to adjust their behaviour in response to a change in rearing conditions in a short period.

The ability of miniature pigs to distinguish between people based on previous handling

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This study examined the ability of miniature pigs to distinguish between people based on previous handling. Five 8-week-old Gottingen line miniature pigs were used for two experiments. They received daily handling from a handler in a pen before and during the experiment. During the handling, the pigs were gently touched and talked to in a friendly voice, and fed raisins as a reward whenever they approached the handler. They were then trained to receive the reward from the handler in a Y-maze installed in an experimental room. In Experiment 1, the handler and a stranger sat in the maze and called to a pig. The pig was rewarded if it chose the handler (correct choice) at each trial. Each pig was subjected daily to one session consisting of 20 trials. The arrangement of the handler's position was changed at each trial according to the Gellermann series. The criterion for successful discrimination was that the pig made over 16 correct choices among 20 trials ($P<0.05$, Chi-square test). All the pigs exceeded 80% correct choice rate within 4 sessions. In Experiment 2, the voice, odour and figure of the handler and the stranger were covered in all sorts of combinations. Only one pig could significantly ($P<0.05$) chose the handler in any situation. The rest of the pigs responded differently to all the combinations. The results suggests that the pigs could distinguish people based on previous handling, but their response to people varies without all the cues.

Notation of cow behaviour with the finite state automaton

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The behaviour of a cow is represented by the finite state automaton (FSA) in the graphics display of a personal computer. Its behaviour is simplified to a set of rules. The set of rules can increase to represent more complicated behaviour. FSA is developed with an object-oriented programming environment, so that it can be applied to any other object in a personal computer such as CAD (Computer Aided Designing) program. A sample layout of a barn and yard which is an object in the computer is applied to test how an artificial cow moves in it. The layout is drawn with CAD software, and its original vector data is converted in a raster picture fashion. It shows that about 50 rules are required to represent the behaviour of a single cow. We adopted simple stimulation-time-reaction relationships in a fundamental scheme of rules. It means that continuation of stimulation results in a behaviour after some specific time. We envisaged a tank being filled up with a mass of stimulation. After a period of time the tank would be filled and overflow would represent behaviour. The threshold of overflow varies with different behaviour such as grazing or rumination. We also represented the behaviour of group of cows. Some rules of interaction between two cows are defined for the extension of the program. Interaction rules such as ranking after a simple fight is expressed with random numbers generation. We also applied some rules of interaction between a cow and a man such as feeding or milking. Internal state changes which correspond with time, affect the relationship between a cow and a man.

With this system we evaluated the condition of barn and yard configuration. By the visual observation of the cows behaviour in a computer, we could tell whether or not a sample layout fits cows' behaviour and movements.

The program has no notation of change in accordance with time. That means there is no representation of birth and death, and the system works in a two dimensional coordinate.

Individual humans as discriminative stimuli for cattle (*Bos taurus*)

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Holstein-Friesian dairy cattle were tested for their ability to use individual humans as discriminative stimuli for the performance of an operant response. Nine animals successfully learned to confine their responding to the presence of the handler (S^D) who reinforced a nose press response. During test sessions where (1) the order of handler presentation, and (2) both handler presentation and trial duration varied randomly, response rates of all cattle were significantly higher ($P<0.005$) in the presence of the S^D handler. Further, the cows' behaviour in the presence of each handler during the 15 s pre-trial periods reflected the underlying Pavlovian component of this discrimination. The ability of animals to differentiate individual humans has far reaching associative implications for the design of both laboratory and field research involving hedonic stimuli.

The effect of long-term housing in an aviary or battery cages on the behaviour of laying hens

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White Leghorn laying hens were housed for three full laying cycles in either battery cages (3 per cage; 733 cm^2/hen; n=336) or an aviary (1310 cm^2/hen; n=436), with forced moults between years. The hens were observed by scan sampling at 5 min intervals for 2 h per day during the 25, 37, 50, 62, 96-97, and 151-159 weeks of life. Data from Year 1 were reported previously. The distribution of behaviours differed significantly with housing system ($P<0.01$). Most notably, caged hens spent more time eating (26.4 vs. 22.2%), drinking (4.9 vs. 2.7%), and performing stereotypic behaviours (15.6 vs. 1.5%) than their counterparts in the aviary. The predominant stereotypic behaviours among caged hens in Years 2 and 3 were object pecking (8.9% and 34.7% of all stereotypies, respectively) and head flicking (81.7% and 19.5% of all stereotypies, respectively). The distribution of behaviours differed ($P<0.01$) with production year, but no clear trend was evident. Comfort behaviour among aviary hens tended to be higher in the afternoons than in the mornings ($P=0.08$). These results confirm the housing system, independent of genetic, nutritional, climatic and management factors, has a significant impact on the behaviour of laying hens.

The effect of music on voluntary approach of dairy cows to an automatic milking system

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To assess the effect of music on the voluntary approach of cows to an automatic milking system (AMS), 19 Holstein cows with 2 months prior experience of twice-daily milking in the AMS were observed. The cows were fed a complete mixed ration in a free stall barn and offered 1.5 kg/cow/milking of grain pellets in the AMS. Music was played during milking period with amplifiers located within the milking compartments and in the barn for 69 days prior to observation. Behavioural observations were recorded during the afternoon milking for 20 days randomly fluctuating between days with music and days without music. On days with music the number of cows in the holding area at five minutes before and five minutes after the onset of milking period increased from 22.3 ± 15.1 to 45.0 ± 18.0% ($P<0.01$). On control days without music this difference was less pronounced, increasing from 27.1 ± 13.7 to 35.1 ± 15.4% ($P=0.15$). Changes in the composition of behavioural states from five minutes before and five minutes after the onset of milking period were significant on days with music ($P<0.01$) but not on control days ($P=0.41$). The results show a stimulatory effect of music, influencing behavioural responses of dairy cows.

Welfare assessment in four housing systems for dry sows

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Three group-housing systems were compared with individual housing in stalls (C) during two years with 90 sows per system. The group housing systems were free access stalls (FAS), electronic sow feeding (ESF) and trickle feeding (TF), all without straw. The sows were kept together from weaning until farrowing in stable groups, apart from ESF in which two groups were mixed after 6-9 weeks. Group size was 10-14 in FAS, 13-26 in ESF and 6-8 in TF. Behaviour, skin lesions, salivary cortisol levels, reproduction results of 1800 reproductive cycles and veterinary treatments were registered until Spring 1996. Behavioural observations in C, FAS, ESF and TF showed 23.3, 16.5, 14.7, and 16,0% standing in 24 h, 51.7, 41.9, 34.1 and 37.9% standing post-feeding ($P<0.05$), and 30.3, 25.2, 15.3 and 37.9% stereotypies post-feeding ($P<0.05$). Mean salivary cortisol levels for C and FAS were lower ($P<0.05$) than for ESF and TF (1.32, 1.83, 3.08 and 3.78 ng/ml,). Mean skin lesion scores caused by aggression were 0.80, 0.51, 0.89 and 0.79 four days after weaning and 0.05, 0.29, 1.10 and 0.56 after 12 weeks. Claw disorders were lower for C and FAS (8.4 and 10.4%) than for ESF and TF (19.5 and 17.8%). There was no difference in veterinary treatments. Mean number of liveborn piglets was 10.7, 10.9, 11.1 and 10.6. The daily gain during the first pregnancy was 613, 638, 574 and 596 g/d.

Factors influencing water intake of group-housed pregnant sows

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A total of 119 crossbred pregnant sows were used to examine the water intake behaviour. In five groups with an average of 24 sows between 6 and 15 weeks of pregnancy, fed by an electronic sow feeder, the water intake was registered electronically. In total 60,000 visits to the drinker were recorded. The mean water intake, feed intake and number of drinker visits per day of the groups of sows with the lowest (25%), middle (50%) and highest (25%) water intake per kg metabolic body weight ($W^{0.75}$) were 5.1, 7.4 and 11.4 l/day ($P<0.01$), 2.88, 2.81 and 2.85 kg/day (NS), 7.1, 10.1 and 13.3 visits/day ($P<0.01$). Water intake and water intake per kg $W^{0.75}$ for young (pregnancy 1 and 2) and older sows (pregnancy 3 and higher) were 7.0 and 8.7 l/day ($P<0.001$) and 0.14 and 0.13 l/kg $W^{0.75}$ (NS). Only group size had a reducing effect on water intake in the highest group (regression coefficient -0.26 l/extra sow in the group, $P<0.001$). Water intake per social rank class 1, 2, 3 and 4 (1=high, 4=low) was 9.2, 8.2, 7.2 and 6.8 l/day ($P<0.05$). Room temperature only had an increasing effect on water intake in the lowest group (regression coefficient 0.20 l/C^0, between 18^0 and 28^{0}C). Litter size and sow weight gain were higher for the lowest group.

Effects of cage confinement on behaviour and plasma cortisol in sheep

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To evaluate digestibility and nutritive value of food resources for cows, sheep have been used as model animals. In these tests, they are individually confined in cages, though they are usually kept on pasture. Such a change of environment may be a stressor. Our purpose was to determine the degree of stress response of caged sheep by analyzing their behavioural and physiological responses. Nine sheep were used. From 2 weeks before testing, 5 had been kept in cages for a week for habituation (Group A). On testing day Group A and B (the rest) were individually confined in cages. Their behaviour was continuously recorded for 24 h using time-lapse video-recording, and durations of lying and standing every 4 h were measured. Blood sampling was done in -1, 0, 0.5, 1, 1.5, 2, 3, 4, 5, 6, 9, 12, 18 and 24 h after they were caged and plasma concentrations of cortisol were measured. In both groups, duration of lying gradually increased. In the first, second, third and fourth hours, however, it was significantly longer in group A than in B. Concentrations of cortisol were high at times -1 and 0 (16.2 ± 5.7, 37.0 ± 31.2 in A, 13.8 ± 2.3, 24.3 ± 11.3 in B respectively). From 0.5 to 24 h, however, they were almost normal in both groups (range 5.0 to 9.8 in A and 5.0 to 13.5 in B).

Frustration of an expectation of food in the laying hen

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Laying hens presumably express an unfulfilled expectation of an event or a desire for a particular need through a specific vocalization, for example, the call known variously as the (pre)laying-call, singing, or "Gakeln". It seems that the laying-call is related to frustration, which means, the thwarting of an expectation. In this study an expectation of a food reward was created by operant conditioning. We trained 15 hens (after 24 h of food deprivation) in a Skinnerbox to peck a key for 10 s access to food. After training all hens were subjected to 3 sessions of 15 minutes. In the first session (pre-frustration) a peck on the key was followed by opening of the feeder and 10 s access to food pellets. During the second session (frustration) the same procedure was gone through as in pre-frustration, except that no food was in the feeder. The third session (post-frustration) was the same as the first one. In the frustration session a larger average number of laying-calls was expressed than in the pre- and post-frustration trials ($P=0.017$). Also a significant ($P=0.0445$) higher number of key-pecks was observed in the frustration session compared to the pre- and post-session. A significant ($P=0.0226$) decrease in the number of key-pecks in the frustration session was found. In this study we found a significant increase in the expression of laying-calls as a consequence of frustrating a hen's expectation. A frustration effect was also found in the number of key-pecks. A slight extinction effect was measured.

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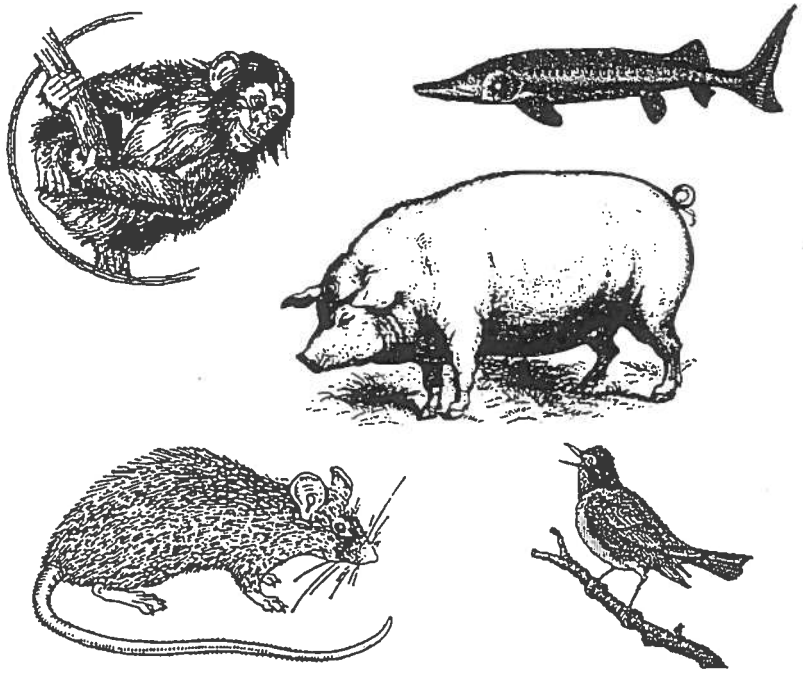

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