ISAE '97

Proceedings of the 31st International Congress of the ISAE

13 - 16 August 1997

Prague, Czech Republic

Edited by

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The organizers thank to following for their assistance:
Helen Knowles, Dominika Vaòková,
Boris Bilèík and Jitka Lancingerová

The Congress acknowledges the support of:
Research Institute of Animal Production,
CZ-104 00, Prague - Uhøínìves, Czech Republic
Institute of Animal Biochemistry and Genetics,
Slovak Academy of Sciences,
SK-900 28 Ivanka pri Dunaji, Slovakia
Farmtec a.s.
Noldus Information Technology

Published by
Research Institute of Animal Production,
CZ-104 00 Prague - Uhøínìves, Czech Republic
and
Institute of Animal Biochemistry and Genetics,
Slovak Academy of Sciences,
SK-900 28 Ivanka pri Dunaji, Slovakia

ISBN 80-88780-16-0

Printed in Slovakia by **Polygrafia SAV**

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10:00		ISAE Council Meeting
14:00	23:00	Registration (Aula), Poster Installation (Poster Hall)
18:00		Dinner
19:00	21:00	Welcome Reception (Poster Hall)

Wed 13th August		
07:30	09:00	Registration (Aula), Poster Installation (Poster Hall)
09:00	09:20	Welcome (Aula)
Session: Plenary Paper		Behavioural Aspects of Domestication and Feralisation Chair: P. Le Neindre (Aula)
09:20	10:00	**Price, E.O.** Behavioural aspects of domestication and feralization
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		Noldus INFORMATION TECHNOLOGY
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The D.G.M. Wood-Gush Memorial Lecture

The organization of stereotyped behaviour

Ilan Golani

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The Problem

The representation of both normal and stereotyped behaviour by descriptive patterns such as “standing”, “pawing” and “circling” is common in ethology. Most of these patterns, however, can be only subjectively measured by experienced observers, and can not be defined formally. Furthermore, these patterns yield an endless list of obsolete ethograms, each exclusively applicable to an idiosyncratic situation, species, or question.

The problem of defining patterns objectively, on the basis of the moment-to-moment relations between the segments of the body, has been largely ignored by ethologists. It arises because many kinematic degrees of freedom (KDFs) are available to the moving animal and because their coordination is usually not fixed, but complex. That is, the execution of a pattern does not imply that the same movements will be performed with the same timing (and in this way reduce the actual number of KDFs). This is true even for “simple” patterns observed in cage- or drug-induced stereotypies. In the area of motor control, this problem is handled by modeling the behaviour with a priori chosen collective variables (i.e. composed of many KDFs). These macroscopic variables are shown to constrain or even “enslave” the behaviour of the many “microscopic” KDFs, thus reducing the number of KDFs that are needed for describing the pattern. In ethology, however, good collective variables can not be constructed according to a priori considerations, but have to be inferred from the structure of the (multidimensional and complex) behaviour.

Aim

My aim is to show how, by a judicious choice of a small number of collective variables, one can come up with a descriptive model of behaviour in which different stereotypies can be obtained from normal behaviour by setting the variables to particular values. Put differently, a morphogenetic continuity between normal and stereotyped behaviour explains the organization of both, and supports the choice of collective variables that highlight this continuity.

Methods

There are at least 2 different ways for recognizing patterns in multidimensional systems. These are symbolic language, and graphic methods borrowed from Dynamic Systems. I will present examples of the use of each of them, and explain how we reveal collective variables that can later be used for a taxonomy of stereotyped behaviour.

Results

The paths traced by the animal in the environment. Symbolic representation of the places visited by a normal rat in an environment reveal that the building blocks of behaviour are excursions performed from and back to a preferred place called a home base. In each excursion the rat alternates briskly between progression and stopping. Since the probability of returning to the home base increases after each stop, the number of stops per excursion is bounded. In amphetamine- and some cage-stereotypies, for example, the home base is preserved, but i) the number of stops per excursion is drastically reduced, ii) the stops are performed in few places, and iii) performed in a more rigid order. This process is reminiscent of the chunking taking place during learning and habit formation in normal humans, and in patients with Obsessive-Compulsive Disorder.

Stereotyped coordination patterns. The problem of revealing a pattern in a time series record of the simultaneous changes in angular relations among all the segments of an animal’s body is a difficult pattern recognition task. Can the many KDFs available to the moving animal be represented as one pattern, constraining the movements of all the segments of the body? When dealing with such a task it is helpful to first use coarse “filters” that produce a first-approximation description of the underlying structure. One such “filter” that highlights the structure of movement is the Eshkol Wachman Movement Notation (EW) - a symbolic language used in our analysis of vertebrate movement. EW provides an articulated description of movement in terms of relations and changes of relation between the parts of the body. By using the “conceptual EW filter”, the eye glasses, as it were, through which behaviour is viewed, we have shown that in many vertebrates, the transition from immobility to mobility consists of a cephalo-caudal build up of movement, separately along each of 3 spatial collective variables: first there is a build up in the horizontal (lateral) plane, then in forward transport, and then in the vertical plane. This process of motor expansion also involves an increase in the number of KDFs available to the animal. It has been termed warm up. A reversed sequence of shut down along the same variables, following the rule “last in first out”, has been established in rats with dopamine stimulants: vertical movement is increased and then eliminated first, forward next, and horizontal last. Both warm up and shut down involve a shift along a mobility gradient. A stereotypy can be characterized by its location on this gradient. Analysis reveals additional variables, such that different stereotypies correspond to differences in their values.

The stability of keeping the body straight. High stability is reflected by a high cumulative time of keeping the body straight per fixed time bins, by a low frequency of forequarter crossing of the midline plane without getting trapped there; and by turning with a straight trunk. I will present video clips of stereotypy of rats whose forequarters show hyper-attraction to the midline plane, and contrast them with videos of rats whose forequarters show attraction to a periodic side-to-side limit cycle attractor centred around the midline.

The propagation of movement along the body. When a quadruped performs a lateral movement (such as turning) it typically starts with the head and recruits the other parts of its body one after the other, hindlegs last. A movement initiated by the head, however, may involve only the head or it may engage some or all the parts of the body. Whereas normal animals often move their head and/or forequarters sideways without engaging the rest of the body in this movement, in some stereotypies, a lateral head movement typically engages the whole body in turning. I will present video clips of stereotypies of rats with hyper-recruitment and rats with hypo-recruitment of the parts of the body.

Phase relations between movements. Stereotyped patterns are often assumed to have fixed phase relations between the movements included in them. To examine this, we studied rats which perform under the influence of amphetamine walking with rhythmic side-to-side head movements. This makes them an adequate preparation for investigating how stereotypies emerge out of the coordination of periodic movements. By applying a Dynamic Pattern Generation paradigm, we have shown that a stable phase relation between stepping and head movements is maintained for only part of the time, whereas for the rest of the time the rat performs “catching-up” steps having all kinds of phase relations with the head movements, but nevertheless systematically closing the phase lag, so as to regain the lost stability. In this way we define the patterns as stable equilibria in a dynamical system, assembled by mutual influence of concurrent movements. This definition is more powerful because it solves the apparent paradox of a stereotypy that shows variability.

A coupling between movements and specific places in the environment. Early ethology abounds with reports of animals having a fixed itinerary in their habitat: both in captivity and in the field, animals perform particular behaviours in pre-established locations, at specific times. Vestigial and hypertrophied versions of this organizing principle, albeit with nonsensical movements rather than movements with an obvious function (such as scent marking), abound in stereotyped behaviour. This coupling between places and movements will be demonstrated in cage- and drug-induced stereotypies and discussed in reference to human Obsessive Compulsive Disorder.

This type of analysis provides a list of collective variables that can be used for establishing a morphogenetic taxonomy of stereotyped behaviours.

Acknowledgment

This research was supported by grant No. 92-00281from the United States-Israel Bi-national Science Foundation (BSF), Jerusalem, Israel.

Plenary Papers

arranged alphabetically
by first author

Feral "domestic" cats - their role in the population dynamics of *Felis catus*

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The term "domestic" is usually reserved for species whose breeding is largely under human control, and strictly speaking should therefore be applied only to pedigree cats. So-called mongrel or non-pedigree cats are (unlike mongrel dogs) largely genetically separate from the specific breeds, but freely interbreed with feral populations; this can be viewed as a special case of the flexible density-dependent sociality exhibited by many carnivores (Gittleman, 1989, *In:* "Carnivore Behaviour, Ecology and Evolution", ed. J. L. Gittleman). Completely feral populations (e.g. cats on uninhabited oceanic islands) are probably subject to the same selection pressures as other predatory species under the same circumstances, i.e. reproductive success is determined by success in hunting, resistance to disease, and competition for mates, denning sites, etc. The most domesticated mongrel cats, those kept as pets in Western countries, are subject to completely different selection pressures, the most important probably being the avoidance of neutering before sexual maturity. Several intermediate stages can also be identified, such as so-called "farm cats", whose genes are likely to have been subject to a variety of influences, both "artificial" and "natural". There are obvious behavioural distinctions between cats living in these different circumstances, but it is unclear how much of this variation is purely phenotypic (e.g. due to socialisation, hunting experience), and how much reflects genetic differences between the populations. However, even within the pet population there is substantial genetic variation in at least one important character, ease of socialisation (Karsh and Turner, 1988, *In:* "The Domestic Cat: the biology of its behaviour", ed. D. C. Turner & P. Bateson), which may therefore vary even more between populations.

It is not immediately obvious why interbreeding between ferals and domestics has persisted throughout the four millennia since the initial domestication of the cat. Cats have sometimes survived as feral populations for long periods, such as during the Middle Ages in Europe, where they were persecuted, thereby disrupting the progress of domestication. However, human factors may not be the whole explanation; it is also possible that cats have had to retain their adaptive abilities in hunting and food selection because of their nutrient requirements, which are far more stringent than those of dogs (Bradshaw et al. 1996, *Comparative Biochemistry and Physiology* 114A: 205-209). Cats, as obligate carnivores, are unlikely to breed successfully on a diet of scraps, and before the advent of modern petfoods the majority of cats would have had to hunt and/or scavenge selectively in order to meet their nutrient requirements.

The current importance of the feral population in maintaining the pet population has emerged from a study in progress at the Anthrozoology Institute. Analysis of the age structure and reproductive status of an urban population of pet cats indicated that neutering was largely responsible for an average lifetime reproduction rate of 0.3 kittens per adult female; retrospective information suggested that this population had not been self-sustaining since about 1983. Life-table analysis indicated that overall this population was stable, with the shortfall being made up from rescued and feral cats. Less intensive surveys of two other urban areas gave similar results; only in a nearby rural area was the population found to be (just) self-sustaining. The impact of these changes on the population genetics of the cat are, as yet, unclear, but it is possible that alleles which accidentally enhance the probability of neutering (e.g. ease of socialisation, fidelity to an interspecific social group) will tend to decline in frequency, and those which promote the feral state and successful breeding within it (e.g. resistance to socialisation, intraspecific competitiveness) may increase.

Zoo biology in the social domain: primates in different environments

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Zoos and other captive settings offer unique opportunities for controlled studies of the adaptive potential of social animals. Many factors are held constant, such as food abundance, absence of predation, and rate of reproduction, whereas other variables can be systematically varied, such as available space, feeding schedule, and so on. The question of how animals handle a relatively crowded environment and the social frictions it inevitably generates is of critical importance in relation to human behaviour. Increasing numbers of people live in "urban zoos" in which the same frictions are apparent. I will discuss studies of primate crowding and aggression, and the highly effective coping mechanisms that primates, and perhaps other animals as well, have evolved.

The main objective of research in this area is to document behavioural differences across conditions. Are animals more or less aggressive under high-density versus spacious conditions? Do they show active forms of affiliation (e.g. grooming, reconciliation after fights) that may serve to reduce social tensions? Behavioural differences give a picture of the effectiveness and method of coping strategies. Supplemented with physiological information (e.g. cortisol concentrations), this picture may include a measure of psychological stress under various conditions.

A second objective is to see how environments affect the overall social organization of a species, hence how flexible that organization really is. For example, the absence of male migration under captive conditions often puts pressure on macaque or baboon colonies since sons remain longer than usual in the group. Or, the presence of a large number of females in close proximity in captive chimpanzee colonies results in a power shift: owing to female alliances, female chimpanzees exert more social influence than in wild communities.

With the collaboration of Drs. Peter Judge and Filippo Aureli, we conducted systematic studies on rhesus monkeys (*Macaca mulatta*) and chimpanzees (*Pan troglodytes*) under a wide range of density conditions. The main conclusion is that the effects can be quite different for short-term versus long-term (permanent) crowding, and that the effect of crowding on nonhuman primates is not nearly as dramatic as often assumed based on classical rodent studies.

Acknowledgment

Research supported by National Institutes of Health grants RR05276 and RR09797

Towards a functional view on domestication

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Animal domestication has often been assumed to be a predominantly cultural phenomenon, driven by conscious decisions of an active domesticator (man). However, a closer analysis of the phenomenon makes it more plausible to view it as an evolutionary process that has taken place because it has increased the Darwinian fitness of both man and the domesticated animals. Even if conscious and purposive selection have certainly been an important factor in the process, the basic laws of evolution should be equally valid and domestication effects should be possible to examine with models from evolutionary ethology. Domestication consists of 3 basic processes: (1) Relaxation of many natural selection factors that are important for the wild counterpart; (2) Directed selection for desired traits; (3) Selection for traits which for different reasons are correlated with the desired traits. The aim of our research is to try to disentangle the functional consequences of the 3 processes, and we have started by examining the effects of relaxed natural selection. As an hypothesis, we suggest that costly behavioural strategies (where cost and benefit are measured in fitness units) become less frequent during domestication. This can be deduced from a simple game-theory model. If we assume that a population contains individuals which may use 1 of 2 different strategies, f1 (more costly) and f2 (less costly), f1 is selected for, and hence evolutionary stable, if the marginal benefits are larger than the marginal costs of f1 compared to f2. An hypothetical example may be a species which can choose to forage in a risky environment with better food availability; if the benefit of food relative to the less risky environment outweighs the increased risk, the more costly strategy is selected. Domestication may affect the selection in 2 different ways: (1) By offering food and other resources, the marginal benefit of the costly strategy will decrease; (2) By offering protection towards predators and diseases, the marginal costs of the costly strategy will increase. Both these processes will favour the less costly strategy, and we suggest that this may be a common trait of domestication. Alternatively, domestication may have loosened the connection between energetical costs of a behaviour and the fitness of an animal. This may happen if animals with “wasteful” strategies are allowed to reproduce, and thus are freed of the fitness penalty. However, wasteful behaviour is likely to reduce production traits such as growth, and thus will be selected against. Investigations of the hypothesis can give 2 different types of results. Firstly, it will increase our understanding of the nature of animal domestication. Secondly, it may provide some new ways of testing evolutionary models. In our research program, we use different functional models of the cost-benefit type to generate specific hypotheses for different behavioural systems. Fields which we have approached so far comprise optimal foraging, honest begging and vigilance behaviour. The species we have used are pigs/wild boars, and poultry/jungle fowl. Results from some of these experiments will be presented during the oral presentation.

Performing under pressure: stress and cognitive function

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An animal's behaviour can be viewed as the performance of a series of activities or tasks (e.g. foraging, monitoring and interacting with other conspecifics, remaining vigilant). Efficient performance of these tasks depends in part on the effective use of cognitive abilities such as learning and memory. For example, a good social memory allows animals to recognise familiar individuals, to keep track of their relative social status, and to make decisions as to whether to attack or affiliate with them. Similarly, spatial learning and memory are important in allowing animals to navigate around their environment.

If cognitive functioning is disrupted, the result may be behaviour which causes husbandry and welfare problems. For example, animals may fail to recognise familiar or high-ranking animals, and choose to behave aggressively towards them, or they may fail to locate and use resources in the environment. Such effects may also hinder the use of preference-testing techniques in applied ethology, for example by impairing the learning and memory of associations between locations and particular resources. The way in which cognitive functioning is affected by disturbance or stressors is thus an important but largely unexplored area of research for applied ethologists. My aim is to provide an introductory overview.

Measuring performance: In order to experimentally examine how cognitive functioning varies under different situations, tasks must be devised which provide some measure of performance. Various learning, discrimination and memory tasks can be used. Tasks in which performance is measured in terms of unequivocal errors (e.g. successful vs unsuccessful relocation of food) are more easy to interpret than those in which alternative choices are possible (e.g. selection of large vs small food items).

A general theory? The Yerkes-Dodson Law states that an inverted-U-shaped relationship exists between an individual's state of arousal and its ability to perform a task effectively. This has intuitive appeal and certainly some tasks are performed most effectively when the individual is in a state somewhere between waking up and a blind panic. However, studies of humans suggest that if the arousing stimulus is directly related to the task at hand, a positive relationship between arousal and performance occurs. Also, there are problems with defining and measuring arousal, which limit the usefulness of the Yerkes-Dodson Law. Instead, empirical findings should be considered in their own right.

Empirical findings: Short-term environmental disturbances or stressors such as time limitation and unexpected or novel stimuli, can act in various ways to alter task performance. They can interfere with the storage and retrieval of memory, shift attention away from, or focus attention on to the task at hand, alter the speed at which a decision is made (e.g. increase impulsivity), alter the specificity of choices, and invoke routine-like responses. Long-term stressors such as chronic restraint or poor quality sleep may impair memory storage and recall. Task difficulty can also affect performance indicating that there are limits to processing capacity. An important question is how task difficulty and disturbance type interact to affect performance.

Performance deficit as adaptive change? Some apparent performance deficits can be viewed as adaptive changes. For example, a forager under time pressure may switch from selection of profitable prey items to eating whatever it encounters. Individuals may also trade off speed against accuracy of performance.

Building on findings and using techniques developed in this area, research is needed to examine how husbandry conditions and experimental techniques (e.g. in choice testing studies) affect cognitive functioning and performance in captive and domestic animals. Such knowledge will help to minimise the occurrence of situations in which disruption of cognitive functioning gives rise to husbandry and welfare problems.

Behavioural aspects of domestication and feralization

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The process of domestication involves adaptation, usually to a captive environment. Domestication is usually achieved by genetic changes occurring over generations, as well as by environmentally induced changes in development that recur during each generation. To the extent that genetic changes are involved, domestication is an evolutionary process. Genetic changes occurring during domestication are a result of both random processes (inbreeding and genetic drift) as well as changes in selective pressures, both natural and artificial, accompanying the transition from nature to captivity. Adaptation to the captive environment may be facilitated by certain recurring environmental events or management practices that influence the development of specific biological traits.

With respect to behaviour, it appears that domestication has influenced the quantitative rather than qualitative nature of responses. The hypothesized loss of certain behaviour patterns under domestication can usually be explained by the heightening of response thresholds above normal levels of stimulation. Conversely, lowered thresholds of response often can be accounted for by excessive exposure to certain forms of stimulation.

Certain behaviours may have been altered because of man's role as a buffer between the animal and its environment. One of the more important behavioural changes accompanying the domestication process is a reduction in responsiveness to changes in the animal's environment. Food provisioning and man's control over the breeding process have reduced competition for important resources, and thus have permitted selection for early sexual maturation and the retention of juvenile characteristics into adulthood (neoteny), especially in the dog.

Longitudinal studies of populations undergoing domestication, although few in number, have given us a better understanding of the biological trends accompanying domestication. Studies on captive populations of animals artificially selected for specific traits (e.g. tameness toward humans) have provided insights on correlated effects of selection on the domestic phenotype. When compared with unselected control populations, these animals have been useful in studying the mechanisms underlying the development and expression of behaviour.

Interest in breeding animals in captivity for release in nature has flourished in recent decades. The capacity of domestic animals to survive and reproduce in nature may depend on the extent to which the gene pool of the population and behaviour has been altered during the domestication process. "Natural" gene pools should be protected when breeding wild animals in captivity for the purpose of re-establishing free-living natural populations. In some cases, captive-reared animals must be conditioned to live in nature prior to their release.

Farm animals' recognition of, and responses to individual people

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Many studies (especially on pigs, poultry and dairy cattle) have shown that aversive treatment of farm animals by people can substantially reduce the animals' productivity and welfare. There is evidence that some of this effect comes about because the animals become afraid, either of people in general or of specific individuals. In this talk, I will review a number of studies showing that farm animals treated aversively can learn to associate the treatment with specific individuals, and that this learned fear of individual people can have marked effects on production. The ability to recognize individual people has now been shown indisputably for many species of animals, although some studies with pigs, poultry and cattle show that, under some circumstances, animals do not behave differently to different people. There is increasing evidence that animals' learned fear of individual people can markedly affect their productivity. For example, in one study, dairy cattle were treated repeatedly by 2 people, 1 of whom treated the cows aversively while the other treated them gently. The presence of the aversive handler during milking reduced milk yield and increased residual milk and heart rates during milking. Thus, dairy cattle's learned fear of specific people can have marked effects on their production. Gentle handling of beef and dairy cattle can make them easier to handle, but there is little evidence that the presence of people can have a positive effect on farm animals. Bottle fed lambs respond less to social isolation in the presence of familiar people. However, the presence of a gentle handler has not been found to increase milk yield of cows, or to reduce cows' responses to novelty/isolation stress. Other studies have focussed on understanding the cues animals use to distinguish between people. Pigs appear to use multiple cues to distinguish people, although visual cues are clearly important. Cows can readily learn to distinguish between 2 people wearing different colour clothes, but have much greater difficulty distinguishing between people wearing the same colour. Furthermore, cows' responses to people change markedly when clothing colour is changed, although this does not seem to be true for poultry. Recent results show that the colour of clothing is an important cue that cattle use to distinguish between people, although other cues are also likely to be involved: dairy cows can distinguish strangers from familiar handlers even when they wear the same colour. However, animals' responses to people can be affected by the context. Cattle's learned responses to individuals can be strongly affected by the place they are in. For example, calves can have trouble generalizing a learned aversion to a specific person to locations other than where the handling occurred, and cows can learn to approach and avoid the same person, in different locations, if they are handled differently in those locations. I shall finish with some suggestions as to what is needed in future research, and how these results can be used to reduce fear in farm animals.

Spoken Papers

arranged alphabetically
by first author

Why do piglets scream at the udder?

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Piglets fighting at the udder produce high intensity vocalizations known as screams. We played back these screams to sows (n=22) and litters (aged 6 to 22 days) during nursing to investigate their effects and possible functions. Recordings were obtained from each litter during nursing attempts, with fighting increased by obstructing access to some of the teats, and edited to produce a 3 min sequence. Three treatments were then imposed on each sow and litter, with piglets removed from the pen for 45 min between trials to make subsequent nursing predictable: they were played their own recording, a recording from another litter, and silence as a control. The order of these treatments was balanced between litters. Playback began when more than 50% of the litter had arrived at the udder and ended after 3 min or when nursing was terminated. We measured the time from the beginning of the nursing until milk ejection (if it occurred) and until termination. Out of the 66 nursings, 20 were terminated by the sow prior to milk ejection. Of these 17 were during playback of piglet calls (8 from the sow's own litter and 9 from another litter) and 3 were during control trials. For the 14 sows that had a milk ejection in at least one of the playback trials and in the control, latency to milk ejection tended to be shorter during playback (77 vs 93 s, sed=7.0; $P<0.1$) and latency to termination was significantly shorter (138 vs 179 s, sed=15.1; $P<0.05$). Piglets that have failed to gain access to a teat during nursing will benefit if they can reduce the interval before the next nursing. A likely function of screaming is to cause the nursing to fail, which does advance the next nursing. Another possible function is to reduce the duration of the nursing and post-massage periods, which may have a similar effect.

What is the impact of allosuckling on the growth of red deer calves?

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It is generally presumed that allosuckling brings benefits to the allosuckling infants. Nevertheless, the data supporting such a presumption are rare. The aim of the study was to determine the impact of allosuckling on the growth rates of allosuckling calves. Fifty pregnant hinds were observed between 28th of May (day of the first delivery) and second of September (weaning of all calves) on a red deer farm at Vimperk, South Bohemia, Czech Republic. We were able to calculate the growth curve for 39 of the 50 calves born. These calves were seen suckling in 1015 bouts during their first mo of life. In 690 cases the calves suckled maternal hinds and in 325 cases non-maternal hinds. Only 25.6% of calves (Group A) exclusively suckled maternal hinds. The prevailing type of suckling behaviour was a combination of suckling maternal hinds and allosuckling (74.4%, Group B). These 2 groups of calves did not significantly differ in birth body weight. With increasing age, the relative body weight increased faster in calves of Group A than in those of Group B ($X \pm$ S.E.% of birth body weight at 99 days of life, Group A 410.93 ± 23.42, Group B 326.31 ± 17.53, difference between groups, $P<0.01$). This gain in body weight was not essentially influenced by whether the calf's mother nursed exclusively filial or non-filial calves as well. However, at weaning (99 days), the lowest body weight occurred in allosuckling calves whose maternal hinds were allonursing. The results suggest that allosuckling does not mean an extra profit for the allosuckler. Instead, in our subjects, allosuckling is better attributed to compensation of nutritional needs based on a combination of various factors, such as discrete differences in body weight at birth, allonursing by the maternal hind, etc.

Evidence for the existence of alarm substances in urine of cattle

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Although the presence of peers may decrease fear, the appeasing effect depends on the emotional state of the peers: in cattle, the presence of a stressed conspecific increased rather than decreased reactivity of heifers to a novel environment. A first experiment, using 20 Aubrac heifers, investigated the possible role of olfactory cues in the social transmission of stress. In a first test, heifers were individually introduced into a novel environment and presented with food which was placed in a bucket on a grid. The space under the grid contained urine. When urine from stressed, rather than from nonstressed conspecifics was used, heifers had a longer latency to feed. In a second test, heifers were presented with a novel object in a familiar environment. They showed a longer latency to explore the object when it had been sprayed with urine from stressed rather than from nonstressed conspecifics. Thus, urine from stressed cattle contains stress-related components that can be perceived by their conspecifics. Furthermore, the perception of these components increases fear-related reactions. A second experiment was designed to assess the response of heifers to urine of stressed and nonstressed conspecifics in the absence of novelty. The responses of 12 Aubrac heifers to odours of the 2 types of urine were measured in a familiar environment and compared with responses to the odours of water, blood and dog feces. Only the odours indicative of potential danger, that is the odours of urine from stressed conspecifics, blood and dog feces, caused an increase in stretched locomotion, suggesting that this behaviour reflects heightened vigilance. Behavioural changes induced by the odour of urine from stressed conspecifics were, however, less pronounced than in the first experiment. These results suggest that urine from stressed conspecifics may not only increase fear reactions in cattle exposed to novelty but also induce fear in cattle maintained in familiar environments.

Artificially suckled lambs react differently towards familiar or unfamiliar caretakers

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The present experiment investigated the ability of lambs to discriminate between a familiar and an unfamiliar shepherd. Female lambs (n=32) were reared artificially in groups of 4 for 6 weeks. Half of them were bottle fed in isolation by 1 shepherd during the first 3 weeks. The other half were fed in the same conditions but alternately by 3 shepherds. After 3 weeks of age, they had no visual contact with humans. Weaning occurred at 6 weeks of age and animals were gathered with the minimum human contact necessary for rearing management. The lamb's reactions to isolation and to human presence were investigated at 3, 6 and 14 weeks of age. The responses of lambs to a familiar and unfamiliar human were observed over 2 days, with half the animals tested with each stimulus each day. Tests were divided in 3 successive parts: a) Isolation for 1 min; b) Presence of an experimenter who squatted at 1 end of the pen for 1 min, trying to touch the lamb if it approached; c) Isolation for 1 min. The number of caretakers (1 or 3) during early rearing had no significant effect on any criteria studied. Animals vocalised less (mean ± S.D.: 5.5 ± 6.4 vs 23.2 ± 7.7, $P<0.01$) and crossed fewer squares marked on the arena floor (8.9 ± 7.7 vs 22.3 ± 1.0, $P<0.01$) when in the presence of the person than when isolated. They also vocalised less (3.4 ± 3.4 vs 7.6 ± 7.8, $P<0.05$), approached more quickly (12.4 s ± 21.5 vs 30.6 s ± 28.4, $P<0.05$) and interacted more (42.5 s ± 24.7 vs 26.8 s ± 26.6, $P<0.05$) with the familiar than with the unfamiliar shepherd. Differences persisted for 2 weeks after the treatment concluded. However no difference was apparent at 14 weeks of age. The effect of human contact and familiarity was clearly demonstrated by this experiment after an intensive early period of contact.

Prenatal handling stress affects behaviour in novel situations and the weight and function of adrenals and gonads in Blue-fox cubs (*Alopex lagopus*)

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Prenatal stress is known to affect the morphology, physiology and behaviour of rodent offspring, but there has been little focus on prenatal stress in farm animals. This study investigated the effects of a 1 min daily handling given to farmed Blue-fox females in the last third of gestation on the weight and function of adrenals and gonads in their 10 day old offspring (n=68), and on behaviour in 3 different novel situations at 35 days of age (n=72).

The adrenals of prenatally stressed cubs weighed only 60% (P=0.0003), the ovaries 77% (P=0.003) and the testes 76% (P=0.0005) of those in the control group. Body weight were equal in both groups. Prenatally stressed cubs showed a higher serum concentration of progesterone (P=0.036), higher *in vitro* production of progesterone (P=0.005) and cortisol (females only, P=0.003) in adrenals, and lower *in vitro* production of estradiol in ovaries (P=0.01). These and other results indicate that prenatal stress may enhance the postnatal adrenocortical function and suppress the gonadal function in the early infancy of Blue foxes. In general, effects were larger in females than males.

At 35 days of age, prenatally stressed cubs were more frequently constantly active with escape attempts during a Human test, in which the cub was held by hand for 20 s (P=0.034). Prenatally stressed cubs crossed more lines (P=0.047) and entered more squares (males only, P=0.027) in an Open-field test with 5 x 5 squares. Subsequently, prenatally stressed cubs more frequently re-entered the open field from a neighbouring box than did control cubs (P=0.017). These results indicate a higher behavioural reactivity in novel situations in prenatally stressed cubs. It remains to be determined whether the increased adrenocortical function and behavioural reactivity is related to increased fearfulness and reduced welfare. However, further studies on the effects of prenatal stress in farm animals are recommended.

The influence of handling on the behaviour and productivity of lactating heifers

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Research in the pig and poultry industries indicates sequential relationships between stockperson attitudes and behaviour and animal fear and productivity. Recent research in the dairy industry has revealed similar human-animal relationships. The major objective of the following study was to investigate the effects of handling on fear and productivity of dairy cows.

Thirty-five heifers were studied over early lactation with animals calving over a 7 week period and treatment commencing at the first milking. They were weighed within 1 day of calving and were randomly allocated within weight strata to 2 treatment groups, positive and negative handling. The handling treatments were imposed for 2 min immediately before and after every milking. The negative handling consisted of slaps or hits with a plastic pipe to the rump region and were imposed on any animals that failed to avoid the experimenter. Positive handling involved the experimenter imposing a positive interaction, such as pats, strokes and the hand resting on the back of the cow, when an animal failed to avoid the experimenter or approached. The milking behaviour of each heifer was monitored at each milking throughout the treatment period and the behavioural response of each animal to humans was measured in a standard behavioural test during the treatment period and approximately 6 weeks post-treatment. At 2 days post-treatment the incidence of lameness was assessed and the heifers were also weighed. Milk yield data was collected for each animal throughout the treatment period and throughout lactation.

As a high percentage of negatively-handled animals became lame within 8 weeks of handling, the handling treatments were terminated at 8 weeks after the first animal commenced treatment. Animals thus received 2 to 8 weeks of treatment. 44% of negatively-handled animals were lame within the treatment period compared to 11% of positively-handled animals ($P<0.05$). The positively-handled animals had a shorter flight distance to an approaching human than negatively-handled animals (2.1 m vs 5.0 m; $P<0.01$). Weight loss in early lactation was lower in the positively-handled animals (66.1 vs 79.9kg; $P<0.05$). Despite the fact that a number of heifers were only in treatment for 2 weeks, the data suggest that milk yield was also affected by treatment. Negatively-handled heifers produced less milk over the treatment period than the positive treatment group (10.2 vs 9.6 l/cow/milking; $P<0.08$). The effects on weight and yield may be an artefact of increased lameness in the negative treatment. Alternatively, stress as a consequence of fear, may have contributed to the adverse effects on weight and yield in the negative treatment. Clearly, further research is warranted to examine the effects of human-animal interactions on lameness and productivity of dairy cows.

The effects of journey duration and conditions on the welfare of sheep

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Considerable public interest within the European Union on welfare aspects of the transport of farm animals has led to discussion of revision of current legislation and has prompted research. Studies of behavioural and physiological (heart rate and hormonal) responses during 4 commercial journeys from the U.K. to continental Europe and 2 experimental journeys between Cambridge and a Scottish island indicated an elevation of response at the beginning of journeys (e.g. cortisol x 2 and x 2.3; $P<0.05$) and a steady decline or adaptation as journeys proceeded. Physical conditions were monitored, including road conditions which were ascertained objectively with a triaxial accelerometer which recorded the incidence of impact or shock events. Responses to ambient sound were not consistent while response to road conditions depended on stocking density, in that close packed animals were less affected by poor road conditions. Other potentially stressful aspects of transport were investigated experimentally. Social mixing of sheep in close confinement (4 sheep/m^2) showed a significant effect of breed: 10 out of 11 Orkney sheep (a genotype associated with extensive husbandry) showed a significant ($P<0.05$) increase in heart rate during days when other sheep were introduced to the pen while only 7 out of 18 Clun Forest sheep (a genotype associated with intensive husbandry) did so (Fisher test: $P<0.01$).

Similar results were obtained with plasma cortisol measured before and after short (45 min) journeys during which responses of Suffolk x Rouge de l'Ouest sheep (100% lowland genotype) and Derbyshire Gritstone (100% upland genotype) were compared; the former showed a much stronger response (analysis of covariance: $F_{4,3,5}=6.59$; $P<0.001$; effect of genotype $F_1=44.91$; $P<0.0001$).

When sheep were subjected to an experimental journey (45 min) after a period of taming (gentle handling with sequential sampling of saliva for assay of salivary cortisol during 17 days), the response of salivary cortisol concentration after the journey was predictable ($F_{1,15}=5.65$; $P<0.65$) from the gradient of the sequence of concentrations during the taming procedure. This implies that sheep which showed habituation to the taming procedure also showed a lower stress response during subsequent transport.

During long journeys, a break may be made for feeding and watering. Legislation dictates a minimum break of 1 h to be taken after no more than 14 h of travel, with a further 14 h of travel permitted after the break. Behavioural studies showed that in these conditions, sheep feed first and drink later (first h 1.2 kg nuts, 0.04 kg water and third to seventh h 0.2 kg nuts, 4.0 kg water per sheep). A break of 1 h is insufficient for the water debt resulting from 14 h of confinement to be paid.

The reliability and validity of keeper ratings of animal behaviour as a method for evaluating the husbandry of endangered species in zoos

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Animal caretakers possess an extensive knowledge of the behaviour and temperament of the animals they care for, a knowledge that is largely anecdotal. When quantified in a standardized manner this knowledge may prove useful for research aimed at improving husbandry and captive propagation. Zookeepers at more than 45 U.S. zoos rated a total of 228 individual cheetah, Great hornbill, Maned wolf and Black rhino on the frequency of behaviours described in an ethogram, the relative applicability of temperament attributes and on the quality of animal/caretaker interactions. For Black rhinoceros, in 77% of the cases where more than 1 keeper rated the same animal there were significant positive correlations between raters for 24 behaviour elements. Principle components analyses were used to combine keeper-rated behaviour elements into a smaller number of more comprehensive behaviour and temperament traits. For Black rhinoceros these were “friendliness to keepers”, “defensive sparring”, “aggressive” and “fear”. Component scores were compared to behaviour observed during 1 h videotaped behaviour tests of reactivity to novelty. “Aggressive” scores were correlated with snort-charging a novel object and “fear” scores with avoiding a novel conspecific odour. Cross-institutional comparisons of husbandry variables and behaviour suggest that density of females, enclosure area, acoustics of walled enclosures and cleaning materials potentially influence breeding success of Black rhinoceros. “Fear” scores were correlated with a measure of health, with the density of males at the zoo and with the degree of exposure to the public around enclosure perimeters. It was concluded that zookeeper ratings of animal behaviour are a useful and under-utilized tool for evaluating exhibit design, husbandry procedures and well-being of zoo animals.

Remedial socialisation of feral kittens: effects of handling

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The primary socialisation period of the domestic cat is thought to lie between the second and seventh postnatal weeks, yet anecdotal evidence suggests that kittens which have no contact with people during this period (eg rescued ferals) can still become pets. In collaboration with the Cats Protection League, we have therefore examined some of the techniques employed in rescue centres for the remedial socialisation of feral kittens. As part of a longitudinal study of 62 feral kittens in 9 rescue centres, the reaction of each kitten to handling by its fosterer was assessed in 2 one min holding tests, the first carried out soon after rescue and the second about 3 weeks later. In the first test, all kittens rescued before they were 8 weeks old could be held for the whole of the test; the proportion that could not be picked up increased with age at rescue. In the second holding test, improvement was most marked in kittens that had received the most handling. A questionnaire-based survey of 126 rescue centres indicated that the amount of handling given to feral kittens influenced the success of homing; kittens returned to the shelter after homing tended to have been handled for less than 1 h per day while in the shelter. We conclude that remedial socialisation can be effective for the increasing number of feral kittens that are entering the domestic population (at least in the U.K., where in some areas over half the kittens homed by rescue organisations are feral in origin), but that the factors which optimise the extensive handling that is required remain to be identified.

Income elasticity as an indicator of behavioural priorities in mink (*Mustela vison*)

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Behavioural income elasticity (or resilience) is the perseverance of behaviour as an animal's time or energy budget is reduced (Dawkins, 1983, *Anim. Behav.* 31: 1195-1205). We used income elasticity to investigate the behavioural priorities of mink by allowing them access to resources for a fraction of the day, and comparing their consumption with that of unrestricted access. Eight mink were individually housed in a home cage containing food, water and nestbox with restricted access to 7 compartments (alternative Nest, Waterbath, Platform, Tunnel, pliable Toys, Novelty and Empty), for 1 of 6 time periods (24 h, 4 h, 2 h, 1 h, 30 min and 15 min randomly ordered) for 5 successive days for each treatment.

Over 24 h, mink spent most of their time in Home (645 min) or Nest (473 min) and some time with Bath (32 min), Platform (26 min), Novelty (12 min), Tunnel (7 min), Toys (3 min) and Empty (1 min). Time spent with Novelty consistently showed highest resilience. A budget cut to 1 h (or by 96% of the day) only reduced time spent with Novelty by 48%. Mink also defended time with Platform (68%), Bath (76%), and Toys (78%), but there was little evidence that mink defended time with Tunnel (90%), Nest (99%) and Empty (100%).

The low defence of Empty (low resilience) and defended use of Novelty (high resilience) were consistent with mink behavioural priorities derived using maximum price paid for access (Cooper and Mason, 1997, *Animal Choices*, BSAS: Penicuik, MidLothian). The rank order of other resources did, however, differ. This may be because the differential value of shortened bouts of behaviour and differential responses to deprivation can both affect use of resources, particularly with smaller time budgets.

Integration of three female Ring-tailed lemurs (*Lemur catta*) into an established troop in captivity

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The aim was to observe the behaviours that occurred when an unfamiliar troop of 2 adult lemur females (4 and 5 years old), and an adolescent female (14 mo old) was introduced to an established resident troop of 2 adult females, 3 adolescent females, 1 adult male and 1 adolescent male. Behaviours recorded were aggression, chasing, following, alert, running, walking, climbing, leaping, eating, sleeping, grooming, sitting, standing and vocalising. Behaviour measures were recorded using scan sampling every 2 min for 4 h over 5 consecutive days. Thereafter, behaviour measures were taken for 1 h every week for the following 3 mo. The first 5 days of data indicates that the new lemurs spent the majority of their time (60%) “alert” watching the resident troop from a distance, whereas the resident lemurs spent their time either “chasing” (30%) or “following” (25%) the unfamiliar lemurs. Members of the resident troop were also observed to strike (recorded as aggression) the new lemurs, which resulted in injuries. Due to the severity of the injuries and loss of weight incurred by the unfamiliar troop, after 3 weeks of persistent following and chasing by the resident troop, 3 resident females were removed from the enclosure. Subsequently the lemurs remaining in the enclosure settled down and shared both food and shelter. In the following weeks the resident females that had been removed were reintroduced 1 at a time. However when they were all together again they regrouped into their original 2 troops and the following and chasing behaviours resumed. Following and chasing behaviours are common in lemurs in rival troops in the wild, and it appears that similar behaviour occurs in captivity, which makes it difficult to merge 2 unfamiliar troops of lemur in 1 enclosure.

The role of maternal vocalizations in parturient sheep

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Sheep are seasonal breeders and form a rapid and exclusive attachment to their young soon after birth. Vocalizations of the ewe and lamb may be important in strengthening the bond, particularly the 'rumble' or low-pitched bleat made by the ewe only at, and after the birth of a lamb. In order to investigate whether bleat rate was associated with ewe-lamb attachment, vocalization data were collected from 84 primiparous (P) and 65 multiparous (M) ewes of a highly-selected lowland (Suffolk: n=39P, 30M) and a less-selected hill breed (Scottish Blackface: n=45P, 35M). Blackface ewes are thought to be better mothers than the more intensively husbanded Suffolk ewes. Low-pitched bleat rate was higher in primiparous ewes when compared to multiparous ewes (average bleats per min: P=5.41, M=2.45, s.e.d.=0.46; $P<0.005$); highest bleat rates were recorded from primiparous Blackface ewes. Litter size (mean litter size ± se: Blackface=1.4 ± 0.5, Suffolk=1.7 ± 0.5) had no effect on low-pitched bleat rate with ewes bleating at the same rate with singleton or twin lambs. Singleton Suffolk lambs had a bleat rate of more than twice that of singleton Blackface lambs (average bleats per min: Blackface=0.25, Suffolk=0.74, s.e.d.=0.13, $P<0.01$). The birth of a second twin lamb caused an increase in lamb bleat rate (average bleats per min: twin Blackface=0.56, twin Suffolk=1.42, s.e.d.=0.14, singleton vs twin, $P<0.01$). These results demonstrate that the main factors affecting ewe low-pitched bleat rate are those intrinsic to the ewe, that is breed and experience, whereas a four-fold increase in overall lamb bleat rate, after the birth of a second twin, did not affect ewe bleat rate. This suggests a hormonal regulation of ewe low-pitched bleating, at least in the early post-partum period. The high bleat rate in primiparous ewes may reflect the immaturity of these animals, and a slower rate of bond formation. Lamb vocalizations are modified by their rearing environment and may act as signals of need, thus functioning as an indicator of the quality of maternal care.

Can tonic immobility predict coping strategies in pigs?

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Tonic immobility (TI) is a well-known phenomenon in many species of animals and has been shown to predict the behaviour of individuals in distinctively different situations (e.g. open-field). The aim of this study was to investigate whether TI exists in pigs, and if so, whether it is related to behaviours in other contexts (e.g. reaction to handling, speed of movement) and if it can be used to predict 'coping strategies'.

The following tests were conducted:

Test 1. 110 pigs from 11 litters were tested for TI at the age of 2.5 weeks.
Test 2. the same pigs were tested for their response to an injection at the age of 4 weeks: relaxed (R), tense (T) and struggle (S).
Test 3. 71 of these pigs (7 out of 11 litters, randomly selected) were tested at the age of 10 weeks for speed of movement from a familiar into an unfamiliar room.

The relaxed (R) pigs did not differ in their response to TI from pigs who were either tense (T) or struggled (S; median test, $\chi 2=0.78$, df=1, n.s.). T pigs had shorter durations of TI than S pigs (median test, $\chi 2=4.31$, df=1, $P<0.05$).

Pigs who showed no immediate immobility response when tested at the age of 2.5 weeks moved faster at the age of 10 weeks than those who did show the response (33.7 ± 2.0 s vs 41.8 ± 2.1 s, t-test, t=2.79, df=40, $P<0.01$).

The results showed that TI exists in pigs and can predict the behaviour of pigs in different situations. If coping is seen as a way of dealing with an aversive situation (e.g. injections), 'tense' can be regarded as a passive and 'struggle' as an active 'coping strategy'. The pigs who showed these 2 strategies differed in their response to TI, which suggests a link between TI and coping patterns.

Stereotyping Bank voles *(Clethrionomys glareolus)* display a general inability to inhibit non-functional behaviour

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The mechanisms underlying the stereotypy-like symptoms of certain localised brain lesions (e.g. dorso-lateral prefrontal lobe dysfunction) are better understood than those of cage stereotypy. Patients suffer from a "disinhibitory disorder", their stereotypy-like behaviour being a symptom of the failure of inhibitory processes that prevent or terminate inappropriate responses. This experiment uses tests diagnostic for the function of inhibitory processes to assess whether individual differences in these mechanisms contribute to individual differences in the cage stereotypy of captive bank voles.

The pattern of performance across different learning paradigms can be used to isolate the precise nature of a cognitive deficit. For instance, subjects with a disinhibitory disorder are unimpaired on simple learning tasks, but do take longer to suppress responding in extinction (where the correct response no longer provides reward). Eight Bank voles were therefore taught a spatial discrimination task to a criterion of 90% correct over 20 trials. The acquired response was then extinguished to a criterion of 65% correct over 20 trials.

In their home cages, the voles spent between 3.5% and 28.1% of total activity performing a bar-mouthing stereotypy. Individual differences in stereotypy correlated positively with trials to criterion on the extinction task ($F_{1,5}$=33.13; P=0.002), whilst trials taken to learn the initial discrimination did not correlate with stereotypy ($F_{1,5}$=3.48; P=0.121). Thus, stereotyping animals were unimpaired in their ability to perceive their environment (as illustrated by their lack of impairment on spatial discrimination), yet they had difficulty using this information to inhibit behaviour.

This may well have welfare implications. Human patients with disinhibitory disorders persist with inappropriate behaviours even when they want to stop. By analogy, the possibility exists that animals might find stereotypy similarly frustrating, despite appearing to perform the behaviour willingly.

Eliminatory behaviour of a bachelor group of Przewalski horses in a semi-reserve; comparison with the domestic horse

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The Przewalski horse (*Equus przewalskii*) is extinct in the wild, but has a current population of around 1300 animals housed in zoos and semi-reserves. As the ratio of births of males:females is about 1:1, males which are currently surplus to the requirements of the breeding program can be difficult to house. A group of 5 male Przewalskis was introduced to the study site at Eelmoor Marsh, South East England, (a designated Site of Special Scientific Interest) as part of an experimental scheme to help alleviate housing pressure in zoos and as an alternative to mowing to control the growth of invasive vegetation. We have investigated the eliminatory behaviour of this bachelor group and the distribution of faeces on the study site, as part of a series of observations of their social behaviour, grazing preferences and habitat use. The distribution of dung was measured and compared throughout the summer months using a transect method. This data, together with continuous observations of the horses during the same period, was used to determine whether defecation was random, avoided preferred grazing areas, or was contagious within specific latrine sites, as reported in domestic horses. Observations of eliminatory marking behaviour and the use of stud piles (communal mounds of faeces) by individual horses were made during summer and winter months to allow comparisons between seasons.

Social status within the group had an effect on the marking behaviour of stallions. The dominant stallion displayed significantly more defecation marking behaviour ($P<0.01$) than the other mature male, and showed defecation marking behaviour more often in response to the dung of the subordinate mature stallion than to the dung of the juveniles ($P<0.005$ and $P<0.05$ respectively). The expression of marking behaviour by mature stallions was higher in the summer than the winter ($P<0.005$). Stud pile use occurred during both the summer and winter months, and was most prevalent in areas where it had a high-impact visual stimulus. These horses did not appear to show latrine behaviour as reported in domestic horses, although they did avoid grazing next to newly deposited faeces on stud piles in the summer. Dung which was not deposited on stud piles was distributed contagiously ($P<0.05$) across the study site, mainly along regularly used tracks. These data support the argument that latrine use in domestic horses may be a response to confinement.

Dehorning calves with or without local anaesthesia

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Two groups (n=10 each) of 4 to 6 week old calves were used to study behavioural reactions which were considered as responses to the experimental stressors. Also 2 additional groups (n=7 and 8) were used to examine physiological responses to thermal dehorning with and without local anaesthesia (injection into the cornual nerve and additional infiltration around the horn bud). On day 1, 16 blood samples were collected from each calf in the 2 physiology groups through a jugular catheter during a 5 h period. After the third sample, each calf in one physiology and one ethology group received a local anaesthetic (A); the other 2 groups served as controls (C). Twenty min later, dehorning was simulated in all calves by pressing an unheated dehorner to the horn buds with the same pressure and for a similar time as during actual dehorning. Behavioural reactions during simulation were video-recorded. During the next 4 h, behavioural data were recorded by visual observations in the ethology groups and blood sampling was continued in the physiology groups. On day 3, the same procedure was repeated with actual dehorning.

During dehorning, C-calves showed significantly ($P<0.05$) more frequent tail wagging (3.5 ± 0.5 [mean ± SEM] vs 1.5 ± 0.5), head moving (5.3 ± 1.5 vs 2.9 ± 0.6), tripping (3.1 ± 0.5 vs 1 ± 0.5), and rearing (1.9 ± 0.5 vs 0.4 ± 0.2) compared with simulation. This increase was absent in A-calves.

Post dehorning, C-calves displayed significantly more frequent abnormal backward-locomotion for 1 h (2.6 ± 1 vs 0) and much higher frequency of head shaking for 4 h (31.4 ± 23 vs 1.9 ± 1), compared with post simulation. These behavioural changes were not seen in A-calves or to a much lesser extent. In C-calves dehorning resulted in a significant increase in plasma vasopressin (peak 9.7 ± 3.8 pg/ml) and cortisol (peak 50 ± 6 nmol/l) in contrast to simulation (peaks 1.9 ± 0.4 pg/ml and 31 ± 8 nmol/l, respectively). Anaesthesia prevented this increase (peaks 1.7 ± 0.6 pg/ml and 30 ± 3 nmol/l, respectively). The injection of the anaesthetic had no significant effect on concentrations of both hormones. Behavioural and physiological responses together indicate that stress and considerable acute pain are associated with dehorning calves by heat cauterization. This can be clearly reduced during and up to 2 h post dehorning by local anaesthesia as used in this study.

Domestication effects on optimal foraging strategies in pigs (*Sus scrofa*)

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During domestication, costly behaviour may have become less advantageous and a shift may have occurred towards less costly strategies. Optimal foraging theory provides predictions that can be used to test this hypothesis. Eight domestic pigs and 8 crossbreds (Holland Landrace X Wild boar) were allowed to forage alone in a maze for 30 min on 4 successive days. The maze contained 6 food patches and corridors between them and on every second test there were 36.5-38.5 cm high wooden barriers between each food patch. In each patch, there was 50 g of commercial feed in a bucket with holes. By manipulating the buckets with their snouts, the pigs could get the food. Direct observations and video recordings were made. Without barriers, domestic pigs spent on average longer time in the patches (P=0.04) and performed feeding behaviour more than crossbred pigs (P=0.01). In domestic pigs the occurrence of the behaviour feeding was also significantly reduced (P=0.03) when barriers were introduced, but this was not seen in crossbred pigs. There was a tendency that ingested amount of feed (P=0.06) in the domestic pigs was reduced when barriers were introduced, but this tendency was not seen in crossbred pigs. The domestic pigs crossed fewer barrier than the crossbreds (P=0.04). Both domesticated and crossbred pigs visited fewer patches in the maze with barriers (P<0.01, P<0.001) compared with the maze without barriers. We conclude that crossbreds used a more costly behaviour strategy than domestic pigs when searching for food in a patchy environment.

Selection for tame and fearful behaviour in mink and the effect on the HPA-axis

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The processes contributing to the adaptation of animals to humans and the artificial environment are called domestication. Domestication is interpreted as a combination of genetic changes over generations and non-genetic influences experienced by the individuals in each generation (Price 1984).

In 1988, behavioural selection for tameness and fearfulness in farm mink was started in Denmark. The “stick test” was used as a suitable stimulus for selection at the beginning of the investigation. The mink react to close contact with humans and direct their reaction towards the tongue spatula, “the stick”. The reaction of the mink is characterized by 4 types: (1) escape; (2) exploration; (3) aggressiveness; (4) unknown.

The mink kits in the F1 - F6 generations were selected on the basis of tests performed monthly from July to November and divided into 2 lines (Line E, tame mink and Line F, fearful mink). More than 3000 farm mink were tested for their behavioural response to human contact.

A regression analysis shows that the explorative and aggressive behaviour in Line F was reduced and the fearful behaviour was increased from F1 - F6. The frequency of fearful males increased from 19.5% in 1988 to 98.4% in 1993. For females the frequency was 42.6% against 94.6%. In Line E, the change in explorative behaviour was not significant but the level of explorative behaviour was significantly higher in Line E than in Line F. The increase in fearful behaviour over generations was higher in Line F than in Line E. The development in the temperament of farm mink during the growth period was characterized by an increase in explorative behaviour and a decrease in fearful behaviour. The base level of cortisol and the reaction to 4 doses of ACTH were independent of the line to which the animals belonged, but mink in Line F reacted to handling with a higher cortisol response than mink in Line E. The results show that to date selection has resulted in marked behavioural and physiological differences in the way in which mink react to acute stress such as handling and human contact.

Accelerated domestication in Silver foxes using artificial selection

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Fear of humans is characterizes wild animals. In the process of domestication fear disappears. This process can be accelerated by selecting animals for confident behaviour towards man. Silver foxes that had been selected for confident behaviour for 37 generations were purchased from Novosibirsk, Russia. After weaning, offspring were housed 1 animal per standard wire mesh cage either with selected (confident, C; n=9) or unselected cubs (MX, n=10) as their neighbours. In adulthood, their behaviour was compared with that of unselected (US, n=9) population.

A higher proportion of C (7/9) and MX (7/10) foxes ate despite a human standing in front of their cage than did US cubs (1/9; $P<0.001$, χ^2-test). A higher proportion of C (5/5) and MX foxes (7/8) took a tit-bit handed by a human than did US foxes (0/9; $P<0.001$). Using the same criteria as used during the selection process, tameness of the C and MX foxes was scored higher (3.6 and 3.6, max=4) than that of US foxes (-1.6, min=-4; $P<0.001$). In a pair contest situation against US foxes, C and MX foxes monopolized food in 9 cases out of 10 (1 unresolved). The confident foxes had a lower concentration ($P<0.01$, ANOVA) of cortisol before (C: 36, MX: 75 nmol/l) and 20 min after handling (C: 87, MX: 139 nmol/l) than the US foxes (160 and 234 nmol/l before and after, respectively). In the open field test there were no significant differences between the groups either in the number of squares entered during 5 min (114, 132 and 134, for MX, C and US foxes, respectively) or the latency to reach the far end of the field (101, 40, and 54 s for C, MX and US foxes, respectively). The differences between C and MX groups were never significant, despite unselected neighbours in the latter group.

The results show that foxes selected for confident behaviour clearly differ from unselected foxes in some behavioural and physiological properties. In their response to a human they can be considered domesticated.

Influence of environmental stimuli on maternal behaviour related to bonding, reactivity and crushing of piglets in domestic sows

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The influence of environmental stimuli related to different phases of nestbuilding on maternal behaviour of domestic sows was investigated. Effects of floor type (beach sand vs concrete) and substrate type (straw feeder vs no straw feeder) were examined in a 2 x 2 factorial experiment with 9 replicates of 4 multiparous sows. From 1 week prepartum until 1315 days postpartum, sows were kept individually in roofed 7.6 m^2 "getawaypens". Video recordings of sow behaviour in the nest area were made for 24 hr on Day 0, 3, 6 and 12 postpartum.

A lower proportion of sows with environmental stimuli crushed piglets by rolling on Day 3, than sows on concrete floors (11% vs 60%; $P<0.05$). At the same time, a lower frequency of postural changes was found for young sows (parity 23) on sand vs concrete (0.55 ± 0.44 vs 3.09 ± 0.47, respectively; $F_{2,18}=5.34$; $P<0.02$) and with vs without straw feeder (0.71 ± 0.43 vs 2.74 ± 0.52, respectively; $F_{2.18}=7.02$; $P<0.01$). On Day 13 postpartum a higher proportion of sows with access to both stimuli responded by standing up towards the playback of a piglet distress call (100% vs 54%; $P<0.02$). The general decrease in time spent in nest-area from Day 0-12 (99.0 ± 0.3% to 90.0 ± 1.8%; $P<0.001$), tended to be less for sows on sand than sows on concrete floors ($F_{1,21}=4.19$; $P<0.053$). On Day 1315 postpartum, latency to recognition of their own piglets during separation from the litter was shorter for sows with access to environmental stimuli than for sows on concrete floors (>180 s vs <136 s, respectively; $\chi^2=4.06$; $P<0.05$).

The results suggest, that provision of environmental stimuli considered relevant for nestbuilding affects the maternal behaviour of domestic sows and favours survival of the piglets. Maternal bonding and responsiveness might be increased, perhaps due to increased comfort of the sow or increased relevance of environmental feedback.

Side-preference in dairy cows and its significance for behaviour and heart rate during milking

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Behavioural side-preference of dairy cows in a two-sided milking parlour was studied under practical and experimental conditions. Historical data, collected over a period of 28 mo, revealed that 12 and 11 out of 89 cows showed significant left side and right side preference in all mo respectively. Two groups of 8 cows, showing either significant or no side-preference, were selected. These cows were individually tested for side-preference under non-social conditions during 18 successive milkings. The tests confirmed historical results for all but 1 cow. By observing the behaviour and heart rate of 8 individual cows which showed side-preference when milked alternately on both their habitual side (H-cows) and their non-habitual side (N-cows), the significance of side-preference was examined in 6 successive afternoon milking sessions. Eight cows not showing side-preference acted as controls (C-cows). During concentrate feeding (1 kg), N-cows paused almost twice as much (0.89 times/min) than H-cows (0.49 times/min). C-cows (0.51 times/min) did not differ from H-cows. Also the increase in heart rate during milking was significantly but slightly higher ($P< 0.05$) in N-cows (13.7%) than in H-cows (11.0%). During the first min of milking, these differences were more pronounced (N-cows: 21.8%; H-cows: 16.7%). No signs of a stress-induced decline in milk production could be detected.

It is concluded that: 1) individual cows differ consistently in either side-preference or random selection of the side of the milking parlour; 2) a proportion of the cows showed consistent side-preference in spite of changes in their social environment; 3) side-preference of dairy cows in the milking parlour seems to be a consistent behavioural routine with only marginal implications for the welfare of cows if it were to be interrupted.

Nasal-ringing in pigs: the impact of food restriction and environmental enrichment

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Outdoor pigs are commonly nose-ringed to prevent them destroying pasture by rooting. As well as inhibiting rooting, this affects grazing, stone-chewing and other behaviours that may have welfare implications. Although rooting has evolved to locate and harvest food, if there is an inherent 'behavioural need' to root, it should continue independently of the drive to feed. Furthermore, it should be possible to alleviate the impact of nose-ringing on welfare by providing other opportunities to root. Thirty gestating sows were randomly assigned to 3 groups: given a 'bull' ring through the nasal septum (BR), clip rings through the upper rim of the snout (CR), or left unringed (UR). All pigs were observed for 6 h/day for 3 day after being put on a restricted diet of roll nuts (1.5 kg/pig/day) for 9 days, and similarly observed after 9 days on enhanced diet (4.0 kg/pig/day). The groups of 10 pigs were subdivided so that 5 pigs of each condition, in a separate paddock, received the high diet first, followed by the low, and the other 5 received the diets in the reverse order. On the middle day of each of the 3 observation days, the paddocks were enriched with a peat-filled rooting tray, loose straw and small stones. Rooting, in any form (digging, nosing or exploring the ground with the snout in any way), and stone-chewing were both unaffected by feed level, in all ring conditions. Grazing, which directly affects nutrient intake, increased under food restriction (from scan-samples at 15 min intervals, the N recorded/3 h session/5 pig group - i.e. the total number of instances observed at all scans during a 3-h observation for a group of 5 sows - rose from 11.6 to 12.4 in UR, 19.6 to 26.4 in CR, and 20.5 to 28.3 in BR when restricted; $P<0.01$). The frequency of interaction with enrichment items was similar for all groups, with no strong preference for any one item. However, ringed pigs rooted more in peat than did controls (N/session/group: 3.6 and 5.8 in CR and BR pigs vs 0.8 in UR; $P<0.01$). In ringed pigs, but not controls, enrichment reduced nosing (palpation-rooting) and sniffing at the ground (N/session/group in BR and CR together: 3.6 falling to 1.3; $p<.01$), and time standing around doing nothing (0.8/pen/session dropping to 0.2; $p<0.05$). The results suggest that the motivation to root may be independent of hunger and that providing other opportunities to root ameliorates the reduction in welfare due to ringing.

Dog housing design: Hear! Hear!

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Kennels are noisy places and hearing protectors are often recommended for humans, but despite the fact that the hearing of dogs is up to 4 times more sensitive, the possible effect of noise on the welfare of dogs has not been considered. The average dog can hear sounds from frequencies of 40 Hz (cycles/s) up to around 50 kHz, with peak sensitivity at frequencies of 500 Hz to 16 kHz. Any survey to assess noise levels from the dogsO point of view should, therefore, cover these frequencies.

In this study we surveyed noise levels over 24 and 48 h periods in a range of dog housing within frequency ranges (1 Hz-20 kHz and 12.5 kHz-70 kHz). Measurements were made of reverberation time at frequencies of 100-3150 Hz and frequency spectra of noise associated with various husbandry events.

The maximum pressure change levels were above 100 dB at all sites and at 2 sites reached 130 dB. Equivalent continuous sound levels (Leqs) ranged from 42-80 dB during the night. In the day Leqs were higher but did fluctuate. Reverberation time in a room without absorbent material in the upper portions of the walls was over a second longer at most frequencies than in a similar room with the absorbent material.

There is a lack of guidelines for noise levels in dog kennels. The noise levels recorded in this study were sufficient to cause damage to unprotected human hearing, but we need more information on the behavioural and physiological effects of high sound levels on dogs. A consensus must be reached on appropriate measures of sound levels in animal facilities, on the desirable limits and means of achieving these limits.

The role of ethology in agroethics

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Ethology, as any other scientific discipline, is not independent of ethical values and value judgements. The selection of goals of scientific endeavour, the choice of experimental strategies and the utilization of obtained knowledge can all be conducted in ways that respect or ignore ethical principles. It is a serious misunderstanding to consider that adherence to ethical principles compromises or conflicts with criteria for rigorous science. Ethology in itself does not generate normative principles for ethical theories, but facilitates better understanding of psychophysiological processes and more accurate interpretation of observable indicators of animal quality of life. Ethological applications may, therefore, contribute positively to the development of agricultural production practices that are better harmonized with physical and psychological needs of farm animals. Concern for prevention of avoidable suffering and promotion of wellbeing to the broadest possible range of sentient organisms is a new logical step in the evolution of human ethics. In this regard applied ethology, perhaps more than any other biological discipline, can contribute to improved operational interpretation of normative ethical principles and their systematic application in animal and veterinary sciences.

Prepubertal immunisation against gonadotrophin-releasing hormone: effect on the development of sexual and social behaviours of young bulls

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Sexual and aggressive behaviour of bulls causes damage to pasture, fences, raceways and can result in serious injury to bulls and handlers. This paper will report on a study that investigated the use of a vaccine against gonadotropin-releasing hormone (Vaxstrate®, Arthur Webster Pty Ltd, N.S.W) to modify bull behaviour.

Ninety Friesian bull calves were either 1) castrated at 2 mo of age; 2) immunised against GnRH (Vaxstrate®, Arthur Webster Pty Ltd, N.S.W) at 2, 2.5, 4 and 7.5 mo of age; 3) immunised against GnRH at 4, 4.5 and 7.5 mo; 4) immunised against GnRH at 7.5 and 8 mo; or 5) remained intact. Behaviour was assessed from 7 to 18 mo of age in 7 bull challenge tests (BCT) and 6 sexual behaviour tests. The incidence of homosexual mounting (indicated by leg wear) and paddock damage were also recorded.

There were no significant differences among immunisation treatments for any of the behaviours assessed so data from these treatments were combined and called "immunocastrates". From 8 to 16 mo of age, bulls scored higher ($P<0.05$) than immunocastrates and steers in the BCT. There were no differences between steers and immunocastrates until 16 mo of age when immunocastrates scored higher than steers. Bulls first mounted an oestrous cow at 7 mo, but did not achieve intromission and ejaculation (I&E) until 8.5 mo. The first immunocastrate mounted at 7 mo but did not achieve I&E until 14 mo. At 18 mo significantly more bulls achieved I&E than immunocastrates (90% vs 35.7%; $P<0.05$). Although some steers did mount, none achieved I&E. Leg wear scores for bulls were highest at 9 mo of age, then steadily declined. Leg wear scores for immunocastrates were lower ($P<0.05$) than for bulls from 9 to 13 mo. No leg wear was detected on steers. Paddock damage score for bulls increased between 7 and 13 mo of age, then declined. Paddock damage for immunocastrates followed a similar trend to bulls, but was lower from 7 to 13 mo of age. Immunisation against GnRH before puberty delayed the development of sexual and social behaviour of young bulls but was less effective than surgical castration.

Behavioural interactions in the Spotted deer (*Axis axis*)

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The behavioural activities, behavioural sequences and behavioural clusters of the Spotted deer, *Axis axis*, were studied in the Trivandrum Zoo. Altogether, 70 behavioural elements were noticed during a total of 454 h of observations spread over 30 mo. Various behavioural interactions of 2-5 string combinations were revealed. There was a close relationship between the acts of resting, chewing, self-grooming and self-licking. A cluster of resting, self-licking, stretching body parts, sniffing and chewing, sniffing and resting, and rubbing by antlers was observed among males. Standing, self-grooming, sniffing and roaming, roaming, sniffing and standing, rubbing with hooves, sniffing and eating, eating, pedal marking, self-grooming and self-licking, following others and allo-sniffing formed another distinct cluster among males. Among females, resting, self-grooming, self-licking, sniffing and chewing, chewing, stretching body parts, rubbing body parts on environmental objects, sniffing, sniffing and resting, and sniffing and standing formed the behavioural elements of one cluster, whereas, sniffing and roaming, roaming, standing, self-grooming and self-licking, sniffing and eating, eating, rubbing with hooves, pedal marking, allo-sniffing and biting were those of the other distinct cluster. Distinct clusters of elements of olfaction, feeding, aggression and social activities were revealed. Allo-grooming, allo-licking and allo-sniffing were prominent during heterosexual interactions.

Behavioural interactions were influenced by sex, age, motivational states, physiological factors, duration of previous act and the number of individual in the herd. There was sexual dimorphism in the association of behavioural acts, transition of behavioural elements and in the formation of behavioural clusters in the spotted deer.

Influence of early rearing conditions on the development of feather pecking and cannibalism in domestic fowl

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The influence of early rearing conditions on the development of feather pecking and cannibalism was investigated. Twenty eight groups of 40 non beaktrimmed chicks (20 Lohmann Brown and 20 Lohmann Selected Leghorn) were reared on either: 1. sand and straw (10 groups), 2. straw (10 groups), or 3. wire (8 groups) from 0-5 weeks of age. All groups were kept on sand and straw from the fifth week of age and until the end of the rearing period at 17 weeks of age. All hens stayed in the original groups and were kept on straw with 7 hens/m^2 from 18 weeks of age and until the experiment finished at 45 weeks of age. The plumage condition of all individuals was evaluated according to the Tauson scale at 19, 33 and 45 weeks of age and behavioural observations of feather pecking activity were made during the experimental period. The results of the plumage evaluations were analysed with a mixed model. The analysis showed that hens reared on sand and straw for the first 4 weeks of life had significantly better plumage than hens reared on, straw only and on wire, when they were 19 weeks old ($P<0.05$, $P<0.001$), 33 and 45 weeks old ($P<0.001$). Hens reared on straw only the first 4 weeks of life had a significantly better plumage condition than hens reared on wire at 19, 33 and 45 weeks of age ($P<0.001$). Mean mortality rate was found to be significantly higher for groups of hens reared on wire compared to hens reared on sand and straw or straw only (14%, 2% and 3.5% respectively, $P<0.01$). The higher mortality rate was mainly caused by cannibalism in the groups reared on wire. Analysis of the behavioural data suggests that hens reared on wire feather peck more than hens reared on either sand and straw or straw only, and that feather pecking develops during rearing. Thus, early rearing conditions appear to have substantial influence on the development of feather pecking, and if developed it continues after chicks are given access to sand and straw.

Rearing piglets in a poor environment: effects on stereotypies, cortisol and oestrus expression after tethering

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It was recently shown that the development of social stress was facilitated in female pigs that were reared in a "poor" environment (de Jonge, Bokkers, Schouten and Helmond, 1996, *Physiol. Behav.* 60:389-396). In the present experiment, which was a continuation of the former study, it was investigated whether "poor" rearing conditions and subsequent social status during social housing, did also increase stress-sensitivity to a non-social stressor (ie chronic tethering stress). The following groups of animals were investigated: 1) poor / dominant (n=5), 2) poor / subordinate (n=5), 3) enriched / dominant (n=7) and 4) enriched / subordinate (n=7). Subjects were tethered during 6 mo before the experiment started. Stereotypic behaviour was measured using a scan-sampling method and the measurement of qualitative aspects of oestrus expression was adopted from de Jonge, Mekking, Abbott, Wiepkema, 1994 (*Behav. Process.* 31:157-166).

The results showed that "poor" rearing conditions enhanced deleterious effects of chronic tethering stress: the amount of stereotypic behaviour was increased from 54.3% to 82.1% of stereotypy-positive scans (ANOVA, $F_{1,19}=10.07$, $P<0.005$), and the expression of oestrus behaviour was decreased from a qualitative score of 11 to a score of 8 (Mann-Whitney, $P<0.05$) in tethered animals that were also reared under "poor" as opposed to "enriched" conditions. Concentrations of saliva cortisol were not correlated with the amount of stereotypic behaviour and appeared to be more dependent upon previously established social status than on early rearing conditions (ANOVA, $F_{1,19}=9.37$, $P<0.005$). Frequencies of stereotypic behaviours fluctuated with oestrus cycle stage, but were not correlated with the quality of its expression. During oestrus, the percentage of stereotypy-positive scans decreased to a level of 45%.

The data are discussed in terms of theories that predict an increased predisposition of prenatally stressed animals to environmentally induced stereotypies as a result of a sensitization process related to increased dopaminergic activity at a neural level.

A comparison of two basic characteristics of a perch for laying hens

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Traditionally perches for domestic fowl have had the same characteristics as the branches used by birds in the wild i.e. off the ground and roundish in shape. However in some housing systems perches have been replaced by wooden bars, placed directly on the wire floor, or by raised platforms. This experiment was designed to determine whether these are perceived as perches by assessing the importance of 2 characteristics of a perch; the possibility for the bird to grip around the perch with its feet, and height.

Six laying hens were each given pair-wise choices between combinations of 4 perch types (high round, high flat, low round and low flat) to compare height preferences (70 or 0 cm) for the same perch shape, or different perch shapes at the same height. Birds were video recorded during 1 entire daylight period for each perch-pair combination and then the median duration on each perch type compared using Wilcoxon matched-pairs tests. All birds spent more time on high than low perches (T=0, N=6; $P<0.05$). Total durations were 937 vs 13 min for high flat vs low flat, and 896 vs 30 min for high round vs low round. There was also a trend ($P<0.1$) for the high round perch to be preferred over the high flat.

It is suggested that birds are less fearful when they are perching (as opposed to standing on a piece of wood) so in a second experiment each bird was exposed to an approaching stuffed predator while positioned on each perch type. There was no effect of perch shape, but birds on the high flat perches allowed the predator to approach significantly closer (1.4 m) than birds on the low flat perches (4.8 m) (T=0, N=6; $P<0.05$) and a similar trend ($P<0.1$) was seen for birds on the high round vs low round perches.

In conclusion, height was a more important perch characteristic than shape, although grippable perches may also have some benefits.

Assessment of chronic inflammatory pain after rubber ring castration of six week old lambs

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Eight 6 week old housed unweaned lambs were castrated using elastrator rings and the neck of the scrotum was assessed twice weekly for 7 weeks for signs of inflammation and sepsis (lesion score). The posture and active behaviours of the castrated and 8 matched control lambs were observed for a 6 h period once a week. This observation period started about 13:00 h and was separated into two 3 h periods by a 30 min interval for feeding and adding a box to each pen for the lambs to play on. Foot stamping/kicking, easing quarters, tail wagging, head turning, rubbing quarters, restlessness, butting and play were observed continuously by 2 observers, 1 of which also recorded the posture of each lamb every 6 min.

Inflammation increased rapidly as the skin integrity broke down about 7 days after castration. The size of the septic and inflamed lesion increased, peaking at 21 to 28 days, with recovery occurring after the scrotum dropped off (mean 32 days after castration). Lambs showed bouts of active behaviours resulting in a significant increase (above the values observed in control lambs) in the total incidence of foot stamping/kicking (mean for control lambs=4 vs 7 for castrated lambs, values were totalled over the seven 6 h periods, $P<0.05$), easing quarters (10 vs 25; $P<0.001$), tail wagging (15 vs 42; $P<0.005$), rubbing the quarters (3 vs 9; $P<0.001$) and head turning (8 vs 15; $P<0.05$). The highest incidence of the above mentioned behaviours occurred between 14 and 28 days after castration. Presence of inflamed lesions did not affect the incidence of playing on the box (178 vs 147), butting (5 vs 9) or restlessness (47 vs 57). One interpretation of the behavioural data is that the lambs with septic lesions suffered recurrent bouts of chronic pain. The severity of this experience did not stop the lambs playing on the boxes, eating or affect daily liveweight gain.

Social behaviour of semi-wild Scottish Highland cattle and Konik horses in nature-reserves in the Netherlands

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In the Netherlands large grazing mammals are used for the management of the vegetation in nature reserves. In special situations 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 minimised when it is based on behavioural knowledge of the relations between animals. Observations commenced in September 1994 on a semi-wild Scottish Highland cattle herd in 'National Park Veluwezoom' (Eastern Netherlands) of about 120 individuals. The social organisation consisted of groups of variable size (2-60 individuals), whose membership varied from day to day. Association indexes between adult individuals were low from March to June (0.11) but high from September to December (0.38) when only single-sex groups of cows (plus calves) and bulls were found. During the hot summer of 1995 not much time was spend on grazing during the day. During the cold winter of 1995/96 the condition of many individuals appeared to be low. Many animals died in spring 1996 and additional food had to be presented. In this period the group size was diminished (2-10 individuals). In the morning and the evening bulls interact intensively. Correlations between rank position (determined by wins/losses) and aggressive (-0.71), sexual (-0.68), and vocal (-0.61) behaviour, were significant. Special attention was given to bull (n=11) vocal communication. A number of bull vocalisations 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, i.e. frequency ($F_{10,35}$=4.46; P<0.001) and duration ($F_{10,35}$=3.41; P<0.01) of the bellows were significant different between all bulls. In conclusion, the social organisation of the Scottish Highland herd is loose, maybe caused by absence of human intervention or predators. Groups continuously change from composition. Seasonal and weather conditions can cause welfare problems. In September 1996 a comparable project on Konik horses was started in the nature reserve the 'Blauwe Kamer', the Netherlands. Social organisation of the horses is characterised by strong cohesion - in contrast with the absence of cohesion in the Highland cattle. Welfare problems arise during high water levels in winter when groups can be separated. Cattle and horses are compared concerning their behaviour and value for extensive management of nature reserves.

Analysis of the human animal interaction demonstrated in sheep by using the model of "social support"

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There is evidence that humans play an important role in the interaction with farm animals. As the concept of "social support" is a well established model of a special kind of interaction between animals, we tried to find out if humans can socially support farm animals. Furthermore we investigated which signals are necessary so that recognition of a familiar person takes place.

Experiment 1. In order to answer the question whether a caretaker can provide social support and reduce the response to stress in farm animals, 6 lambs (experimental group), which were bottle-fed by 1 person (familiar person), and 6 lambs (control group), which were reared by their mothers, were subjected to 4 different situations at the age of 8 weeks, 4 mo and 1 year. After weaning, contact with humans in general was minimal, and contact with the familiar person occurred only during tests. The 4 test situations consisted of confinement for 15 min in a sound proof room 1) alone (social isolation), 2) with the familiar person, 3) with an unfamiliar person, and 4) with a familiar lamb. Each lamb was subjected to the 4 situations on 4 different days in a systematically different order.

Experiment 2. In order to find out if certain details of a human are sufficient or if the whole person is necessary for the recognition of a familiar person in a novel test situation, 8 artificially-raised lambs were subjected to 4 different situations at the age of 10 weeks. After weaning at 6 weeks, the lambs were intensively handled by a person. The 4 test situations consisted of confinement in a sound-proof room with 1) the familiar person 2) the presence of his voice (sound recording), 3) his smell (clothes), and 4) his visual image through a plexiglass-pane. Each lamb was subjected to all situations on 4 different days in a systematically different order.

Experiment 3. The period of handling was systematically changed. Three groups of lambs were handled at different times: a) directly after birth, b) after weaning and c) continuously from birth to weaning. The test situations consisted of confinement with 1) the familiar person, and 2) with a new object (for analysing the effects of early handling on the general fear response).

In each experiment 15 min before the beginning of the confinement 7 blood samples were taken every 15 min via intravenous catheter for cortisol determination and heart rate was recorded at an interval of 15 s. During the confinement, behaviour was observed directly and also recorded on video tapes (continuous behaviour sampling).

All test groups in "social isolation" showed marked increased restlessness (97% of time spent in confinement), more frequent vocalisation (on an average of 5 calls/min), heart rate (mean value:175.2 bpm; basic level;108 bpm) and cortisol secretion (second and third samples: 8.9 and 28.9 ng/ml). In testing with the "familiar person" only the bottle-fed lambs showed no stress-reaction (categories of behaviour $P<0.05$; vocalisation $P<0.01$; heart rate $P<0.05$; cortisol $P<0.05$). Similar results were found 1 year later. Lambs behaved in a similar way with the visual image of the familiar person as with the person present. There were no significant differences in cortisol, behaviour and vocalisation between the groups handled at different times.

Despite the relative small number of test animals, it was demonstrated that the presence of a familiar person is capable of reducing the stress reaction to an unfamiliar novel situation. In such a situation, the person may play the role of social support. The time when the animals are handled seems to be less important.

Effect of cage size and access to earthen level on behaviour of farm Blue foxes (*Alopex lagopus*)

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Harmfulness of wire mesh netting and very limited cage space have been major targets of criticism against fox husbandry. The present experiments were part of a comprehensive Finnish co-study entitled “Alternative housing environment for farmed foxes”. The aims in Blue foxes (*Alopex lagopus*) were to clarify: (1) amount of appropriate cage space; (2) necessity for ground contact; and, (3) possible need for ground digging behaviour. The experimental set-up employed a novel construction in which the animal spent the first 2 weeks in a small wire mesh cage (80 cm long x 105 cm wide x 70 cm high). Thereafter, cage size was enlarged from 80 cm to 120 cm for a further 2 weeks and then to 240 cm. Finally, the animals also had free access to an earthen floor cage (120 cm long) on the ground directly below the experimental large wire mesh cage. Behaviour of the animals was recorded for 24 h by video camera equipment. Eight similar test cage constructions, with 1 male Blue fox in each, were simultaneously studied. The first experiment was conducted during May-June 1996 at the Kannus Research Station. The second experiment (July-September) was otherwise similar, but after foxes had spent 2 weeks on ground flooring, the floor material was replaced by net. The third experiment (October-December) was similar to Exp. 2, but now juveniles were studied instead of adults. Initial examination of data by graphs showed variable behavioural response of foxes within and between experiments. In Exp. 1, the activity rate of 4 and 3 foxes tended to increase and decrease, respectively, as cage size was enlarged. In Exp. 2, however, activity of 6 out of altogether 8 foxes showed a decreasing tendency as cage size was expanded. Some foxes were interested in movement on the ground, but others totally avoided it. Of the total 24 h locomotor activity, ground level locomotion varied from 0 to 52%. Ground digging was slight; only a few foxes occasionally dug for longer times (maximum 178 min/24 h). Because all of the data analyses, and video recordings from Exp. 3 are still in progress, any final conclusions cannot be made. However, it appears obvious that any unambiguous conclusion that foxes need bigger or earthen floor cages in order to satisfy their behavioural needs cannot yet be drawn.

Influence of food restriction on brain dopaminergic activity in broiler breeders

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Parent stock (breeders) of meat-type chickens (broilers) are subjected to routine severe food restriction during rearing. Such restricted-fed birds are much more active than *ad libitum*-fed ones, and they show stereotyped oral behaviours such as pecking at non-food objects and over-drinking. Their expression of these activities is correlated positively with the level of food restriction imposed. Based on pharmacological manipulations of different neurochemical receptor systems, it was hypothesised that dopaminergic mechanisms play a major role in control of this behaviour.

The aim of this study was to assess the possible relationship between the degree of food restriction and brain dopaminergic activity. Fifteen broiler breeder females were divided into 3 groups, which received either a recommended commercial ration (R), twice that amount (2R), or *ad libitum* food (AL). At 60 days of age, birds were killed and their brains dissected into 6 regions: forebrain roof, basal telencephalon, diencephalon, mesencephalon, cerebellum and pons + medulla. Dopamine receptor densities were estimated by specific binding of [^{3}H]SCH 23390 (D_1) and [^{3}H]spiperone (D_2) and levels of dopamine and its metabolites DOPAC and HVA by HPLC.

There were no significant differences in D_1 or D_2 dopamine receptor binding between the feeding treatments in any brain region tested. However, possible differences in more discrete areas cannot be excluded. The levels of dopamine in basal telencephalon were significantly higher in the R group than in the AL one (2165 vs 1595 pg/mg wet tissue, $P>0.05$). On the other hand, there was significantly less dopamine in tissue samples from cerebellum (55 vs 65 pg/mg wet tissue, $P>0.05$) and medulla + pons region (125 vs 185 pg/mg wet tissue, $P>0.05$) in the R than in the AL birds. There were no significant differences in dopamine turnover (DOPAC and HVA levels) between the different feeding treatment groups.

The increased levels of dopamine in basal telencephalon found in restricted-fed birds are consistent with results of our previous studies, showing stimulation and suppression of their post-feeding oral stereotypies following treatments with dopamine receptor agonists and antagonists, respectively.

Temporal changes in comfort behaviour of laying hens in modified battery cages

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Changes in comfort and aggressive behaviour of 124 ISA Brown laying hens in a commercial scale trial of conventional and modified battery cages were studied throughout a laying year (age 18-70 weeks). We hypothesised that fluctuations in behavioural incidence would occur during early lay and later stabilise as birds settled and established dominance hierarchies. Differential rearing methods might also affect habituation to the cage environment. Observations were taken during 18-22 weeks of lay, following caging at 17 weeks, and subsequently at approximately 10-weekly intervals. Six treatments were included, covering the following factors: rearing method (cage or litter); cage type (conventional or modified); density (4 hens per cage, 625 cm^2 per hen in conventional cages; 5 (750 cm^2 per hen) or 8 (469 cm^2 per hen) hens per cage in modified cages). All modified cages had nest boxes and perches, and some were fitted with dustbaths. A repeated measures ANOVA showed that leg and wing stretching ($P<0.001$), balancing wing flaps ($P<0.001$), bill wiping ($P<0.05$) and tail wagging ($P<0.001$) decreased and remained low after the first few weeks. Aggressive pecking increased significantly with time ($P<0.05$), while feather pecking was variable and showed a slight decrease in modified cages ($P<0.05$). There were minor differences in cages; this cost was clearly not offset by providing a larger and enriched modified cage environment.

High ranked hens are socially facilitated to dustbathe by a video image

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Laying hens are social animals that live in groups with clear dominance relationships. Their behaviour is usually synchronised and social factors may be involved in this synchrony through the process of social facilitation. This occurs when an animal initiates a behaviour or performs it more frequently or more intensively when it sees another performing the same behaviour. Considering the importance of social rank, differences in the effect of social stimuli on high and low ranked hens may be expected. The aim of this study was to examine whether dustbathing is socially facilitated and whether birds are affected differently depending on their rank.

Video images were used in the experiment. Birds were ranked after observations of aggressive interactions and avoidance. Twelve high and 12 low ranked birds were used as test animals and 4 middle ranked birds were recorded and used as stimulus birds. After 9 days of dust deprivation, each bird was in tested in a cage with sand on the floor, in front of a TV-monitor. Three different test videos were used; a dustbathing hen, a standing hen, and an empty cage. Each bird was exposed to each video image according to a balanced design. Social facilitation was tested by comparing responses of the test hen to a dustbathing hen and a standing hen, and social inhibition and solitary inhibition were tested by comparing responses of the test hen to a dustbathing hen and a standing hen with responses to an empty cage.

Differences were found in latency to dustbathe using analyses of variance ($P<0.05$). High ranked birds dustbathed sooner if they were shown a video image of a dustbathing hen (latency 2491 ± 850 s) compared to a standing hen (latency 5772 ± 810 s). For low ranked birds, no significant difference was found between treatments. In conclusion, dustbathing was socially facilitated in high ranked birds.

Effects of simulated brooding cycles on growth and behaviour of broiler and layer chicks

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Domestic chicks appear to develop normally without contact with the mother hen. To date, management practices concentrate on keeping chicks warm and on stimulating them to feed and drink. To achieve this, chicks are commonly reared under continuous bright light for the first 3 days after hatching. However, one function of the mother hen has been forgotten; during the normal brooding cycle, periods of activity alternate with periods of synchronized rest as the whole brood gathers in the thermally-comfortable micro-environment under the mother hen. The objective of this study was to see if broiler and layer strain chicks would adapt to a simulated brooding cycle which allowed them to rest synchronously. There were 4 trials with 4 groups of 10 layer chicks and 4 groups of broiler chicks in each trial. Half the groups were subjected to a long-day schedule (LD) of 19.33 L : 4.67 D. The other half were subjected to a simulated brooding cycle (SBC) which consisted of the same long day but with alternating 40 min light, 40 min dark periods throughout the main light period. Growth characteristics and behaviour were measured during the first 14 days. As expected, there were significant strain effects for growth rate, feed:gain, body composition and shank length ($P<0.001$); however, no differences were found between lighting treatments ($P>0.10$). Chicks on both lighting treatments mainly rested during the dark period. During the dark period, birds were observed to feed only 0.5 ± 0.5 (SE); 0.2 ± 0.1; 0.4 ± 0.4; 0.8 ± 0.2 min/h of darkness/bird for the layer LD, layer SBC, broiler LD, and broiler SBC, respectively. Apart from feeding, birds in all treatments moved about the pen for less than 1 min/h of darkness/bird. These data suggest that there is no disadvantage in providing chicks with a SBC and, no advantage to the continuous lighting that the industry currently implements. Chicks can do just as well if kept on a much more natural lighting schedule.

Effects of flightiness, sociability and previous handling experience on the behaviour of cattle in yards

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This study aimed to determine the influence of animal-animal and human-animal interactions on the ease of handling cattle in yards. Groups of 7 Simmental x Angus steers were allocated to 3 treatments based on the level of previous handling experience during the rearing period (None, Moderate, Intensive). There were 4 replicates of each of the N and M treatment groups and 2 replicates of the I treatment. The following measures were taken on all individual animals: flight distance at pasture and in pens, intensity of behavioural disturbance when in close proximity to the handler, strength of attraction of an isolated animal to its familiar herdmates (measured by the readiness of the isolated steer to cross a barrier that separated it from its group mates), time taken to draft a single animal from its group in a pen, and the response to restraint in a weigh crate. These measures were recorded for each animal in each replicate on 2 separate occasions, 1 week apart.

The mean flight distances in the paddock were greatest for N (14 m, $P<0.05$) and not different between the M and I treatments (6 and 5 m, respectively). The mean pen flight distances for N, M, and I were 8, 7 and 6 m, respectively, with the difference between N and I being significant ($P< 0.05$). The N and M animals showed similar and more disturbed behaviour than the I animals when close to the handler. The N and M animals were both strongly attracted to their herd mates while the I animals were only weakly attracted. The mean drafting times were 50, 30 and 21 s ($P<0.05$) for N, M and I, respectively, but there were no consistent differences between treatments during restraint in a weigh crate. This study has shown that a moderate level of handling (e.g. intermittent yarding and drafting) substantially reduces flightiness but has little effect on the level of attraction between herd mates (sociability). Intensive handling (including bucket feeding of milk to calves) reduces both flightiness and sociability. Further, we have shown that ease of drafting is improved most by handling experiences which reduce both flight responses to humans and the attractiveness of other cattle.

Previous familiarity has little effect on behaviour and stress responses in re-grouped laying hens

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DeKalb hens were raised in 20-bird groups from hatching in pens visually isolated from neighbouring pens. At sexual maturity, hens were placed into treatments as follows: 1) 6 hens drawn from 6 different rearing pens so that all hens were unfamiliar (MIX), 2) 3 hens drawn from 1 rearing pen and 3 from another, so that the group contained a mixture of familiar and unfamiliar hens (partially mixed, PMIX), and 3) 6 hens drawn from the same rearing pen so that all hens were familiar (FAMIL). Each social group of 6 hens was placed in a new pen in the rearing building. There were 4 replicates (pens) for each treatment. Aggressive and spacing behaviours were monitored for 6 weeks, and plasma corticosterone (CORT) assessed at 4, 11, 18 and 25 days after grouping. CORT was higher ($P<0.05$) in PMIX (3.8 ng/ml) than FAMIL hens (2.8) at day 4; levels were similar in all treatments on subsequent sampling days. Aggression was highest during weeks 1 and 2, and then declined. Distance from pen centre decreased ($P<0.01$) from 96.1 cm the week after mixing to 75.7 cm by week 3. Interindividual (interback) distances similarly decreased ($P<0.05$), from 99.1 to 86 cm, as did the orientation index (interback minus interhead distance). During week 1, hens tended to be oriented parallel to one another (index -0.1), but by week 3 they tended to face slightly away from one another (-3.6). There were, however, no treatment effects on behaviour. Previous familiarity thus appears to have little differential effect on spacing or social behaviour in hens when overall group composition is changed by creating a smaller sub-group of an existing group or by mixing unfamiliar hens, although plasma corticosterone concentrations are transiently higher in groups containing both unfamiliar and familiar hens.

Effect of lip twitch restrain in cribbing horses

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Among oral stereotypies in horses cribbing is one of the most frequently observed (McGreevy, French, Nicol, 1995, *The Veterinary Record*, 36-37). From preliminary observations, it is clear that during this stereotypic behaviour heart rate is lower than during other behavioural patterns (Minero et al, 1996, *Measuring Behaviour '96*, Utrecht, The Netherlands). According to the homeostatic hypothesis, stereotypies may have a self regulating function and help the animal to cope with stressful situations (Cooper and Nicol, 1991, *Anim. Behav*., 41:971-977; Schouten and Wiepkema, 1991, *Behav. Proc*., 25:125-132). The aim of this work was to determine if cribbing horses differ from non-stereotyping horses in reaction to the application of a short term stressor, lip twitch which is a common practice in horse restraining. Behaviour and heart rate were recorded in 12 adult saddle horses, (7 geldings and 5 non pregnant mares). Six of them were long time crib-biters, the other ones had no stereotypic disorders (control subjects). Heart rate was recorded with the heart monitor system Polar Electro PE-3000 meter and a special girth belt adapted for horses. The monitor detected heart rate and stored the information expressed as the mean heart rate per min at 5 s time interval. Heart rate was recorded for 4 min before the application of the lip twitch (basal level), 4 min during restraining with the twitch and 4 min after the removal of the stressor. Reactivity of horses to the twitch has been classed as "calm" or "highly reactive" in relation to the percentage of time that they spent attempting to flee, their pawing and their facial expression of alarm. Immediately after the application of the twitch, all the horses showed a significant increase in heart rate ($P<0.001$) compared to basal values; the increase was statistically higher in control animals ($P<0.05$). The mean heart rate in cribbers in the first minute of twitch was: 51.2 bpm vs 37.3 bpm basal value (maximal value 104 bpm) while in control animals was 54.9 bpm vs 35.5 bpm (maximal value 123 bpm). Heart rate turned back to basal values more rapidly in cribbers (during the second min of application of lip twitch) than in control horses (during the third min of application of lip twitch). Control animals showed also a higher reactivity to the lip twitch. After removal of the twitch, cribbers returned to normal activities showing more locomotion ($P<0.05$) and ingestive behaviour ($P<0.01$) while control subjects showed a higher degree of immobility ($P<0.05$), perhaps linked to the higher reactivity to the restraining. Heart rate and behavioural data seem to suggest that cribbers show a lower level of reactivity to the application of this short term stressor.

The behavioural and physiological effects of 'environmental enrichment' on six strains of laboratory mice

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The addition of features into the caged environment of animals (often termed 'environmental enrichment') has been championed as a method for improving welfare. Some previous studies examining mice have indicated that increasing the complexity of the cage environment disrupts social hierarchies and increases aggression levels. Limited evidence also suggests that behavioural responses to 'enrichment' differ between strains. We examined the behavioural and physiological responses of 6 commonly used laboratory mouse strains (the outbreds ICR(CD-1) and TO; and the inbreds BALB/c, C57BL/6, CBA/Ca, DBA/2). Mice of each strain were housed in 8 groups of 4 in polypropylene cages. Half of the cages were `enriched' by the addition of a Perspex tunnel and a handful of shredded nesting material. Time budget samples were taken of the behaviour of each individual. Testosterone, IgG and corticosterone levels were measured from individual blood samples as they have previously been found to correlate with behaviour.

The data were analysed using appropriate parametric and non-parametric statistics. Important strain differences in behavioural time budgets were found including aggression ($P<0.001$). The strains ICR(CD-1), TO and BALB/c could be categorised as aggressive, the other strains showed very low levels of aggression.

Within strains, mice housed in `enriched' cages showed significant differences ($P<0.05$) compared to those in non-enriched cages in certain aspects of their time budget and physiology, but not aggression. The behaviours in which these differences were found were not the same across strains. The differences in responses of each strain to housing conditions may have important strain-specific implications for welfare recommendations.

Cover, group size and predation risk in Label Rouge chickens

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In wild animals, predation risk is reduced in the presence of cover and in larger versus smaller group sizes. Although these factors no longer affect predation risk in domestic animals housed indoors, we hypothesized that cover and group size would influence the use of space by Label Rouge chickens in the same direction as that observed in wild animals. We reared 55 female, and 55 male, Label Rouge chickens in each of eight 14 m^2 floor pens. Throughout rearing, each group was given access to a 65 m^2 "observation" pen adjacent to their home pen for 1 h daily. This pen was divided into 9 equal quadrants, providing 0.07 m^2 of floor space per bird if all birds were in 1 quadrant. Birds were able to move freely between quadrants. The 4 corner quadrants were supplied with 1, 2, 4 and 8 panels of vertical cover (green plastic mesh), respectively. At 9 weeks of age, observations were made of the use of space in the observation pen by each group. On 1 observation day, the whole group (110 chickens) was observed whereas, on the other day, only 20 chickens (10 females, 10 males) from the group were given access to the observation pen. The order for observing the 2 group sizes was balanced across the 8 groups. Starting 5 min after bird entry to the pen, 6 scans were made at 10 min intervals of the total number of birds in each quadrant. The index of dispersion was calculated for the distribution of birds across the 9 quadrants during each scan and data were subjected to repeated measures analysis. Birds were more dispersed in groups of 110 than in groups of 20 ($P<0.05$). This result was not due simply to a stocking density effect because dispersion increased over the 1 h observation period at both group sizes ($P<0.01$). The proportion of birds in each quadrant increased as the number of cover panels increased from 0 to 8 ($P<0.05$). However, birds in the larger group size used cover less than birds in the smaller group size ($P<0.05$). Our results are consistent with predictions based on predation risk in wild animals.

Advances in digital video technology: Perspectives for ethological research

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The use of computers for the collection and analysis of behavioural data is now widespread. A desktop, notebook or handheld computer, equipped with an event recording program, allows easy entry and accurate timing of behavioural events and eliminates data transcription.

Often the observer keys in the data while watching the animal(s). However, live observation and scoring are not always possible or desirable, e.g. when behaviours occur too rapidly or if too much happens at once. In such cases, one typically videotapes the process and next codes the behaviour from tape, with the VCR playback speed adapted to the complexity of the behaviour observed. Accurate timing of videotaped events, however, requires synchronization between what is visible on the tape and the computer timer. Through the integration of event recording software with video time code and multimedia hardware, fast and convenient coding, annotating and reviewing of video tapes becomes possible. During preparation of a tape recording, a time code generator adds an invisible time code to each video frame. During data collection, a time code reader retrieves the time code from the tape, allowing frame-accurate event timing independent of VCR playback speed. Each keyboard entry is firmly anchored to the video frame displayed at the instant the user presses the first key of a behaviour code. Observational data can be reviewed and edited, with synchronized display of the corresponding video images. The VCR can be controlled by the computer, allowing software-controlled jog, shuttle and search functions. For optimal visual feedback during coding, one can display the video image in a window on the computer screen. Video images can be captured and saved as graphics files, for use as illustrations in documents, slides for presentations, etc. Marked video episodes can be copied to an edit decision list for easy creation of highlight tapes.

The disadvantage of video tapes is that they allow only linear access. As a result, search operations can be associated with considerable tape (re)wind times. Furthermore, tape quality deteriorates with repeated playback. These problems are solved by digital storage media, such as CD-ROM and Digital Video Disk, which will gradually replace analog video tapes. Digital video allows immediate access to any video frame as well as multi-point playback (e.g. from a video server in an institutional network). Video files can also be copied without loss of quality. This offers exciting opportunities for the ethologist. Research results can thus be illustrated with video images and clips (digital movies) of selected behavioural patterns into multimedia reports. These can be distributed on CD-ROM or published on the Internet or an organization’s intranet. Some examples of this new technique will be demonstrated during the presentation.

Different methods of supplying water to horses - A preference test

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The aim of this study was to investigate the preference of horses for different water sources and flow rates. This was measured as the percentage of their daily water intake from each of 2 simultaneously presented alternatives. All data are presented as mean values (with SE). When testing differences in water intake between the alternatives Statistical Analysis Systems, procedure GLM was used. Six Standardbred geldings (2-9 years, 472-563 kg) were kept indoors in individual boxes (ambient temperature +10 to +15°C) and let out in sand paddocks for 3 h a day (air temperature -5 to +10 °C). The horses were fed a grass hay and oat diet 4 times a day, added with their daily requirement of sodium.

The study comprised 3 water sources: 2 buckets of 20 l each refilled twice daily (B), pressure valve (PV) and float valve (FV) waterers. The horses were normally watered from the FV waterer but were accustomed to the buckets and the PV waterer before the tests. The PV waterer was tested at 3 flow rates: 3, 8 and 16 l/min (PV3, PV8 and PV16). All horses were assigned to the following treatments in a random order: a) PV8 and B, b) PV3 and PV8, c) PV8 and PV16, d) FV3 (3 l/min) and PV3, and e) FV3 and PV8. Each treatment lasted for 2 consecutive days. In between these experimental days the horses were watered from buckets for 4 days. All horses showed a strong preference for buckets, the intake from B was 98 ± 1% compared to 2 ± 1% from PV8 ($P<0.05$). The intake from PV8 was greater ($P<0.05$) than from both PV3 (72 ± 11 vs 28 ± 11%) and from PV16 (90 ± 4 vs 10 ± 4%). When the 2 automatic waterers were compared, FV3 with PV3 (40 ± 13 vs 60 ± 13%) and FV3 with PV8 (52 ± 13 vs 48 ± 13%), the water intake between the waterers did not differ significantly.

Housing and husbandry of wild-caught Brushtail possums used in research

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Possums (*Trichosurus vulpecula*) are New Zealand's main vertebrate pest, causing severe damage to our native environment and facilitating the spread of bovine tuberculosis. Possum control is therefore a national research priority, with over 1500 captive animals used in research during 1995. The adaptation of wild-caught possums to captivity is essential if they are to be used for research purposes, as the stress of capture may influence their physiological and behavioural responses, as well as adversely affecting their welfare. Investigations into improving housing and husbandry systems have therefore been an ongoing part of possum research. Discussion on aspects of our current systems will demonstrate how bodyweight losses of up to 25% during the first 4 weeks post capture and mortality of 10%, in the 1980's, have been reduced to 5% weight loss and 3% mortality. Although the basic cage dimensions have remained the same over this time, several modifications have been made. One of the key areas was the provision of a warm environment as possums are very susceptible to cold temperatures (<8°C). Studies into preferences for varying nest box sizes and bedding materials have resulted in the use of different types of nest boxes in our different housing facilities. We have also evaluated the use of a top shelf versus a branch within the cage. We would recommend possum cages be a minimum of 1 m^3, include an elevated area, nest box and nipple drinkers, and be disinfected regularly whilst maintaining a dry environment. The time required for behavioural adaptation to captivity for possums in our system has been determined using a simple behavioural measure: daily response of each possum (approach/avoid) to the same handler, at feeding. The behavioural responses and other haematological data suggest that at least 4 weeks adaptation to cages should be allowed before possums are used in experimental studies.

Psychobiological consequences of different weaning methods in sheep

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In mammals, weaning can induce psychobiological changes with unknown consequences. In sheep a selective mother-young bond rapidly establishes at birth, and persists even beyond the lactation period under natural conditions. In commercial flocks, weaning means profound changes of diet, mother-young separation and sometimes moving animals into different paddocks. The aim of this study was to measure consequences of 4 different methods of weaning on behavioural and physiological measures of stress in sheep (10 ewes and 15 lambs, 10 twins and 5 single lambs, in each group): 1/ progressive weaning (PROG) with daily and temporary separation from 3.5 weeks to 3 mo versus sudden weaning (SUDD) at 3 mo; 2/ total separation (TS: ewes and lambs moved into different enclosures) versus partial separation (PS: separated in the same building by an open fence).

Overall, ewe and lamb vocalizations increased dramatically after separation. Mothers and young from PROG group habituated to separation since at weaning they vocalized less than the SUDD group (ewes: 55 vs 2 and lambs: 315 vs 8 per 10 animals/20 min during the day of weaning; $P<0.001$). However the high frequency of vocalizations observed in the SUDD group was transient. TS animals vocalized less frequently and for a shorter time than PS animals (ewes: 27 vs 55 and lambs: 46 vs 163 per10 animals/20 min during the day of weaning; $P<0.001$). Number of coccidial oocysts excreted were higher in PROG than in SUDD lambs ($P<0.05$) and TS lambs excreted more coccidial oocysts after than before weaning, unlike PS lambs ($P<0.05$). Therefore lambs seem more sensitive to coccidial infestation if they are progressively weaned or totally separated. Plasma cortisol concentrations were unaffected by weaning method. No difference in immune response nor in weight gain of lambs was observed between the different weaning methods. In conclusion, in contrast to primates and rodents, our results suggest that no obvious link appears between behavioural and other parameters and that these different weaning methods do not induce a high level of social stress in sheep.

Components of milk eliciting non-nutritive sucking by calves

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Previous research has shown that non-nutritive sucking by calves is elicited by the ingestion of milk. To examine the role of the various components of milk, male dairy calves were allowed to suck a non-nutritive teat after being given small quantities (5-50 ml) of milk replacer or reconstituted milk, and the amount of non-nutritive sucking was observed. A minimum of 12 animals was used in each experiment and each animal was its own control. More non-nutritive sucking was elicited by milk replacer than either water or a suspension of grain, and non-nutritive sucking increased as milk replacer concentration increased even up to 300% of normal concentration. The concentration of the different components of reconstituted milk was varied. Increased concentrations of lactose in milk elicited increased non-nutritive sucking, but increased concentrations of fat and the protein components had no consistent effect. Water solutions of the protein components did not elicit more non-nutritive sucking than water, while removal of these protein components and of fat did not eliminate sucking. However, removal of lactoserum proteins reduced sucking. Removal of the non-protein component of lactoserum (containing the lactose) reduced sucking, but sucking did not return to normal levels when only the lactose was replaced. Conversion of lactose to other sugars by lactase did not affect sucking. Changes in the composition of the milk drunk can affect non-nutritive sucking. Non-nutritive sucking appears to be elicited by the overall taste of milk, rather than by the taste of any one component. However, the concentration of lactose plays a role in determining how much sucking is elicited, at least when the non-protein solid components of lactoserum are present.

Effect of siting of supplementary feed on intake and paddock use by beef cattle

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Supplementary feed is provided to cattle to minimise weight loss during periods of drought or when plants are dormant. Large variability around an optimal average intake means that the cost-effectiveness of this feeding is reduced.

This study examined the effects of the siting of supplementary feed on intake and paddock use by small groups of steers. Sixty steers (average weight 335.5 kg) were allocated to 6 paddock groups based on liveweight. There were 2 treatments: (i) a dry-season lick block was sited about 25 m from the water trough (N), (ii) a dry-season lick block was placed at the opposite end of the paddock from the water trough at a distance of about 1.8 km (F). The blocks comprised approximately 33% molasses, 20% urea, 3% cotton seed meal, 6% salt, plus various minerals (e.g. calcium and phosphorus) and trace elements. A switch-back design was used with each of 3 paddocks receiving either treatment N or F for the first mo, followed by a mo on the other treatment and the original treatment during the third mo.

Daily group intake of block was measured and the position in the paddock and the behaviour of the groups of steers were recorded at 0830 h, 1200 h and 1530 h. At the end of each mo individual supplement intakes were determined using a lithium marker technique.

Preliminary analysis suggests that supplement siting had minimal effects on the way in which cattle used the paddocks. Regardless of treatment cattle were found at or near the water trough on the first observation of the day, were resting and ruminating at the trough on the second and were grazing away from the trough on the third. Supplement intakes were higher on the N treatment than on the F treatment, with mean intakes (g/head/day) being for mo 1: N=138, F=115 (n.s.), mo 2: N=163, F=95 ($P<0.05$), mo 3: N=212, F=150 ($P<0.01$). Average liveweight gains during the first mo tended to be higher ($P=0.077$) on the N treatment (N=16.5 kg, F=9.5 kg) but there were no significant differences on subsequent mo.

The ingestion of amniotic fluid and placenta and the behaviour of the parturient cow and its calf

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The influence of the voluntary ingestion of amniotic fluid (AF) and placenta (PL) on the maternal behaviour of 36 multiparous Holstein cows and in the early development of their calves was studied. The animals were randomly assigned to 4 treatments: AP (AF and PL available), AN (AF available, PL not), NP (AF not, PL available), and NN (AF and PL not available). Therefore, the amniotic fluid and membranes were either removed or not from the calves' surface immediately after delivery and placenta was either left available or immediately removed from the pen after expelled. The behaviour of the cow-calf pair was registered every 2 min for 12 h following fetus' expulsion. Parturition was classified as assisted or unassisted. The calves were ranked for precocity according to time of first standing. On average, the cows stood in less than 1 min following fetus' delivery and eliminated the placenta in 317 min. The time the cows spent resting and helping or licking the calf in the first 6 h following birth was not affected by the treatments. Cows in the second parity ($P<0.03$), as well as the ones with unassisted births ($P<0.03$), had a shorter resting time than older or difficult birth' cows, respectively. During the second hour after birth, cows in parity 2 licked their calves longer ($P<0.004$) than cows in parity 4 and up. Licking time linearly decreased ($P<0.003$) over the 6 h following delivery. The elapsed times, since birth, for the calves to attempt to stand, to first stand, to start teat seeking, and to suckle, were not affected by the treatments, parity of the cows, udder conformation, or calf's gender. In the first 8 h of life, 19 out of 36 observed calves failed to suckle. Precocity of the calf ($P<0.02$) was the most important factor affecting the first successful suckling. Maternal behaviour and calf development, as measured in this study, were not affected by the ingestion of AF or PL. The stimulus for multiparus cows to lick in the early hours after parturition was not dependent on the full presence of AF on the coat of the newborn.

Effects of domestication on behaviour development in the Norway rat

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Hereditary reorganization of the rates of ontogenetic development of exploratory behaviour, glucocorticoid functions and neurotransmitter systems during selection of wild Norway rats for absence of defensive reactions against man (domestication) was studied. Wild rats bred for maintenance of aggression against man were taken as control. Interrelated shifts in the development of behaviour and neurohormonal systems were shown. The ontogenetic development of behaviour was studied with the use of open-field and hole-tests in rats of both strains from 2 weeks to 4 mo of age. Differences in behaviour between the strains arose at the age of 21 days. At this age tame rats had higher parameters of locomotion (number of crossed squares 107.5 ± 9.7 in tame rats and 56.3 ± 7.46 in wild rats, $P<0.001$) and exploration (number of head dippings 9.5 ± 2.2 and 1.5 ± 0.48, respectively, $P<0.01$), these differences increasing to the age of 45 days. The age of 3 to 4 weeks seems to be critical in the ontogeny of reactions to novelty in grey rats. Simultaneously, differences in the development of the pituitary-adrenal system were observed at this age. This was also confirmed by the data on brain serotonin and catecholamine content. Data obtained on the results of selection of the Silver fox, for the same behavioural traits also indicates unidirectional changes in the regulatory systems of this animal which belongs to a different taxonomic group.

Environmental influences on the expression of aggressive behaviour in English Cocker Spaniels

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Although the English Cocker Spaniel (ECS) is a popular breed in the United Kingdom, it has attracted some negative publicity especially during the early 1980s because of problems with aggressive behaviour. In the present study a group of 'low' (n=217) and 'high' (n=218) aggression purebred ECSs were compared in relation to demographics and owner interactions. These 2 groups were selected from a total sample of 1109 ECSs, which had been collected for a previous study by the authors. In the earlier study, 2000 questionnaires were randomly distributed to UK owners of purebred ECSs. Owners were asked to rate the frequency with which their dog(s) displayed aggression (on a scale of 1 to 5) in each of 13 different situations. From these data, aggregate scores were calculated (sum of the 13 possible rating scores for each dog). Based on the frequency distribution of these aggregate scores, the lower and upper 25th percentiles were calculated and used as cut-off points for the two sub-samples in the present study. Those in the lower 25th percentile were classified as 'low' aggression dogs while those in the upper 25th percentile were classified as 'high' aggression dogs. Owners of 'low' aggression dogs were more likely to be: older (65 years+; χ^2=18.753, P<0.01) and more attached (measured on a 5 point scale; 1=not attached, 5=very attached) to their dogs (U=20346, P<0.001). Dogs in the 'high' aggression group were: significantly more likely to be of a solid colour (χ^2=38.13, P<0.001); more likely to have been chosen for pet purposes only (χ^2=25.161, P<0.001); more likely to have suffered an illness during the first 16 weeks of life (χ^2=14.899, P<0.001); groomed less often (t=2.252, P<0.05); given less time for walks/exercise (t=2.618, P<0.01); slow in obeying commands (U=17967.5, P<0.001), more likely to pull on the lead (U=16663, P<0.001); and more likely to react to loud or high-pitched noises (χ^2=14.142, P<0.001). Factors often quoted to be important in the development of dominance-related aggression, such as feeding the dog before the owner eats, a lack of obedience training, and playing competitive games with the dog, were not found to be significantly different between the 2 groups. Determining the importance of various factors in the development of canine aggression will enable us to better advise owners in the rearing of their dogs.

A genetic study of fear-related behaviours in rats

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The influence of genetic factors on stress responses has been demonstrated for several animal species. In order to investigate the genetic basis and the multidimensionality of emotional behaviours, we tested 144 rats from 6 inbred strains (12/strain/sex) in 4 tests of emotionality/anxiety (open field, elevated plus-maze, black/white box and social interaction test). Significant interstrain differences were found for all behavioural measures. A factor analysis of all variables revealed 2 main axes, the first related to the approach/avoidance towards aversive stimuli and the second axis to the locomotor activity in novel environments. Defecation was not related to either of these 2 dimensions. Two rat strains (SHR and Lewis) were consistently different for measures associated with the first axis (which is thought to reflect 'anxiety'), without differing in relation to the second axis ('locomotion'). These 2 contrasting strains were crossed and, along with their F1 and F2 descendants, they were tested in the open field and the plus-maze tests. Because SHR rats are hypertensive, the blood pressure of all rats was also measured. Consistent differences regarding anxiety-related behaviours were found between the parental strains, which also differed in their blood pressure. There was no difference in anxiety-related traits or blood pressure between the 2 reciprocal F1 crosses which indicated that the contrasts between the parental strains were due to direct genetic effects, rather than to maternal influences. A factor analysis on the F2 generation similarly produced 1 'anxiety' factor and 1 'locomotion' factor, both being independent of blood pressure. The heritability of all phenotypic traits was estimated. These results suggest that fear-related behaviours may be modified by genetic selection and that F2 animals derived from the 2 contrasting strains may be useful in the study of genes and gene products affecting some aspects of emotionality.

Social relations in a small group of African elephant (*Loxodonta africana*)

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A group of 6 African elephants kept on Imire Safari Ranch, in Zimbabwe, were studied. There were 5 males and 1 female, aged between 8 and 13 years. The aim of the study was to carry out a detailed examination of the social relations between the individual elephants. The elephants spent the day grazing and browzing in the 1500 ha game park accompanied by 3 scouts (whose job it was to protect them from poachers). At night the elephants were shackled next to each other. The elephants were observed between 0830 and 1630 h for 21 days in January 1996. Every 15 min the maintenance activity engaged in by each elephant was recorded, as were the proximal relations between the 6 elephants. The proximity data consisted of the identity and proximity of each elephant's nearest neighbour. In addition, instantaneous observations were made of the social interactions occurring between the elephants (158 different social behaviours). Assessment of 2226 observations of maintenance behaviour obtained indicated that the elephants spent 48% of their time grazing, 23% browsing and a further 12% walking. The remainder of their time was spent standing, grooming, drinking and engaging in social activity. Analysis of the proximity data revealed that, first, the typical distance maintained between neighbouring elephants was between 5 and 15 m, second, some individuals were more 'popular' than others (i.e. were frequently the nearest neighbour of other elephants) and third, each individual had a preferred nearest neighbour, and moreover this preference tended to be mutual. Of the 2410 social interactions observed only 7% could be categorised as aggressive and 3% as withdrawing, whilst 40% were 'affiliative'. Closer inspection of the social interaction data indicated that some individuals were more socially involved than others, and furthermore, that some individuals tended to be 'performers', whilst others tended to be 'receivers'. In conclusion, much of the social interaction occurring between the 6 elephants was of an affiliative nature, individuals differ in how socially involved they are, and whether they tend to be a 'performer' or a 'receiver'. Furthermore, examination of the proximity relations and social interaction data suggests that 'friendships' between individuals exist.

Individual variation in rates of giving and receiving feather pecks in Bantams, and some behavioural correlates

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Six mixed-sex groups of 14 Bantams, housed in pens with litter floors and pelleted food, were observed at 11 and 12 weeks of age to describe individual variation in their feather pecking activity, and compare it with other aspects of behaviour. This was done to see whether traits associated with high and low rates of giving/receiving pecks might help to explain causation of feather pecking. Pecks were classed as either gentle (often at particles on plumage) or feather pulls (this category included infrequent pecks at bare skin), and systematic counts were made of numbers given and received (other types of oral activity were also recorded). During all observations (24 min per bird x 83 birds), there were 5 times as many gentle pecks (2596) as feather pulls (525). Frequencies of individual birds' rates of giving and receiving pecks and pulls were all distributed in a negative exponential way, in all pens; 16% and 6% of all birds were arbitrarily defined as "high" givers and receivers of gentle pecks, and 10% and 6% as high givers and receivers of feather pulls. Individuals' rates of gentle pecking and feather pulling were only weakly correlated (4/12 Spearman's rank coefficients significant), and were inconsistent from week to week (3/24 coefficients significant). However, the ranks of birds defined as high did not differ between weeks (by Wilcoxon test), and males and females did not differ in their rates of giving/receiving pecks/pulls (by paired t-tests). Comparisons of other aspects of behaviour indicated that low givers of gentle pecks also gave less feather pulls, high receivers of gentle pecks showed more feeding pecks, high givers of feather pulls received less pecks at the beak, and high receivers of feather pulls showed more preening movements. In separate tests, high givers of feather pulls were more active, and high receivers of feather pulls both avoided a novel object more and pecked less at a caged group mate. The results indicate that propensities to peck or pull at other birds' plumage, or to be pecked or pulled, are all quite distinct. However, the comparisons of other behaviours between defined high and low birds were based on small sample sizes and so cannot be regarded as conclusive.

Temporal differences in the adaptation to a repeated stressor between physiological and behavioural responses in domestic pigs (*Sus scrofa domestica*)

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The speed of adaptation to chronic intermittent stress often appears to be different for behavioural and physiological responses. The aim of this study was to determine if different physiological and behavioural systems showed different temporal responses to a repeated stressor.

To induce a stress response we separated 8 castrated male pigs (7 mo) visually and auditorily on 10 successive days from their group mates. Each social separation lasted for 1 h and was carried out at different times of day. Different types of reaction were measured on the 1st, 2nd, 3rd, 6th, and 10th day: (a) the hormones cortisol, ACTH, adrenalin and noradrenalin, (b) heart rate, and (c) behavioural activity including vocalisations.

Cortisol as well as ACTH were significantly affected by repetition of tests (Friedman, $\alpha \leq 0.05$) and showed higher titres on the first 2 days than on the following days of test. In contrast, adrenalin and noradrenalin were not influenced by the repetition of tests. Also the behavioural activity as well as the vocalisations did not differ between the successive tests.

The results suggest that the different types of reactions showed different temporal courses. The hormones cortisol and ACTH that represent the hypothalamo-pituitary adrenal system showed a significant adaptation to the repeated stress within the first 3 days of exposure. Adrenalin and noradrenalin that represent the sympathetic adrenal medullary system as well as the acoustic and non-acoustic behaviour of pigs did not adapt to the repeated stress within the 10 days. The latter findings indicate that the pigs were not able to adapt to the repeated stressor used in the experiment at the level of the central nervous system in a sense of learning. Consequently, the adaptation of cortisol and ACTH might be caused by physiological changes at the adrenocortical or pituitary level.

DFG grant: To 13/21-1

Behavioural and physiological differences between domesticated and crossbred pigs: effects of domestication

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Domestic pigs have been selected for physiological, morphological and other properties beneficial for a high animal production. Less attention has been paid to the selection of behavioural characteristics. In order to study possible effects of domestication on explorative, aggressive and other behaviours, we compared the behaviour of crossbred pigs (Dutch Landrace X Wild Boar) and domesticated pigs (Dutch Landrace X Great Yorkshire).

Behavioural testing was performed on 10 female domesticated pigs (DOM) and 8 crossbred pigs (CROSS) from 19-27 weeks of age. The pigs were subjected to a human test, a combined transport and novelty test and a social encounter with an unfamiliar conspecific of the same breed and sex. Saliva samples were taken before, during and after the transport/novelty and aggression tests. Elevations of saliva cortisol concentrations were regarded as a measure of the responsiveness of the hypothalamus-pituitary-adrenal (HPA) system to stressful stimuli.

During the 5 min presentation of an unfamiliar human subject standing in an upright position in the pen of the pigs, the median latency time to make physical contact with the stimulus did not differ between CROSS and DOM (45 and 32 s respectively). CROSS explored the human longer than DOM (186 ± 21 and 124 ± 23 s respectively; $P<0.04$). When put individually into a novel pen divided into 6 segments of the same size, CROSS crossed the borders between the (imaginary) segments 78 times in 40 min, whereas DOM performed 54 segments visits ($P<0.05$). Besides a difference in mobility, a difference in the times spent in the individual segments were measured: CROSS showed a relative preference for the outer parts of the new environment. During the 30 min social encounter, CROSS spent more time on aggressive behaviour than DOM (637 ± 222 and 192 ± 114 s, respectively; $P<0.05$). This difference was caused by the large contribution of the element "leaning" (572 ± 221 s) to the aggressive behaviour of CROSS. Leaning was almost absent in DOM (14 ± 7 s).

Baseline saliva cortisol levels (2-3 ng/ml) did not differ between the breeds. Maximum hormone concentrations were measured 40 min after the onset of the transportation/novelty test. Mean maximum cortisol concentration of CROSS (8 ng/ml) was significantly ($P<0.05$) higher than that of DOM (4 ng/ml). In DOM, cortisol levels returned to baseline within 30 min after the occurrence of the peak value, whereas in CROSS hormone levels remained elevated (6 ng/ml).

It is concluded that there are marked behavioural and physiological differences between DOM and CROSS. Further studies are needed to investigate whether "useful" characteristics have been lost during the domestication of pigs.

The time budgets and injurious pecking of pair-housed commercial turkeys

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Commercially reared turkeys are often housed in large groups at relatively high stocking densities. Such conditions might adversely affect behaviour patterns and exacerbate injurious pecking behaviour. An initial step to examine this possibility is to study the behaviour of turkeys in small groups and at relatively low stocking densities. Twelve male domestic turkeys were housed as 6 pairs in pens measuring 3.6x3.0 m. The behaviour of each pair was video-recorded throughout the light-phase (12 h) on 12 occasions between 4 and 22 weeks of age. Time budgets were determined by 5 min scan sampling, and the frequencies of comfort behaviours and incidence of injurious pecking were quantified from continuous observations of the tapes. Over the duration of the study, the proportion of the light-phase in which the turkeys engaged in sleeping, pecking the environment, wing-flapping, or running decreased, but increased for stretching. Drinking or pecking other birds remained constant, whereas feeding, standing, sitting, strutting, preening whilst standing, preening whilst sitting, or walking, all varied throughout the study. Changes in activity may have been variously attributable to age effects, or the development of musculo-skeletal weakness. At 18 weeks, the turkeys spent a considerable proportion (30%) of the time-budget performing a sexual courtship display, i.e. strutting. Injurious pecking was infrequent; only 14 bouts of behaviour likely to cause injury were recorded in 1656 turkey-hours of continuous observation, and no turkey required medical attention as a consequence of this behaviour. Feather pecking and cannibalism did not occur despite the use of a light intensity (40-70 lux) considerably higher than conventionally used (1 lux). These results offer preliminary support to the suggestion that small group size/low stocking density can reduce the frequency or intensity of injurious pecking behaviour by male turkeys.

Domestic pigs prefer short to long confinement

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The aversiveness of a confinement for an animal may differ according to the duration of the restraint. However, this would be true if domestic animals are able to perceive differences in the duration of an unpleasant situation. We used a choice test to investigate whether pigs are able to differentiate between a shorter and a longer confinement.

Twelve gilts, group housed in enriched pens, were allowed to feed in 24 small crates twice a day. On the way to the crates, they had to choose whether to go to the left 12 crates or to the right 12 crates which were marked with different visual cues. The left choice was selected as the short-duration treatment for 6 gilts, and the right choice was the short-duration treatment for the other 6. If a gilt chose the short-duration side, she was released back to the pen after 30 min. After having choosen the long-duration side, the gilt stayed locked in the crate for 4 h. We recorded the choice, latencies to enter the crates, and the behaviour in crates.

During 16 repetitions of the test, the gilts chose the short-duration side more often (67%, n=12, P=0.016, Wilcoxon T-test). The latencies to enter crates did not differ between the short-duration and long-duration side. Between the 20th and 25th min after entering the crate (i.e. 10 to 5 min before any difference between the consequences of the choice started), the gilts stood more (29% vs 17%, n=12, P=0.012, t-test on LSMeans), and lay less (34% vs 50%, P=0.008, n=12, t-test on LSMeans) in the short-duration crates than in the long-duration ones. This difference was even more pronounced during the last 6 tests (21% vs 4% (P=0.017) for standing, 37% vs 18% for sitting (P=0.027) and 42% vs 78% (P<0.0001) for lying).

We conclude that the gilts demonstrated the ability to differentiate between a 0.5 h and a 4 h crating in 2 ways: A. They prefered the former one; B. They learned to expect the end of the shorter crating while remaining calm after the same time in the long-term confinement.

Recreating a chimpanzee society in a zoo: lessons from 25 years Arnhem Zoo Chimpanzee Consortium.

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Zoos face the dilemma of, on the one hand, keeping their animals, as much as possible, under conditions that allow the expression of the natural behavioural repertoire, and, on the other hand, preventing and controlling those aspects of behaviour that, even if these are 'natural', cause unacceptable welfare problems or are emotionally disturbing to the public. Such a dilemma is evident with respect to the chimpanzee colony of Burgers Zoo in Arnhem. This colony has been founded in 1972 with the objective to create a society in captivity which would mirror the natural social structure as much as possible. Thus it has been the intention to realize a multi-male colony, in which both male coalitionary behaviour and competition as well as the maintenance of social homeostasis (the regulation of social tension and conflict) could be studied. In retrospect the undertaking has been very successful, although it has also proved to involve certain risks. One of these is infant abuse by males, a phenomenon known to occur in various primate species (even in the form of infanticide) in nature. In captivity this has often been regarded as a pathological phenomenon, possible due to social stress. We have analysed a number of such cases over the past twenty years. The behaviour was associated with uncertainty in males' relations, and was shown particularly by males trying to rise on the social ladder. The choice of victims may be influenced by the relationship with the victim's family, but this was not an obvious connection. A comparison with the occurrence of such behaviour in the wild and in other species is made. The possibility of controlling the phenomenon will be discussed.

The effects of mixing litters during lactation and at weaning on piglet behaviour and performance

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Litters were housed in pens with sows in crates until piglets reached 11 days of age. Barriers between pens for 'get-away' litters were then removed, allowing groups of 3 litters to mix freely in a central area. Control groups were treated identically except piglets from the different litters were not allowed to mix prior to weaning. We compared aspects of piglet behaviour and performance for 10 groups of get-away piglets and 10 controls groups (i.e. a total of 60 litters). We observed little or no aggression when get-away litters were first allowed to mix. On the contrary, piglets played and rested in inter-litter groups. Although piglets could and did enter the pens of other litters, we recorded little cross-suckling. Time spent away from the sow increased over the course of the lactation from less than 25% to almost 50% ($P<0.001$). Get-away piglets were nursed less frequently than controls, especially during the later stages of lactation ($P<0.001$). However, there was no difference in the amount of creep feed consumed or rate of gain before weaning. After weaning, get-away piglets ate more solid feed (approximately 70 g/d more during the second week after weaning, $P<0.05$), and although they tended to also gain more weight (approximately 50 g/d) this difference was not significant. Confined piglets spent almost 60% more time fighting after weaning when litters were mixed than if litters were not mixed, but no such difference occurred for the get-away litters (interaction $P<0.05$). Thus get-away housing for piglets allows for mixing at an early age (much as occurs in nature) with little conflict, provides piglets with a socially enriched pre-weaning environment, reduces piglet demands on the sow during lactation, avoids fighting between mixed piglets at weaning, and allows for better post-weaning feed consumption and the potential for improved gains.

Posters

arranged alphabetically
by first author

Periparturient behaviour and occurrence of stillbirths in relation to spatial restriction in pigs

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A total of 76 crossbred multiparous sows previously group-housed in a straw-bedding system during gestation, were randomly assigned to two farrowing systems: a restrained farrowing crate (R=34) and an unrestrained traditional farrowing pen (UR=42) in Sweden.

The objective was to measure the effects of spatial restriction on pre-farrowing behaviour, farrowing duration and stillbirth rate.

Results showed no overall treatment effect on the following production traits: gestation length, birth intervals, total pigs born alive and mummified piglets. Although not significant, interesting trends were found in the R sows for longer farrowing duration (50 min more than the UR sows). There was a clear diurnal pattern in the initiation of the farrowings. The inter-birth mean interval for individual born alive piglets was 25 min. Significant differences were found in the stillbirth rates, the R group was higher than the UR one (5.5% vs 4.0%; $P<0.05$).

The behaviour of 11 R and 11 UR sows was monitored by time lapse video recording from 24 h before farrowing until parturition was over. Nest building was not affected by the housing system. A peak in straw manipulation was found 8 h prior to parturition in all sows, regardless of time of farrowing. The animals in the restrained environment performed more stereotypes (e.g. bar biting 1.6 vs 0.5; $P<0.01$; head waving 2.1 vs 0.2; $P<0.0001$) and had more postural changes (4.6 vs 2.8; $P<0.05$) than the penned animals. The behaviours were not correlated with measures of farrowing duration, and stillbirth rates and thus, the relationship is unclear and remains a subject for further research.

Treatment of coprophagia in the companion dog

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Coprophagia is a well known, unacceptable behaviour in canines. A number of theories have been offered to understand the behaviour, however, there appears to be no reliable treatment for this habit. Although many therapeutic approaches are used, including the practice of spiking faeces and using electric shocks, most of these methods address only the symptom and not the cause.

Coprophagia is explained according to the model of motivation by Hughes and Duncan (Hughes and Duncan, 1988, *Anim. Behav*., 36: 1996-1707). This states appetitive behaviour will continue until satisfaction is reached. Internal variables then result in a negative feedback terminating appetitive behaviour. Therefore inappropriate food/feeding will prevent negative feedback resulting in the eating of any obtainable substance, including faeces, in an attempt to satisfy this physiological need.

It is suggested that coprophagia can be eliminated by appropriate feeding, simply achieved by allowing each individual canine a free choice. Most dogs preferred fresh meat which was supplemented with cooked vegetables and raw meaty bones. Small, appealing meals were fed frequently, increasing the amount gradually until intake stabilized. This regimen was maintained throughout the treatment. Exercise was not encouraged during recovery. Weight was monitored and no obesity reported.

A retrospective study was done (n=20). The most common breeds were Labradors and Labrador crosses, German Shepherd Dogs and German Shepherd Dog crosses. Ten were male and 10 female and 16 of the dogs were less than 18 mo old. Twelve dogs were from rescue shelters. Nineteen dogs showed gluttonous/food deprivation behaviour and/or allotriophagia. Follow-up information was received from 18 dog owners. Fifteen dogs had responded satisfactorily and showed improvement after 1 week of treatment.

Nasal ringing in pigs: consequences for feeding efficiency

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Outdoor pigs are most commonly fed by distributing feed-nuts on the ground. Subjective observations of nose-ringed pigs suggest that their efficiency at extracting and picking up nuts was restricted. Feeding rate was timed in 3 groups of 8 gestating sows, one group given a septal 'bull' ring (BR), one with 3 clip rings on the upper rim of the snout (CR), and one left unringed (UR). On observation mornings, pigs were brought unfed into an indoor yard with individual feeding stalls. Using 50cm square steel feeding trays, they were timed eating 20 roll-nuts, systematically distributed in each of 5 media: on the plain steel surface (PS), on the surface of lightly packed soil (OS), on the surface of grassed turf (OT), and with the nuts embedded horizontally, with the flat side just visible, in soil (IS) and in turf (IT). Pigs in general, including URs, took longer to pick up nuts from the steel surface than the surface of soil or turf, because they rolled around and into corners (mean feeding times for the ringed conditions pooled: 84.9, 42.4, 53.9, 124.7, 102.8 secs for PS, OS, OT, IS and IT respectively; $p < 0.001$). On soil or turf surfaces, the trend for ringed pigs to take longer (with BR > CR >UR) was not significant. On plain steel, BRs took much longer (53.9, 55.1, 145.6 secs for UR, CR, BR respectively; $p < 0.001$). When nuts had to be rooted out of soil or turf, both types of ringed pig took longer (IS: 72.3, 112.1, 189.6 ($p < 0.001$), and IT: 75.8, 87.1, 145.4 secs ($p < 0.005$) for UR, CR and BR respectively). Ringing impedes feeding, especially where food has to be rooted out. The results have practical implications where troughs are used, where ringed and unringed pigs are fed together, or where food has become trodden into the ground.

Effects of daily change in social environment on inter-individual distances in guinea pigs

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Changes of group composition influence social relationships, which can be characterized by spatial distances between the members of a group. The mother-young bond, as well as the pair-bond, are often indicated by the spatial closeness of the bonded partners. On the other hand, a large distance between animals can characterize their social relationship as aversive. However, quantifying distances between animals without auxiliary means is often difficult.

The aim of this study was to investigate the consequences of social instability on spatial behaviour in groups of guinea pigs. A new method was used that allowed for easy and accurate acquisition and evaluation of spatial data.

The experimental groups (n=9) consisted of 1 dam with offspring and 1 adult mixed-sex pair. In order to generate a situation of social instability, the dam and her young were transferred into a different enclosure with another resident male-female pair (n=13) daily during the whole study. In control groups (n=8) of equal composition, the dams and their young were also handled daily, but remained in their home-cages. All groups lived under standardized conditions in enclosures of 0.5 m2 and had food and water *ad libitum*. The behaviour of these animals was recorded for 1 h on days 1, 4, 7, 10, 13, 16 and 19 after birth and was analyzed by the Mann-Whitney U-test.

The daily change of social environment resulted in a decreased distance between the young (eg mean distance on day 19: 28 cm vs 36 cm for controls; $P<0.05$), an increased distance between the mother and the resident female (e.g. mean distance on day 1: 60 cm vs 47 cm for controls; $P<0.05$) as well as an increased distance between the resident pair and the pups (e.g. mean distance between young and adult male on day 13: 60 cm vs 37 cm for controls; $P<0.05$).

These results can be interpreted as follows: both the mother-young-bond as well as the pair-bond are more pronounced under unstable social conditions which results in an increased spatial separation of the family group and the resident pair.

Is milk production hard work for dairy cows?

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It has been suggested that intensive milk production relying on bulky silage-based diets, can lead to metabolic and physical exhaustion as the dairy cow attempts to satisfy high metabolic demands which conflict with her motivation to rest. This study investigated this proposition by assessing the influence of changes in production and management during the housing period on the time budgets of autumn calving Holstein Friesian heifers. In year 1 animals were fed grass silage and milked twice daily. Eight animals were studied in each of 2 cohorts: cohort I was fed 0.5 t concentrates with a mean yield of 5720 l; cohort II was fed 1.5 t concentrates with a yield of 8453 l. In year 2, animals were housed in the same conditions but management was changed to increase production: cohort III (9 animals) was fed grass clover silage, draff and 0.36 t concentrate, milked twice daily, mean yield 6162 l; cohort IV (10 animals) was fed grass silage, draff and 1.9 t concentrate, milked thrice daily, mean yield 9309 l.

Activity was recorded in 6 watches of 24 h, every 2 weeks, starting 6 to 8 weeks post calving until turnout. Lying times were shorter in year 2 than year 1 (11.4 vs 13.7 h, sem=0.34; P=0.01) but did not differ between cohorts in the same year. Feeding time was greater in year 2 but not significantly so (4.6 vs 4.3 h, sem=0.28; P=0.24), cohorts I and II (year 1) did not differ significantly but cohort III (year 2) spent significantly longer feeding than cohort IV (4.9 h vs 4.4 h; P=0.02). Overall feeding time was negatively correlated with time spent lying inactive (r=0.15; P=0.025) but not with time lying ruminating. Increased production was associated with reduced lying time without a significant corresponding rise in feeding time; however, the negative association between time feeding and lying inactive suggests animals that fed for longer sacrificed lying time. Increased production between years affected activity budgets by decreasing lying time and this may be linked to increased feeding time. However results are inconclusive as the animals on a lower plane of nutrition may have been working as hard as animals on the higher input/higher output regime, meeting metabolic demand by feeding for longer on a less energy dense diet and possibly drawing on body reserves to a greater extent.

Effect of group size on tonic immobility in laying hens

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It has been shown that the duration of tonic immobility (TI) can reflect actual predation risk and level of fearfulness. Since the chances of escaping predation are higher in larger groups, birds from larger compared to smaller groups should have a shorter TI duration. On the other hand, increased competition between birds in larger groups would suggest a longer TI in larger groups. The aim of this study was to test these 2 hypotheses.

Laying hens, which had been raised in floor pens, were used. The experiment had 4 group size treatments (15, 30, 60 and 120 hens per group) and 4 replicates. Tonic immobility tests were performed on adult birds either “in” their home pen or “out” in a separate room.

The mean duration of TI in groups tested “in” was significantly shorter than groups tested “out” (58.6 s vs 199.3 s, respectively; $P<0.001$). In the test “in”, duration of TI increased with group size, with a significant difference between group sizes 15 and 120 hens per group (46.8 s vs 68.5 s, respectively; $P<0.05$). In the test performed “out”, there was a trend for TI to be longer in the larger groups.

The results support the hypothesis that the duration of TI reflects the response of the individual to social competition within the group at the time of testing, rather than the theoretical risk of predation.

Ethological observations of the regeneration sheep grazing in the Krkonoše National Park

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The Krkonoše National Park is a mountain region containing grasslands of a specialised botanical composition. After the Second World War, interruption to grazing changed the composition of these grasslands. The grazing behaviour of sheep was investigated as part of a project examining the effects of extensive set stocking on restoring the original botanical diversity. Mountain breed sheep were used from 1991 to 1992, while East Friesian × Stavropol Merino crossbreds were used from 1992 to 1996. From mid-June to mid-September, 20 ewes with their lambs were grazed at a stocking rate of 5 ewes per ha, 1250 m above sea level. The behaviour of 5 marked ewes was recorded every 10 min during daylight, for a total of ten 2-day observation periods. During these periods, meteorological variables were recorded every h. The grazing of different plant species was assessed every 2 weeks during the study by examining for recent bite marks. Ewes spent 492 min per day grazing (s=74 min; V=15%), of which 65% was spent in the higher pasture regions. Ewes also spent 84% of their resting time and 74% of total time in the higher pasture areas. Grazing was reduced or ceased in response to intensive solar radiation, heavy rain, or wind speeds exceeding 10 ms^{-1} (depending on the terrain configuration). Such meteorological factors had additive effects on grazing behaviour, and ewes changed their grazing and resting patterns in response to climatic variables. During the grazing season, ewes initially grazed *Poaceae spp*, then changed to the dominant *Polygonum bistorta* and also displayed a taste preference for *Adenostylus alliarie*. Later, ewes grazed less palatable species such as *Deschampsia cespitosa* and *Rumex alpinus*, returning to the newly grown grasses and *Polygonum bistorta*. In the following seasons ewes started to graze less palatable species earlier.

Effects of an enriched environment before weaning and around parturition on subsequent fear reactions of artificially reared lambs and ewes

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Experience during certain periods of an animal's life (including exposure to an enriched environment) is known to profoundly influence subsequent emotional reactivity. We have demonstrated that ewes placed for 3 mo in an enriched environment (presence of coloured mobile objects and a human-like model) soon after parturition and while nursing their young, display reduced fear reactions at weaning and 5 mo later, compared to controls. By contrast, fear reactions by their lambs were not affected. In the same manner, fear reactions of cyclic ewes placed for 3 mo in the same environment were not reduced.

Based upon these results, 2 hypotheses were tested:

1) the strong mother-young bond may focus the lamb's attention and this would minimise the impact of the enriched environment;
2) the period of "particular sensitivity" of lactating ewes towards their physical environment could be limited to a few days around parturition, as for the development of mother-young bonding.

In order to test the first hypothesis, fear reactions of artificially reared lambs (in the absence of the mother), placed in the same enriched (E, n=21) or control (C, n=19) conditions for 3 mo, were compared at weaning using a battery of previously-validated tests, involving isolation, surprise effect and presence of a human. Fearfulness scores, calculated from 26 behavioural items related to fear, were used: the higher the score, the more fearful the animals. Fearfulness scores were lower for "enriched" lambs (E, 18.3 ± 6.9 vs C, 22.9 ± 4.6; P=0.03, in the isolation test; E, 18.4 ± 5.8 vs C, 22.9 ± 5.2; P=0.02, in the human test; and E, 18.9 ± 5.8 vs 22.3 ± 5.6; P=0.08 in the surprise test). This confirms our first hypothesis: the effect of the environment depends on the presence of the mother.

In an initial attempt to assess the second hypothesis, we compared fear reactions of ewes (n=27) that were housed in the same enriched environment 5 days before and 10 days after parturition, to controls (n=25). Fearfulness scores of "enriched" ewes were significantly lower in the surprise test 3 weeks after parturition (E, 9.6 ± 2.6 vs C, 12.5 ± 2.2; P=0.02) and in the isolation test at weaning of their lambs (E, 23.7 ± 5.8 vs C, 29.5 ± 6.2; P=0.001). Thus environmental enrichment seems to be effective in reducing fear reactions even if limited to a few days around parturition.

The development of a prototype decision support system to assess the welfare status of pigs

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Quantifying welfare for decision-making purposes is a challenging issue in the field of applied ethology. The assessment of welfare can be approached by surveying the scientific knowledge on animal welfare and identifying a range of relevant parameters. However, the problem remains how these parameters can be integrated to provide a single assessment of welfare.

We have constructed a prototype decision support system to assess the welfare status of sows. This is a computer programme which takes a description of a housing system for individually-housed, pregnant sows as input and produces a welfare score as output. For this purpose it uses scientific statements, a welfare decomposition procedure and a formal set of calculation rules. Scientific statements are collected from the literature and directly from experts. They define which are the relevant aspects for welfare assessment. They also have a function in inferring truth values about these aspects in the housing system under assessment.

The welfare decomposition is a tree in which welfare is analysed as a function of a set of component need states. The idea is that welfare can be assessed by answering a set of questions. These include “have the animals been hungry, socially deprived, did they suffer from disease, pain, etc”. Through this approach, aspects which have more than one effect on welfare can be assessed. For example, vaccination may imply both a painful injection, which is negative for welfare, and (later) disease prevention, which is positive for welfare. In the prototype, welfare is calculated as a weighted average of component need scores. One major assumption is that all weighting factors are set at 1 by default, while attributing a higher weighting to special cases such as abnormal behaviour patterns.

The formalised procedure for integrated scientific welfare assessment as developed in the prototype will be developed further. At present we are trying to establish a firmer consensus and scientific basis for certain assumptions in interviews with experts.

Behavioural symptoms of travel sickness and concentrations of plasma lysine vasopressin in pigs

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Two experiments were conducted to investigate plasma concentrations of lysine vasopressin (LVP) as a possible indicator of travel sickness in pigs. In the first, seven 40 kg pigs, prepared with jugular catheters, were loaded onto a livestock lorry and transported over a 2 day period on routes characterised, by means of an accelerometer, as rough or smooth. Two 100 min journeys, 1 rough and 1 smooth, separated by a 100 min rest period, were conducted each day. The experimenters travelled with the animals and blood samples were taken for hormone analysis from each pig at 20 min intervals. On the third day, samples were collected from the pigs when housed in their home pen (control). In a second experiment, six 35 kg pigs, prepared in advance with jugular vein catheters, were loaded onto a commercial livestock lorry (0930) where they were individually penned. The vehicle remained stationary with the engine off and blood samples were taken at 30 min intervals during the next 8 h (control). Two days later this procedure was repeated while the vehicle was driven for 8 h (on main roads and motorways). In both experiments behaviour was observed at each sampling point and an assessment made of the number of animals showing symptoms of travel sickness which appeared to occur sequentially (sniffing, repetitive chewing, foaming at the mouth, retching and vomiting). In experiment 1 concentrations of plasma LVP showed no clear response to either rough or smooth journeys. Incidence of travel sickness was low with only 2 pigs showing foaming at the mouth, the most severe symptom observed. Concentrations on days 1 and 2, when pigs were transported, were significantly higher than on day 3 (control) ($P<0.05$). In experiment 2 concentrations of plasma LVP during driving increased between 2 and 4.5 h which approached significance relative to the stationary control ($P=0.05$) and coincided with behavioural observations indicating that the pigs were travel sick. Measurement of plasma LVP may provide an indication of travel sickness which is necessary for the assessment of the welfare of pigs during transport.

Behaviour and physiology of pigs during road transport: effects of mixing and time in transit

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In experiment 1, 12 groups of four 90 kg pigs were transported in a livestock lorry for 1.5 h. Half the animals were transported in their social groups (unmixed condition) and half with groups of previously unfamiliar pigs mixed together (mixed condition). Behaviour was recorded and saliva samples were taken during the journey. Pigs spent most of their time standing in both conditions. Mean concentrations of salivary cortisol were higher in the mixed condition at the beginning (unmixed: 3.23 nmol/l (s.e. 1.02), mixed: 10.69 (4.03); $P<0.08$), middle (unmixed: 4.78 (1.21), mixed: 9.91 (1.32); $P<0.01$) and end of the journey (unmixed: 7.02 (1.72), mixed: 11.65 (1.66); $P<0.06$). In experiment 2, six 35 kg pigs with jugular catheters, were loaded onto a lorry (which remained stationary) and blood samples were taken every 30 min during the next 8 h (control). Two days later the procedure was repeated while the vehicle was driven for 8 h (experimental). Concentrations of plasma cortisol increased after loading and remained higher throughout the journey compared with the control ($P<0.05$). Cortisol was particularly elevated (relative to the control) for the first 5 h (330% higher in the experimental treatment after 4 h, 80% higher after 5 h and thereafter less than 50% higher). Concentrations of β-endorphin also increased after loading but levels did not differ between control and experimental treatments except during the final 180 min when the control was higher ($P<0.01$). It was concluded that mixing unfamiliar pigs during transport should be avoided and the first 5 h of a journey was particularly stressful.

Behaviour and performance of dairy cows kept in a tie-stall barn with geoactive zone

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This study investigated the effects of disturbed homogenity of the electromagnetic field on maintenance behaviour and milk yield of dairy cows. Twenty-eight Holstein cows matched by stage of lactation and current milk production were randomly assigned to 4 treatments (geopathogene zones). The geopathogene zone was formed as a gradient across an electromagnetic field and assessed on a 6 point scale. Treatments 1 and 2 were exposed to higher levels (Levels 5 and 4 on the scale, respectively), Treatment 3 received Level 2 and Treatment 4 served as the Control (Level 0). All cows were kept in the same barn with tie-housing and without access to paddocks during the whole 12 week experimental period. The treatments were spatially separated in order to maintain a constant intensity level. Ethological observations were made during three 24 h periods in the second, sixth and tenth week. We found the shortest time of lying on the left side (15%) and the longest time of lying on the right side (31.3%) in Treatment 3. The longest time of lying on the left side was recorded in Treatment 1 (30.6%). No significant differences between treatments were found for the total times of ruminating, lying and standing. Total lying time was highest in Treatment 4 (764 min) and lowest in Treatment 3 (667 min). Minimum differences were assessed in the total rumination time among the treatment groups. Total standing time was highest in Treatment 3 (773 min) and lowest in Treatment 4 (676 min). The number of the lying bouts per cow on the left side was highest in Treatment 1 during all 3 observation periods (14.8, 15.8 and 18.1 bouts per 24 h) and lowest in Treatment 3 (9.6, 8.7 and 6.1). During all 3 observations, cows from Treatments 3 and 4 spent the most lying bouts on the right side. The differences in the bouts of standing and ruminating were not significant. The greatest bout length of time spent lying and ruminating were in Treatment 2. In all weeks the milk yield was higher, although not significant higher, in Treatments 3 and 4. The average production during the whole period of the experiment was significantly different. The lowest yield was in Treatments 1 and 2 (24.5 and 24.4 kg) and the highest in Treatment 3 (26.7 kg). Significant differences were recorded between Treatment 1 and 3 and between Treatment 2 and 3. Based on this experiment it was concluded that the geopathogene zone effect decreased milk yield and slightly affected the welfare of dairy cows kept for 12 weeks in tie stall housing.

Acknowledgment

This publication is based on work sponsored by the U.S. - Slovak Science and Technology Joint Fund in cooperation with US Department of Agriculture, Washington, D.C., and Slovak Ministry of Agriculture under Project Number 010-95

Behaviour and welfare of small Mexican felines under two types of confinement: a diagnosis for ex-situ conservation

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In Mexico there are 6 wild feline native species: jaguar (*Panthera onca*), cougar (*Felis concolor*), ocelot (*Leopardus pardalis*), margay (*Loepardus weidii*), jaguarundi (*Heipailurus yagoarondi*) and bobcat (*Lynx rufus*). All of them have decreased in their original geographic distribution range and are now considered endangered or threatened. This lead to the establishment of ex-situ conservation programmes as a matter of priority. However, much information related to the welfare of these animals (i.e. how to reduce levels of stress, improve reproduction and health) remain unknown. The aim of this study was to identify the behavioural repertoire of 3 small native species (ocelot, margay and jaguarundi) in confinement. Direct observations and videotape is being used to collect information on behavioural diversity and levels of activity in order to make an assessment of any abnormal behavioural patterns expressed by the cats. This information will be related to faecal cortisol concentrations using RIA as a non-invasive technique. A second part of the study will include the measurements of a reproductive hormonal profile which can be eventually related to behaviour and cortisol levels. Once all the data have been collected a comparative study will be conducted using these 3 species under 2 types of confinement, enriched and barren. Levels of activity, time budgets, behavioural diversity will be compared between and within housing conditions and species. This information will be useful for designing future experiments on environmental enrichment, using behaviour, and stress and reproductive hormones as welfare indicators. This data will give feedback to in-situ and ex-situ conservation programmes.

Behavioural thermoregulation in outdoor kept monkeys

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Thermoregulatory behaviour is very important for the maintenance of monkeys in outdoor cages and corrals in the subtropical northern border. The aim of the investigation was to study various aspects of behavioural thermoregulation in monkeys kept in groups in Adler and Sukhumi monkey colony. The experiment was carried out on 3 macaque species, Green monkeys and Hamadryas baboons kept in cages and corrals.

During the 15 min sessions at 1 min intervals, the numbers of animals in each group engaged in different forms of activity were recorded as well as the time of the day, season, and weather. The observations showed that during the summer period behavioural thermoregulation is characterized by an increase in the behavioural pattern “sitting alone” or “lying alone”. Falling ambient air temperature caused behavioural changes in monkeys, characterized by an increase in total percent of animals sitting near to each other, or embracing. Such behavioural dynamics during warm and cold seasons of the year occur in all the animals except Japanese monkeys. Behavioural thermoregulation is also expressed in the form of reaction of monkeys to sunlight in different seasons of the year. Despite the variations in activity during the day in summer, the monkeys of all groups actually preferred to stay in the shade. The most shade-seeking were *Cynomolgus macaques* and the most tolerant to intensive sunlight were Japanese macaques. During the cold period of the year, reaction of monkeys to insolation varies dramatically. Preference for sun-lit places is most expressed in *Cynomolgus macaques* and the least expressed in Rhesus monkeys. Seasonal dynamics in temperature influences spatial localisation of animals. In all the groups of *Cynomolgus macaques*, Japanese macaques and Green monkeys, there was an increase in the frequency of using different above-ground constructions.

The species - specific regulation of thermoregulatory behaviour of monkeys must be taken into consideration in the construction of cages and corrals for outdoor maintenance of monkeys.

Effect of 16 h transport and a novel environment post-transport on the behavioural and physiological responses of sheep

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The effect of previous housing on the ability of sheep to recover from transport was investigated. Four groups of 6 sheep were kept outside in grass paddocks, and 2 groups of 6 sheep were housed in pens with straw bedding and hay. Two outside groups and 1 inside group were transported for 16 h, after which 1 outside group and the inside group were returned to their original pens, and the other outside group was placed in an inside pen. Another outside group was moved (without transport) to an inside pen. One outside group and 1 inside group remained in their pens as controls. The sheep were observed every 6 min during transport and for 24 h before and after transport. During transport, sheep from outside pens lay down less (0.08 of scans) and ruminated less (0.07 of scans) than those from inside pens (0.31 and 0.17 of scans, respectively, $P<0.001$). Post-treatment, there was no difference in lying between sheep moved from outside to inside (without transport) and those which remained inside ($P>0.05$). In sheep transported to inside pens, those from outside pens spent more time lying (0.65 of scans) than those previously inside (0.48 of scans, $P<0.001$). Sheep moved from outside to inside (with or without transport) spent less time eating during the first 12 h inside (0.23 of scans) than those returned to their familiar inside pen (0.42 of scans, $P<0.001$). Hay and water intakes post-transport tended to be lower in sheep transported from outside to inside (0.40 kg/sheep and 2.5 l/sheep, respectively) than in those previously inside (0.74 kg/sheep and 3.3 l/sheep, respectively). In additional groups of sheep that were automatically blood-sampled before, during and after transport, there was no obvious effect of a novel environment post-transport on biochemical measures of stress (plasma cortisol), feed restriction (plasma free fatty acids and β-hydroxybutyrate) and dehydration (plasma osmolality). These results suggest that both during and after transport, the behaviour of sheep previously kept outside was affected more than those previously housed. However, the lower post-transport feed and water intakes in sheep moved to a novel environment did not appear to affect blood biochemistry.

Social and individual behaviour of free ranging pigs in the Mexican tropics

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The majority of pigs in Mexico live under free ranging conditions. However, no data are available on the behaviour of these animals. A study was carried out to observe social and individual behaviour of pigs in extensive conditions. Observations were made during the wet and the dry seasons, from 0600 to 1800 h, during 50 days in each season. Five groups of pigs with adult, sub-adult and juvenile individuals were observed. The categories of maintenance behaviour recorded were feeding, resting, idling and walking. It was found that time of day, weather conditions and age significantly influenced (P<0.05) these behaviours. It was revealed that feeding, idling and walking time during the wet season was concentrated (P<0.05) from 0800-1200 h (P<0.05) and during the dry season between 0600-700 h and from 1700-1800 h. Resting during the wet season was concentrated between 0600-700 h and at 1800 and during the dry season between 1000-1400 h. In relation to social behaviour, groups of 8-13 individuals were formed. Adult females performed more aggression (P<0.05) towards individuals inside and outside the group, and more frequently to other adult animals. Analysis of social and individual behaviour found that affiliative behaviour was positively correlated (P<0.05) with resting and negatively correlated (P<0.05) with idling and walking. This information will be useful to understand more about the behavioural needs of these animals in order to propose new management and housing methods in the tropics.

The effect of brightness and colour of lighting on flock member discrimination in laying hens

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Commercially housed laying hens are often kept under dim (and sometimes red) lights for a variety of reasons including the cost of electricity, reproductive development, production, and reductions of activity levels and behavioural problems such as feather pecking and cannibalism. It is not known what effects these lighting conditions have on social recognition, which is thought to involve mainly visual cues. In this study, the effect of dim and coloured lighting on the discrimination of flockmates from unfamiliar hens was investigated in a choice arena. Two small flocks of 5 and 6 birds were used. The subjective brightness to the hens of 3 colour treatments (white, red and blue) were equalised at 2 intensity levels, comparable to the home pen (approximately 77 lux) and to farm conditions (approximately 5.5 lux). On the basis of feeding preferences and aggressive interactions, hens discriminated between familiar and unfamiliar birds at levels above chance in only the bright white treatment (9/10 birds chose familiar, 2-tailed binomial $P<0.05$), although there was a trend to prefer familiar birds under dim white light as well (7/9 birds chose familiar, 2-tailed binomial $P<0.1$). Preferences for familiar hens under the other lighting treatments were as follows (bright red 6/10, bright blue 5/7, dim red 5/10, dim blue 7/10; hens showing no preference are excluded from all of these figures). There was a significant effect of lighting colour on the proportion of choices for familiar hens; it was highest under white lights, and lowest under red ($F_{2,48}=3.20$, $P<0.05$). There was no effect of brightness ($F_{1,48}=0.01$, $P>0.05$) and no significant interaction of colour and brightness ($F_{2,48}=1.06$, $P>0.05$). This study confirms the hypothesis that visual cues are important in social recognition in hens, and that colour is an important part of the stimulus. The fact that the social discrimination of laying hens is impaired under coloured lights could theoretically result in either positive or negative welfare consequences. This is discussed in the light of the different processes that might underlie hen social behaviour.

Effect of isolation stress on body temperature and heart rate in pigs

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Stress-induced hyperthermia is a well described reaction to various stressors in many species, e.g. in pigs it has been described in reaction to restraint. In this experiment, the effect of isolation stress on body temperature was studied in 12 castrate boars. In addition, heart rate was measured and behaviour was observed. Castrate boars were housed in groups of 4 pigs in climate controlled rooms. In 1 castrate boar per group, a transmitter measuring core body temperature and heart rate was implanted intraperitoneally. At 14 weeks of age, pigs were subjected to 1 h of isolation stress in a separate room. Large individual variation in behavioural and physiological reaction to isolation was observed. Body temperature and heart rate were averaged over 15 min periods and compared to a 15 min baseline value. Body temperature decreased until 0.57 ± 0.26°C below baseline level during the last 15 min of isolation. Large individual differences were observed especially during the first 30 min of isolation: In some pigs body temperature first increased, in other pigs body temperature immediately started to decrease. Heart rate increased 45 ± 18 bpm during the first 15 min of isolation and decreased to baseline level during the test, but there was also large individual differences in heart rate reaction. Body temperature and heart rate reaction during isolation were positively correlated or tended to be positively correlated (1st period: r=0.7, $P<0.05$; 2nd period: r=0.6, $P<0.10$; 3rd period: r=0.67, $P<0.05$; 4th period: r=0.6, $P<0.1$). This experiment shows that not only hyperthermia, but also hypothermia, can be observed in reaction to a stressor. Moreover, large individual variation in the physiological reaction to isolation is observed.

Assessment of fear reactions in dairy sheep, and influence of temperament

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The aim of this study was to assess the fear reactions in dairy ewes, using different fear inducing tests, and the influence of the temperament on fear susceptibility.

The study was carried out on 54 local Stara Zagora ewes of previously determined temperament. The animals were of the same age and lactation. The distribution of the temperament types was as follows: Strong type, 14 ewes; Strong-inert, 12 ewes; Strong-unbalanced, 15 ewes and Weak, 13 ewes.

The temperament of individual dairy ewes being milked in a milking parlour system “Casse” was evaluated with a calibrated-line method using 4 objectives to describe traits, e.g. position into the milking parlour; activity toward neighbours; feed reaction toward forage offered by hand (stranger); and reaction toward positioning of teat cups. The temperament was also evaluated with Pavlov’s method of conditional reflexes. Both approaches showed high levels of consistency in the behavioural responses of the ewes.

Two fear-inducing tests were used; Open field test and Surprise test, including measurements of parameters used to quantify fear. Fear reactions were studied in the morning, before feeding, in a specially designed room (6 x 6 m) using a trough containing concentrate forage. The duration of each individual test was 4 min and the surprise test was performed after an 8 day acclimatisation period.

This study showed that the tests and parameters used to quantify fear in dairy ewes are sufficiently effective. The following parameters made the largest contribution to assessment of the fear reaction: feeding latency, feeding time, latency to sniff for the first time, squares entered and immobilizations.

Fear reactions were influenced by the temperament. Significant differences were established between the Strong type and the other 3 types ($P<0.001$ and $P<0.01$) but not between the other 3 types in both tests.

Effects of a naturalistic cage design on agonistic interactions and endocrine reactions in all-male groups of Zur: ICR mice

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In laboratory mice the increase of agonistic interactions as a consequence of slight or partial enrichment of standard cages has been frequently shown. The present study was carried out to compare aggressive behaviour and some endocrine measures in groups of male mice (12 groups of 6 individuals per housing condition) housed either in standard cages (S), or in enriched cages (E) with presumed key features of a natural mouse habitat (e.g. several food and water resources, huts and burrows). Cage size (0.5 m^2), with upper galleries accessible via ladders, also provided a spatial opportunity to display natural behaviour. Based on their attacking behaviour, mice were assigned to one of three dominance categories: high- (h), mid- (m), and low-ranking (l). At age 80 days, mice in E showed a significantly higher number of agonistic interactions compared to mice in S (medians of frequencies per 8 h observation time: E=106.5, S=59.5; $P<0.001$). However, no injuries were detectable in animals from either E or S cages. Differences in initiating agonistic interactions were significant only when comparing high-ranking (h) animals (medians: E(h)=70.0, S(h)=22.5; $P<0.001$). In E, both mid- (m) and low-ranking (l) animals were more successful escaping from the attacks of higher ranking cage-mates (medians: E(m)=64.6, S(m)=30.9, E(l)=70.7, S(l)=30.7; $P<0.001$), and showed more submissive postures than (m)- and (l)-mice in S. In E, the burrows and provided huts appeared to be of little importance with regard to successful evasion, with escapes usually ending in areas of the cage open to view. Comparing physiological parameters, plasma corticosterone titers were higher in S than in E (means in ng/ml plasma: S=293.1, E=257.5; $P<0.01$); with the highest titers found in S(m)- and (l) animals. In contrast, tyrosine hydroxylase activity (THA) was higher in mice from E (means of turnover in nmol/h/2adrenals: E=2.2, S=1.7; $P<0.01$), with the highest THA found in E(h) animals. Phenylethanolamine-N-methyl- transferase (PNMT) activities did not differ between the housing conditions. These physiological results are in contrast to recent studies, and the data presented indicate that the behavioural and physiological effects, apparently induced by cage enrichment, may depend on the actual design of the construction, rather than on the enrichment *per se*.

Mother-infant behaviour of wild boars in farrowing pen

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In general pig management, the suckling period is very important. The mortality is higher in suckling period than in other stages, with problems such as crushing and diarrhoea. Wild boars also require much care in this stage. Observations were carried out on Japanese wild boars (*Sus scrofa leucomystax*) under captive conditions in order to clarify the mother-infant behaviour and development of social play in piglets. Three females and their litters (4 piglets each) were observed. The behaviour of females and piglets was classified into 10 and 11 categories, respectively. Each family was housed in a farrowing pen and observed by scan sampling once a week for a mo from birth. The pens measured 5.8 x 1.8 m each and contained a nursing box. The behaviour and location of piglets were recorded at 30 s intervals from 0600 to 1800 h. In females, nursing bouts were few in early morning but increased after their feeding time from 0700. Throughout this observation, there was no change in time spent nursing. In weeks 1 or 2 after farrowing, resting decreased, and walking and exploratory behaviour increased. In this period, the time spent in the nursing box by piglets decreased. In the 1st week, when piglets were in the nursing box, the mother rested with her nose into entrance of the box. Suckling of piglets was synchronized. In epimeletic behaviour, nose attachment to piglet, moving piglet by nose, and vocalization to hide into nursing box were observed. Piglets performed other behaviours such as climbing on their mother's back when she was nursing or resting. Standing, resting, fur biting, exploratory behaviour, mock-fighting and clinging by piglets were also observed on mother's back. On occasions, all litter mates climbed simultaneously. They play very active on the back and around their mothers. It seems that their mother is not only a tranquil place but also an athletic field to develop their kinetic ability. Social play behaviour contained mock-fight, sexual play, play chasing and suckling pen mates. Mock-fighting usually started with head pushing which occasionally progressed to head butting. In next stage (2 and 3 weeks of age), mock-fighting showed diversification and intensity.

Competitive ability of rams selected for high and low levels of sexual performance

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The objective of this study was to determine if rams differing in levels of sexual performance also differ in their ability to succeed in a competitive situation.

Twenty sexually-experienced Targhee-type rams were pre-selected from a population of 95 males for exhibiting relatively high and low ejaculation rates when individually exposed to oestrous ewes for 30 min (6.0 ± 0.2 and 1.7 ± 0.2 ejaculations per 30 min, respectively). Each of 10 high-performers (HP) were paired with each of 10 low-performers (LP) on 3 occasions when competing for feed (after food-deprivation) and twice when competing for an oestrous female. Tests were 5 min in duration.

Food-deprived HP and LP rams were equally aggressive when competing for a source of feed that could only be accessed by 1 ram at a time (number of successful agonistic interactions, HP: 8.4 ± 0.5, LP: 8.6 ± 0.8, n.s.). Time feeding by HP and LP rams did not differ (HP: 152.6 ± 14.1 s, LP: 136.2 ± 20.8 s, n.s.). HP rams spent more time with the oestrous ewe (HP: 170.1 ± 15.0 s, LP: 90.5 ± 24.0 s; $P<0.05$) and attained more mounts per pairing than LP rams (HP: 7.3 ± 1.4 mounts, LP: 1.4 ± 0.5 mounts, $P<0.001$) even though HP and LP rams did not differ in number of successful agonistic interactions (active displacements and successful defences) when competing for the ewe (HP: 2.9 ± 0.4, LP: 3.0 ± 1.0, n.s.).

It was concluded that HP and LP rams do not differ in their basic competitive ability and that the greater mating success of HP rams can be explained by their higher levels of sexual motivation.

Stallion-foal interactions in a semi-feral pony herd

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Domestic stallions are rarely pastured with mares and foals. A popular belief among North American horse owners is that stallions may seriously injure or kill young foals, particularly if they are not the sire. Case reports of captive Przewalski stallions savaging foals which they did not sire have supported the idea of stallion "infanticide". The goal of this study is to characterize stallion-foal interactions with a focus on sire versus non-sire harem stallions.

In a semi-feral pastured pony herd, 5* foals were observed during a 3 mo period spanning birth to 60 days. For 2 foals their sire remained the harem stallion throughout the study. The 3 remaining foals were born after their sire had been displaced from harem stallion status. At 8 days of age, 1 of these 3 was "stolen" with its dam by another non-sire stallion where it remained for the 60 days of observation. Thus observations included 6 stallions, 2 sires and 4 non-sires (1 of which was harem stallion for only the first 8 days of a foal's life and another of which was harem stallion for that foal for days 8 through 60). Intermittent focal dyad sampling totaled 628 h (113 to 132 h per foal). A total of 433 harem stallion-foal interactions were observed, representing 26% of all foal social interactions with ponies other than the dam (other foals 25%, other harem mares 40%, mares from other harems 4%, other harem stallions 3%, and bachelor stallions 2%). Only 18% of harem stallion-foal interactions were classified as aggressive (neutral 18%, investigative 48%, friendly 8%, submissive 11%, playful 3%). All aggressive interactions were mild in nature, and most were within a protective context (ie, retrieval of the foal to the harem). Non-sire and sire harem stallions were similarly non-aggressive toward foals (each type had a mean of 0.1 stallion-initiated aggressive interactions per foal h of observation). These results suggest that under semi-feral conditions stallions interact mostly positively with foals, and that non-sires are not more aggressive with foals than sires.

Acknowledgment: This is a Dorothy Russell Havemeyer Foundation Project conducted at the Georgia and Phillip Hofmann Center for Animal Reproduction Research with partial support from NIH-K04-NS01537

*At the time of presentation, data will include 16 foals (9 sires and 7 non-sires expected, including some sires with examples of sired and non-sired foals).

Effects of transport and environmental changes on physiological and productive traits in dairy cows

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Transport and environmental changes are considered potential stressors in farm animals. In order to evaluate the effect of a 1 h trip and of the new environment on physiological and productive traits, 32 Italian Friesian cows out of a herd of 100 animals were monitored before and after transportation and introduction into a new stable. Cortisol levels, lymphocyte proliferation and milk production and characteristics (protein, fat and somatic cells) were analysed before transport and at different intervals after the introduction into the new environment. Transport and changing environment did not markedly affect milk production and quality, however milk yield decreased after transportation (average difference, -0.9l, t=2.29; $P<0.05$). Milk fat percentage gradually decreased during the first month after the introduction into the new environment, probably due to different quality of feedstuffs. The average cortisol level after transport was 6.32 μg/100 ml higher than the average basal level (t=20.07; $P<0.0001$) and the levels returned to basal within the next 24 h, in agreement with analogous studies. This trend seems to be related mainly to acute stress produced by the transport and its related manipulations rather than to the long term effect of the new environment. Lymphocyte proliferation significantly decreased after the introduction into the new environment (average difference, 24458.54 cpm; t= -2.21; $P<0.05$) and began to increase only 50 days later (average difference, -2467.8 cpm n.s.). These results indicate the importance of using sensitive indicators, such as lymphocyte proliferation, able to detect environmental situations that do not appear to be stressful to the animals.

Object permanence in the domestic hen

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Object permanence is the notion that objects have a physically distinct identity and continue to exist when removed from an observer's immediate perception. As well as being of a fundamental interest, this is an important question for animal welfare, as the degree to which animals have representations of resources that they cannot directly experience may determine their ability to suffer in the absence of these resources. Six tasks were presented over 6 weeks to investigate the ability of hens to locate an occluded feeder. Each hen observed the remotely-controlled occlusion of a feeder behind a screen in a testing arena. The ability of the hen to locate the feeder was determined during successive tests with 0, 1 or 2 additional screens. In effect food was hidden behind all screens. The order of presentation of the tasks was varied such that 3 hens received tasks with 1 screen first (then the 2 and 3 screen tasks) and 3 hens received tasks using 3 screens first (then the 1 and 2 screen tasks). Each task was presented between 6 and 18 times and a 90% success rate was decided as the criterion for defining success at any particular task. All hens tested succeeded in locating the food when there was only 1 screen within 1 min of it being hidden. At least 1 hen (at most 2 hens) succeeded on each of the other tasks. Hens were more successful at the beginning of testing irrespective of which task was presented (Fisher exact test, $P<0.05$). Furthermore, mistrials due to the hens scratching and pecking in the litter or approaching the exit were not observed in the first 2 days of testing for any hen. These findings suggest that motivational conflict arises with increasing repetition of the tasks rather than because of increasing difficulty. It is concluded that hens can initiate search behaviour and locate objects even after complex visible displacement and occlusion, suggesting that they may be able to form mental representations of objects that they cannot directly perceive.

Techniques to reduce non-nutritive sucking in calves

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Producers deem that calves sucking each other (cross-sucking) is undesirable and wish to control it. Following a milk-meal, calves are highly motivated to suck and will suck an artificial teat that does not deliver milk (non-nutritive sucking). Our objective was to determine whether drinking water or having hay would reduce non-nutritive sucking. Fourteen Holstein calves sucked their milk through artificial nutritive teats and we measured the amount of non-nutritive sucking following the milk-meal. Replacing the milk-covered nutritive teat with a clean, dry teat did not reduce non-nutritive sucking compared to leaving the nutritive teat in place (P=0.7). Replacing the nutritive teat by a clean teat that delivered 100 ml of water reduced the non-nutritive sucking that followed the water treatment by 59% (P<0.01). Delivering 1 l of water through the milk-covered teat also reduced the ensuing non-nutritive sucking by 62% (P<0.01). However, when the time taken to drink the water was included as non-nutritive sucking, there were no differences among treatments (P=0.1). This suggests that after a milk meal, calves have a set amount of time during which they are motivated to suck and that neither the taste nor the ingestion of water reduces that time. In the second experiment, the calves were given hay immediately following the milk-meal. This reduced non-nutritive sucking by 55% compared merely distracting them by pretending to give them hay (P<0.01). Making hay available at the beginning of the meal and then distracting the calf at the end of the meal reduced non-nutritive sucking by 58% (P=0.01). The motivation to eat hay competes with the motivation to suck after the meal, but the motivation to suck is too strong to be reduced by distraction. We conclude that providing water through a teat or offering hay reduces the ensuing sucking motivation, which may help in the control of cross-sucking.

Social strategies in cattle and their relationships with health, stress and reproduction

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Studies of social behaviour in farm animals have moved away from a dominant-subordinate classification and have instead focused on consistent behavioural characteristics or strategies based on the experience of each individual in agonistic and non-agonistic interactions. It has even been suggested that in terms of consequences for its physiological state and health, the strategy the animal adopts is probably more important than the actual social status achieved. Information on this topic in cattle is scarce. Three separate studies were carried out to observe social and individual behaviour of 2 herds of Holstein-Friesian cattle, 1 in Britain and 1 in Mexico, and 1 herd of Brahman cattle in the Mexican tropics.

In the first herd, using factor analysis, 3 groups of behavioural strategies were identified. These were aggressive, passive and avoidance and correlated with time spent performing non-interactive behaviour. Time spent feeding and lying were negatively correlated (r=-0.34 and -0.40; $P<0.05$, n=40) with the passive and aggressive strategies respectively. Time spent standing still and the number of clinical cases of lameness were positively correlated (r=0.32 and 0.34; $P<0.05$, n=40) with the strategy of avoidance. One interpretation of these correlations is that the individual susceptibility to lameness in dairy cows is determined by behavioural factors which make the animal stand for long periods of time. An ACTH challenge test to measure long term response of cortisol was carried out in herd 2, and a statistical analysis is presently being carried out to identify any relationship between social strategy and adrenal cortex activity. In herd 3 social strategies are being related to sexual behaviour to better understand the individual motivation of mounting behaviour which will be useful for designing improved programmes of oestrus synchronisation. Complete data of the 3 herds will be presented at the conference.

Odour production from the tarsal glands of male white-tailed deer

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During the breeding season, dominant male White-tailed deer often develop a characteristic rutting odour. Previously, we suggested that this odour results from the microbial decomposition of urinary components on the tarsal gland. Bacteria residing on the tarsal hair may produce compounds important for conspecific communication by transforming the mammal's secretions or by excretions from their own metabolic activity. These compounds are transferred to the environment via rub-urination, which is a urine-washing event often performed in association with scraping behaviour. This is perhaps one of the most common and conspicuous signposts produced by male white-tailed deer during the breeding season. The urinary and tarsal components deposited in these scrapes frequently are investigated by male conspecifics in order to determine social status. Additionally, these signposts may play a role in mate selection, as they also are investigated by female conspecifics. We collected naturally-voided urine and tarsal hair from 12 male deer of various ages to determine if odours from the tarsal hair and urine differed. Using gas chromatography-mass spectroscopy, we tentatively identified 167 compounds. Differences in the concentration of volatiles occurred among voided urine and tarsal hair. We also collected microbial samples from 27 male and female deer to determine if tarsal microbial flora differed between sexes and among age classes. We found 18 species of bacteria specific to the tarsal region, with older males having a higher diversity of microbial flora than females. Additionally, because bacteria are often associated with odour production, we compared the voided urine and tarsal hair samples with urine spiked with tarsal bacteria. Twenty-four compounds were specific to the tarsal hair, 12 occurred in the spiked urine only, and 3 were common to tarsal hair and spiked urine. Volatile composition is likely influenced by bacterial decomposition of conjugated compounds, bacterial waste products, selective retention of volatiles by tarsal sebum and production of volatiles by the tarsal gland. Because rub-urination among dominant males increases at the onset of the breeding season, and dominant bucks typically excrete higher concentrations of conjugated androgens prior to and during the breeding season, the microbial conversion of these and other compounds probably plays a role in dominance recognition by other males and/or mate-selection by females. Variability among individuals suggests that the tarsal gland also may provide an individual olfactory signature.

Spacing and social behaviour in female llamas

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Observations were made in a group of 5 adult female llamas of European origin on pasture (0.5 ha) at the Experimental Station of Giessen University. Over a period of 4 consecutive mo inter-individual distances were estimated between all animals by time-sampling method (every 10 min during 5 h daily on 28 observation days). The facial alignment was classified according to the angles adopted between heads and body postures, positions of ears and tail and social interactions (threatening, spitting or biting) were recorded. In addition basic activity patterns such as lying, walking, standing and grazing were recorded.

Most of the time was spent standing, grazing or lying, while little walking or running occurred. In general, overt aggression was nearly absent indicating stable social bounds. With regard to inter-individual distances, bodily contact was very rare. Social grooming which is well documented for cattle and horses was never observed. Inter-individual distances were usually between 5 and 10 m. In some individuals, slightly closer average distances were found and may indicate some form of “pairing”.

With regard to head angle, it is of interest to note that certain head positions were avoided such as direct frontal head to head contact. Animals had a pronounced tendency to adopt head alignments that allowed visual contact between group members and facing the rear of another animal was avoided.

The group under observation was then mixed with 6 other females on 0.9 ha of pasture. From the day after mixing, the same traits as before were observed for the former group members during 1 week. Average distances between the observed animals remained rather stable. The results suggest both repeatable spatial and social relationships between group members. According to the inter-individual distances, llamas can be classified as distance animals avoiding close physical contact between one another. This may also have implications for the human-animal-relationship in South American camelids as the animals might also avoid touch by humans.

Responses of slaughter pigs to lairage sounds

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The aim of the current study was to assess the degree of aversiveness of slaughterhouse sounds. Forty-three groups of 4 slaughter pigs were separately loaded onto a lorry and transported for 25 min. Following unloading pigs were moved to a race with a length of 15 m and a width of 1.5 m. One of the following recordings was played at 85 dB(A) for 10 min: Pigs in front of the restrainer, Machines in lairage, White noise, or Control (no sound).

Pigs exposed to the Machines and White noise treatment spent a significantly greater percentage of the sound exposure period close to their group-mates compared to Control pigs (Machines 25.6 ± 4.6%; White noise 31.3 ± 4.5%; Control 12.4 ± 4.2%; $P<0.05$), with pigs subjected to the pig sound being intermediate (19.9 ± 3.9%). Heart rate was highest during loading and unloading, and did not significantly differ between sound treatments. Salivary cortisol concentrations rose significantly in response to transport (before 3.03 ± 0.17 ng/ml, after 6.74 ± 0.28 ng/ml; $P<0.01$) and remained high after the sound exposure period, but did not differ significantly between sound treatments (Pigs 6.46 ± 0.44, Machines 6.04 ± 0.40, White noise 6.40 ± 0.41, Control 6.51 ± 0.46 ng/ml). It is concluded that when pigs are exposed to sound under the described circumstances social support from conspecifics may be an important factor in reducing stress.

Hierarchy and competitive feeding in pigs - evaluation of social stress by means of plasma cortisol

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Cortisol has been shown to increase in response to the acute stress experienced during fighting in newly mixed pigs, and chronically or intermittently stressed pigs may have an altered response to acute stress. As part of a study to evaluate the effects of social factors such as hierarchy and aggression on boar taint, an assessment was made of the level of social stress by means of plasma cortisol response to an acute stressor. In 4 replicates of 100 animals (50 intact males and 50 females), pigs were randomly reallocated 4 times at 1 mo intervals (periods) to mixed groups of 10, and 1 week later observed during 2-3 weeks for agonistic behaviour at competitive feeding. At the end of the last 2 periods (P3 and P4, coinciding with beginning puberty), blood samples were taken and the plasma analyzed for cortisol. The blood sampling procedure was time monitored and included a standardized stressor: local anaesthesia and fat biopsy excision followed by 2 blood samplings 90 and 120 min after (C1 and C2 respectively), and involved restraint in a nose sling. Data were analyzed by Mixed Models in SAS. Cortisol concentrations in C1 and C2, and the difference between them (CD) were analyzed in relation to rank, and agonistic behaviour. Cortisol concentration in C2, but not in C1, was positively influenced by the duration of sampling in males (P=0.001), but not in females. Cortisol in C1 was significantly affected by rank in males at P3 (P=0.03) with low ranking males having the lowest concentrations, but not in females and not in P4. However, females generally had a lower C1 than males (P3: P=0.05; P4: P=0.02), and a larger CD (P3: P=0.04; P4: P=0.06), but sexes did not differ in C2. There were thus some similarities between responses of females and low ranking males. Cortisol was not affected, in either sex, by the amount of aggression initiated, aggression received, or changes in rank, implying that in males the current position in the hierarchy was of greater significance than the behaviour involved in its maintenance. The results may also imply that social relationships in a competitive environment may be reflected in an initial acute cortisol response, as shown for males, but that the effects of the employed challenge procedure may have masked subsequent differences. The reasons for the sex differences are not clear, these, and the responses measured in P4, may be influenced by different experience of the sampling procedure, timing of the procedure in relation to the animals' reactivity as well as by stage of sexual maturity.

The influence of cattle, pigs, sheep, unfamiliar red deer and humans on the behaviour of farmed red deer alongside and within races

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The effect of the movement of unfamiliar animal species and humans in a race adjacent to pens of farmed red deer on the behaviour of the deer and the influence of unfamiliar species in pens beside a raceway on the speed of movement of deer in a race in simulated abattoir lairage was investigated. In the first of 2 experiments, groups of cattle, pigs, sheep, unfamiliar deer and humans were moved alongside replicated groups of 5 female yearling red deer. The effect of movement of cattle, pigs or humans was to reduce the proportion of lying behaviour (0.00 of all scans) compared to movement of sheep or unfamiliar deer (0.09 and 0.12 of scans, respectively, $P<0.05$). When sheep moved passed the pens, deer moved more and stood less (0.21 and 0.70 of scans, respectively) than when cattle passed the pens (0.04 and 0.96 of scans, respectively, both, $P<0.05$). Alert behaviour was less when sheep moved alongside the pens, compared to cattle or pigs (0.27 vs 0.53 and 0.58 of scans, respectively, $P<0.05$). When cattle were in the race, deer occupied a location furthest from the raceway (more than 2 m away, compared to less than 1 m away) for a significantly greater proportion of scans than when unfamiliar deer or sheep were in the race (0.26 vs 0.10 and 0.08 of scans, respectively, $P<0.05$). In the second experiment, when deer were moving along a raceway, they reached the end of the raceway sooner when they had to pass 2 pens containing unfamiliar deer or humans (9.6 and 10.9 s, respectively) than when they had to pass cattle or pigs (13.4 and 13.7 s, respectively, $P<0.05$). Overall, the time taken to move along the race decreased with the number of tests (first test 15.3 s, fourth test 10.0 s; $P<0.01$). It is concluded that yearling red deer hinds find novel exposure to cattle and pigs (and to a lesser extent sheep) in a raceway system unsettling (their behaviour is altered and results in a reduction in their ability to rest), although there is a modulation of this response with experience. The presence of unfamiliar species along the side of a raceway is likely to reduce the ease with which deer can be moved.

Acknowledgment

The study received financial support from the Scottish Office, Agriculture, Environment and Fisheries Department.

Spontaneous alternation behaviour and exploration in hens

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The term spontaneous alternation behaviour (SAB) refers to the tendency for animals to consistently alternate their choice of arm in successive runs in a T- or Y-maze, a phenomenon studied largely in laboratory rats. SAB may be the expression of an adaptation which facilitates foraging and exploration, and may represent a form of intrinsic exploration. In terms of welfare, animals capable of expressing intrinsic exploration may be prone to boredom in barren housing environments. Previous research with hens has failed to find evidence of SAB, although it was inferred that regular handling might make the hens less fearful of experimenter-assisted return to the home cage than of staying in the novel maze. In the present experiment, 2 groups of 6 hens were tested, with 1 group receiving a handling treatment prior to the maze trials. Each hen was habituated to the maze environment and then given 6 runs/day for 9 days in a T-maze which had 1 green and 1 red arm. Choice of arm and behaviour were recorded. When alternation on 2 successive runs was observed (i.e. each arm was entered on 2 successive runs), this was positively associated with the number of looks made into the arms prior to choosing the second arm ($P<0.05$). Generally low levels of alternation were shown, but 2 hens performed above chance levels of alternation and 3 performed below this level ($P<0.05$). There was no effect of handling treatment on alternation rate ($P>0.05$). It appears that some hens are capable of showing SAB, and the association between alternation and looking behaviour indicates that active comparative and decision-making processes are involved which may have a cognitive basis. The difference between the levels of SAB shown by rats and hens may reflect the primary exploratory modality of the animal concerned.

Play behaviour in domestic calves (*Bos taurus*)

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Observations of play behaviour were recorded in 2 herds of domestic beef-type cattle, one that involved spring-born calves and the other autumn-born calves. The objectives of this study were to determine age, sex and time of day influences on play behaviour. Calves observed ranged from birth to 175 days of age and were either Angus or Angus-Hereford crossbreds. Over 100 h of observation from 50 observation days were recorded involving 109 spring-born calves and 64 autumn-born calves, with 1650 total play bouts recorded. Play behaviour was categorized as either social, locomotor or object directed. Bouts/h of locomotor behaviour were more frequent ($P<0.05$) among younger calves (3.7, 3.4, 3.0, 1.2; 1 to 4 weeks, respectively), while social play (pooled over dam-calf and calf-calf interactions) showed no consistent trend as age increased. Female calves performed more bouts of locomotor play than did males ($P<0.01$), but sex had no influence on frequency of social play. Object directed play was consistently low in frequency, was not influenced by either age or sex, but greatly exceeded ($P<0.01$) other types of play in duration per bout. Social bouts were longer ($P<0.01$) in duration than locomotor bouts (9 vs 19 s, respectively). The duration of play bouts increased with age ($P<0.05$) from birth to week 18 (approximately 10 to 30 s, respectively), with this increase due in part to less locomotor play and more social play. The number of bouts in the hour before sunset compared with the bouts/h pooled over the rest of the day differed greatly ($P<0.05$: 11.5 vs 6.2 bouts/h, respectively). Our goal is to obtain a data base that can be used to compare the development of play behaviour of domestic cattle to their wild and feral close relatives. The hypothesis that we are particularly interested in testing is that domestication functions to produce more neotenized animals. We believe that understanding play behaviour could be a critical part in identifying any role of neoteny in the domestication of animals.

The use of multivariate techniques in the study of animal welfare

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This paper reviews and explores the use of multivariate models in welfare and stress studies.

The physiological stress response is a multivariate syndrome. It manifests itself in interacting and interdependent changes in various endocrinological, physiological and immunological systems. As such it is essentially a multivariate phenomenon. To accommodate the multivariate character of the physiological stress response, it is recommended that a variety of measures be used when measuring the response. An alternative, sometimes complementary, approach uses the animal's decisions in choice situations as the basis from which to tackle welfare aspects of housing conditions in particular. However, even where various parameters are measured, they are typically subsequently analysed by univariate or bivariate parametric methods. Multivariate analytical techniques can be used to detect (weighted) combinations of correlated variables or correlations between sets of variables. Such combinations may be used as diagnostic profiles of the animals as regards their physiological state of stress. In social stress studies, behavioural variables may be combinable with immunological, physiological and endocrinologcal parameters to describe the different behavioural strategies adopted by animals in social environments.

While, in principle, such models seem well suited to investigate mulivariate concepts such as stress or welfare, care must be taken to ensure that the variables used have the properties that would allow parametric statistical methods to be applied. The variables must be measurable on ratio or interval scales and normally distributed (raw or transformed). The requirement for a high ratio of replicates (where replicates are individual animals) might present a bigger obstacle to a wider use of multivariate models.

The relationship between the behavioural response of lactating sows to humans and the mortality of their piglets

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Extensive research in the pig industry has shown significant relationships between the behavioural response of pigs to humans and their reproductive performance. The present study examined the relationship between the behavioural response of lactating sows to the close presence of humans and the mortality of their piglets in 25 farrowing units at a large commercial farm. The behavioural response of about 25 sows in each farrowing unit, which had 150 farrowing places, was studied at both 2-4 and 16-18 days of lactation using the following technique. About 100 g of food in a novel metal tray was placed on the floor in the front of each sow's farrowing crate and after 5 s of feeding, an experimenter slowly approached the front of the crate, and leaned through the horizontal bars on the front side of the crate and placed her hand about 5 cm from the snout of the feeding sow. The sow's behavioural response to the close presence of the experimenter was recorded over the subsequent 15 s. Correlation analysis, using either unit averages or individual sow data, was used to examine behaviour-productivity relationships in the farrowing units.

Based on unit averages, some moderate correlations were found between the withdrawal response of lactating sows at days 16-18 of lactation to an experimenter and the stillbirth rate of sows. For example, there was a significant positive correlation between the proportion of sows withdrawing in the close presence of the experimenter and percentage stillbirths (of total born) in the unit ($r=+0.41$, $df=23$, $P<0.05$). There was no significant correlation between withdrawal response and mortality of liveborn piglets to 4 days of age. Sow parity was not significantly associated with stillbirth rate using unit averages, however this association was significant using individual sow data across the 25 units ($r=0.18$, $df=621$, $P<0.01$). Thus, behaviour-productivity relationships were also examined using individual sow data within parity groups. Small but significant correlations were found between the proportion of sows withdrawing in the close presence of the experimenter and stillbirth rate for both parities 2-4 and parities 5 and greater ($r=0.14$, $df=349$, $P<0.01$, and $r=0.17$, $df=149$, $P<0.05$, respectively) but not for parity 1 sows ($r=0.06$, $df=119$, $P>0.05$). The results of this preliminary study indicate that high levels of fear of humans by sows may adversely affect the survival of their piglets.

One explanation for this fear-stillbirth relationship is that the appearance and activity by the stockperson in the farrowing unit, by disrupting sows in the process of delivering piglets, particularly those that are fearful of humans, may have adverse consequences for piglet survival.

The impact of weaning and processing on the health and performance of beef weaners

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Weaning is potentially an extremely stressful period and in northern Australia weaning stress on beef calves is exacerbated as the calves are also 'processed' (ear-marked, vaccinated, branded, de-horned and males castrated) at this time to reduce costs associated with mustering large areas of country.

This study asked whether it is better for the health and performance of calves to have weaning and processing separated in time. Approximately 100 male and 100 female calves were divided between 2 treatment groups: (i) the normal procedure involved the removal of calves from cows, confinement and feeding in yards for about 2 weeks, followed by processing on the day they were moved out to a paddock (WP), and (ii) the processing of calves 6 weeks prior to the weaning date, with the calves being returned to their home paddock with their dams until they were weaned with the other group (EP).

All cattle were weighed and had their temperaments scored (flight speeds) at regular intervals, with a sub-group of male calves on each treatment also having their behaviour recorded in the paddock, and blood and faecal samples collected.

Preliminary analysis of the liveweight data indicates no treatment differences in gains for the females (63.9 kg and 64.8 kg for EP and WP respectively), but for males liveweight gains on the EP treatment were reduced from the time that they were processed and 9 months later were, on average, about 5 kg less than the WP males (70.8 kg vs 75.7 kg). Flight speeds of the WP group increased (cattle became more 'flighty') after weaning and processing (changed from 1.9 m/s to 2.6 m/s). Flight speeds did not differ between the start and end of the trial for females (2.1 m/s), but for males increased from 1.8 m/s to 2.1 m/s.

The small differences in liveweight gains found between the 2 treatments indicate that there is no advantage in mustering and handling cattle twice to separate processing and weaning in time.

Early weaning: its behavioural aspects

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In mammalian species, a new biological unit, formed by the mother and her offspring and consisting of a specific sequence of events, begins at birth. It is aimed at promoting the survival of the newly born, and by these events, it continues to be connected with the mother. Among these events, of special importance is the role of nutritional mechanisms. They are aimed at a very intensive process in which the mother transfers nutrients, other substances and chemical messengers to her offspring. These events acquire the form of a cyclical, intermittent bouts of suckling and sucking; a regularly repeated stereotype having several phases. Both the mother and offspring play an active role in this. The nutrient transfer is so intensive that, for example, a sow may lose about 15% of her body mass during one lactation, while her litter may double its birth body mass within 7 to 10 days.

In animals cared for by man, for example cattle and pigs, and kept in industrialized production systems, this developmental process is destroyed for economic reasons. The offspring are separated from their mothers very early, sometimes immediately after birth, and in polytocous species often isolated from each other. From the strongly ritualized behavioural sequence in a litter, only fragments remain.

These effects markedly influence the behaviour of mothers and their offspring. Factorial mathematics indicate that in monotocous species only 2 combinations of interactions between dam and her young may occur, whereas in polytocous species (such as pigs) with 10 young in the litter, the number of behavioural interactions increase to 92 or 110. Some of the behavioural consequences of early weaning occur and sometimes disappear rapidly, others persist for a long time. Furthermore, some remain hidden, and may occur later, in puberty or in adulthood.

Behaviour of animals with regard to the process of domestication

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Successful domestication is based on many conditions of which the most important are the geographical and social structure of human society and the set of life manifestations of wild animal species of the given region and their ability to adapt.

The present paper discusses the suitability of some wild animal species for commercial use connected with domestication. Domestic cattle and Eland (*Taurotragus oryx*) were used as examples of differences involved in this process. Domestic cattle is a species where domestication began as long ago as the 8th millennium B.C. The rearing of Eland was introduced in the regions of its occurrence repeatedly many times; however, the formation of a domestic form - breed has not been successful and domestication which was the same in both species - meat production, has not been reached.

We consider the reasons of these different results and state that:

1. Basic manifestations of behaviour characterized for both species in the study of Lewis (1977) are supplemented with investigations on the behaviour of the mother with the young differing in the period of uptake of feed and in the period of repose.

2. Social behaviour and herd hierarchy are strong in both species, however, in cattle the dominant position is not necessarily connected with the so-called leading position of the individual within the herd.

3. The relationship between the mother and the young animal is based on the social behaviour of species, but is affected by different ontogenesis of behaviour, (Hillman, 1988).

4. Sexual behaviour in cattle is considerably affected by the degree of breeding of the respective breeds and its manifestations are not so strong, discussed in Eland by Treus (1969).

5. The forms of communication among cattle are limited to the immediate vicinity and responses are less distinct.

Do quality and availability of foraging materials influence feather pecking in domestic chicks ?

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Feather pecking may cause severe welfare problems in laying hens, as it may lead to feather damage, injuries or even death of the pecked individuals. The 2 experiments presented here are part of a study on the relationship between foraging behaviour and feather pecking in domestic chicks. Twenty-six groups of 30 or 31 chicks, *Gallus gallus domesticus*, were reared in pens and provided with different types of foraging materials. Feather pecking and foraging behaviour were quantified when the chicks were 4 and 5 weeks of age. In experiment 1, chicks with access to long-cut straw showed more foraging behaviour and less feather pecking than chicks that were provided with straw in a shredded form. The same inverse relationship between foraging behaviour and feather pecking was found in experiment 2, in which chicks were provided either with polystyrene blocks or with beads of the same material. The beads were picked up by the chicks but were too small for further manipulations. The availability of the foraging materials was varied as a second factor in experiment 2. We found that chicks showed more foraging behaviour and developed less feather pecking when they had access to the materials during the whole day rather than only in the morning. It is concluded that both the form and the availability of foraging materials have significant effects on the time chicks spend foraging and on the development of feather pecking.

Telemetric blood pressure and heart rate recordings in relation to plasma catecholamine levels during parturitionin conscious, unrestrained goats

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The aim of this study was to investigate the extent of sympathetic nervous system activation during parturition in 4 goats. Chronically implanted radio-telemetry devices were used to register heart rate and arterial blood pressure from unrestrained animals round the clock. Telemetric registrations and blood sampling for determination of plasma adrenaline and noradrenaline concentrations were made before, during and after labour. Two goats were in labour for 1.5 and 1.6 h, respectively, and delivered 2 kids each after moderately intensive abdominal contractions. One vocalised during the labour, the other remained silent. A third goat had dystocia due to ringworm and was treated with prostaglandin $F_{2\alpha}$. One normal kid and 1 mummified foetus were delivered manually while the goat vocalised loudly. After milking, a third kid was born spontaneously (labour took 11 h). The fourth goat experienced severe abdominal contractions, vocalised most loudly of all, and delivered 1 kid after 8 h of labour. Mean blood pressure was 69 ± 2 mm Hg the day before parturition, increased gradually during the labour pains, and reached a maximal value of 120 ± 7 mm Hg when the head of the first kid was visible (P<0.001). Heart rate was 134 ± 4 bpm the day before parturition and peaked when the first kid was born (159 ± 6 bpm; P<0.01), as did plasma adrenaline concentration (from 0.4 ± 0.2 nmol/l to 2.7 ± 1.2 nmol/l; P<0.001). The concentration of noradrenaline increased from 4.8 ± 2.3 nmol/l to 12.2 ± 8.4 nmol/l (P<0.05), when the head of the first kid was visible. Expulsion of the second and third kids caused relatively smaller increases in pressure, heart rate and catecholamines than those seen with the first born kid. It is concluded that changes in pressure, heart rate and catecholamines during parturition are related to the different phases of labour and not to its duration or severity.

Piglet vocalization after milk ejection information about piglet needs?

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Immediately after milk ejection, piglets frequently initiate nose contact with their mother which is often accompanied by typical 'croaking' vocalizations. The frequency of these nose contacts with vocalizations (NCVs) is variable both between and within litters. The aim of the study was to investigate whether the occurrence of NCVs after milk ejection provides information about the piglet's condition and whether it can be used as an indicator for piglet need. We assessed the 4 following hypotheses:

1. The frequency of NCV differs when long and short suckling intervals are enforced.
2. The weight gain of individual piglets is related to their NCV rate.
3. The milk intake of individual piglets in a particular nursing influences the probability of performing NCV after milk ejection in that nursing.
4. A piglet massages its teat longer in those nursings in which it performed NCV than in those in which it did not.

Nursings of 14 sows were observed over 24 h at days 7 or 8 post partum. The sows were either enforced a 35 min internursing interval (group MIN35, n=7) or 70 min interval (group MIN70, n=7). NCVs and udder massage were recorded before and 10 min after milk ejection. Milk intake was estimated by the weighsuckleweigh method.

NCVs were less frequent when the sow was forced to nurse every 35 min (Kruskal -Wallis analysis, P=0.03) and gave, on average 27% more milk than a sow nursing every 70 min (Mann-Whitney U-test, P<0.01).

The weight gain of individual piglets during the experimental 24 h was not related to their NCV rate.

In group MIN70, the milk intake of an individual piglet was the same in the nursings in which it performed NCV and in those in which it did not. In group MIN35, the milk intake was higher by 5 g in the nursings in which a piglet did not make a NCV (n=40, Wilcoxon matched-pairs signed rank test, P=0.002).

The duration of massage, analyzed within a piglet, was the same in nursings in which the piglet had NCV and in those in which it had not (Wilcoxon matched-pairs signed rank test, n.s.).

The study indicates that the nose contacts with vocalization after milk ejection cannot be considered as an indicator of the piglet condition as piglets losing more weight over 24 h or those receiving less milk during a particular suckling did not vocalize more. On the other hand, the results suggest that well satiated piglets vocalize less after milk ejection.

An enrichment feeder for caged laying hens

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The objective of the present study was to compare the behaviour and feather condition of caged hens fed by 2 different type of feeders. Seven tennis balls were placed on the feed trough to hide the feed in experimental treatments (Group B). Control treatments had the same feed trough without balls (Group NB). Forty-eight commercial White Leghorn hens were divided into 2 groups of 24 each and fed by B or NB feeders. They were housed in cages with 4 birds per cage (474 cm^2/bird). The experimental period was from 22 to 32 weeks of age. Feather condition of both groups was fine at 22 weeks. Feather damage scored on a scale of 0 (no damage) to 3 (denuded) for 5 areas increased with age, and that of Group B was less than Group NB during the experimental period ($P<0.05$). At 28 weeks of age, the mean proportion of hens feeding was significantly greater in Group NB than in Group B ($P<0.05$). On the other hand, pre-feeding (to extend the neck over the trough, or peck at balls) was significantly greater in B than in NB ($P<0.005$). The birds in Group B spent more time thrusting (to thrust others aside and try to eat) and less roosting than Group NB ($P<0.005$). At 32 weeks of age, the mean proportion of hens feeding and pre-feeding in both groups showed the same tendency as that at 28 weeks of age. Egg production rate in both groups was almost the same during the experiment period (Group B: 89.0% and Group NB: 89.8%). Body weight change was not affected by the type of feeders. This device might provide hens with more attractive environment than conventional feeders, however behavioural habituation may occur toward this device in a few weeks.

Lying down behaviour the first weeks after tethering in young cattle

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Tethered cattle may have problems lying down, and this study aims to investigate how lying down behaviour is affected after a few weeks of tethering. Twenty-four dairy heifers in 2 trials were used. In trial 1 heifers weighed 234 kg (SD 18 kg) and in trial two 200 kg (SD 18 kg). Before the experiment all heifers were housed individually in straw-bedded pens. During the experimental period of 4 weeks, heifers were either tethered in stalls with a concrete floor during all 4 weeks, stayed in the straw-bedded pens for the first 2 weeks and were tethered for the last 2 weeks, stayed in the straw-bedded pens for the first 3 weeks and were tethered for the last week, or stayed in the strawed-bedded pens for the whole 4 week period (control). Stalls and pens were in the same building. At the end of the 4 week experimental period the behaviour of all heifers was video recorded during 24 h. The mean number of times that the floor was sniffed before lying down was largest in heifers tethered for 1 week (5.8, 1.9, 2.0 and 1.2 for treatments 1 week, 2 weeks, 4 weeks and control; $P<0.01$), and the number of times one of the forelimbs was bent without lying down was also greatest (1.2, 0.4, 0.1 and 0.0 for treatments 1 week, 2 weeks, 4 weeks and control; $P<0.01$). The lying down movement took longer in heifers tethered for 1 week and 2 weeks compared to control (4.8 s, 4.1 s, 3.4 s and 3.0 s for treatments 1 week, 2 weeks, 4 weeks and control; $P<0.001$). The number of lying periods was lower in the heifers tethered for 1 week and 4 weeks compared to control (8, 12, 10 and 13 for treatments 1 week, 2 weeks, 4 weeks and control; $P<0.01$). Heifers tethered for 1 week appeared to have the most problems and loose-housed heifers appeared to have least problems lying down. The results suggest that heifers have problems lying down in tie-stalls, especially shortly after tethering.

The effect of feeding before, during and after milking on behaviour and milking related oxytocin secretion

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Feeding concentrates during milking has been demonstrated to influence milking related oxytocin secretion. It is not known if feeding before or after milking has similar or different effects. Oxytocin has been shown to exert a number of behavioural effects. The aim of the present study was to find out how feeding in relation to milking influences milking-related oxytocin secretion and cow behaviour.

An experiment was performed on 24 cows (3 groups of 8). The cows were fed *ad libitum* twice a day with a mixture of roughage and concentrates and milked twice daily, at 0630 h and 1500 h. The 3 groups of cows were used in a latin square design experiment with 3 week periods over a 9 week study: feeding 1.5 h before milking (T1), feeding exactly at the time as milking (T2) and feeding 1.5 h after milking (T3). For the first 1.5 weeks in each period the cows were accustomed to the treatment. In the last 3 days of the second week behaviour was observed. Recordings of individual behaviour were made during 4.5 h around morning milking, with instantaneous direct observation of each cow with an interval of 3 min. For the statistical analyses, the recordings were divided into 2 groups: group 1 (G1), 0-1.5 h after feeding and group 2 (G2), 0-1.5 h after milking. Blood samples for analyses of milking related oxytocin secretion were taken on the last morning milking in the third week. All data were subjected to Least Squares Analyses of Variance using the General Linear Model (GLM) procedure of SAS (1988) for behaviour data and Mixed procedure for oxytocin values.

The interesting findings in this study were a) milking related oxytocin secretion was significantly ($P<0.05$) higher when cows were fed during milking (T2) and tended to be higher ($P<0.1$) when they were fed before milking (T1), compared to when they were fed after milking (T3); b) in G1, the frequency of lying was higher in T2 ($P<0.01$), which is in agreement with earlier studies where oxytocin seems to result in more inactive animals; c) in G1 the frequency of lying ruminating was higher in T2 ($P<0.01$). Lying and ruminating has previously been shown to be a more common state for ruminating than standing and ruminating; d) in G2, the cows in T3 had a significantly ($P<0.001$) lower frequency of social interactions and a significantly ($P<0.05$) higher frequency of oral activity (nosing/licking all surrounding equipment, bar/chain-biting and tongue-rolling). One interpretation is that the cows that were fed 1.5 h after milking (T3) may have had an increased proportion of conflict behaviour. More studies are needed to elucidate whether there is a positive effect of feeding during milking on dairy cow behaviour.

The grazing behaviour of Hokkaido native horses on woodland

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To clarify the grazing behaviour of Hokkaido native horses grazed on woodland, 24 h consecutive observations were conducted in summer, non-snowy winter and snowy winter. In August, 3 woodland paddocks, which measured 50 m x 50 m and were almost flat, were used as experimental paddocks, and 3 Hokkaido native mares were grazed for 48 h on each paddock. In December and January, 3 mares grazed with 46 horses of this breed on hilly woodland were used as experimental horses. The area of the paddocks were about 15 and 30 ha, and the snow depth in the paddocks were 0 and 40 cm, respectively. The woodland paddocks consisted of broadleaf trees and the underlying vegetation was mainly bamboo grass (*Sasa nipponica*). The grazing and resting times of the horses were recorded at 1 min intervals. The frequency and duration of biting bark by horses were recorded on all occasions when observed. The routes of locomotion by the horses were recorded on the map, and distance travelled was measured from the mapped routes. Additionally, the dry matter intakes of *Sasa nipponica* by horses were estimated by double-indicator method using Cr2O3 and AIA. The dry matter intakes of *Sasa nipponica* were 7.9, 8.2 and 7.0 kg/d, 2.2, 2.1 and 1.8% of their body weight in summer, non-snowy winter and snowy winter, respectively. The grazing times were 799, 763 and 605 min/day, respectively, and that in snowy winter was shorter than those in summer and non-snowy winter ($P<0.01$). The distances travelled were 8.2, 4.0 and 4.3 km/day, respectively. The number of instances of biting bark were 19, 14 and 32 times/day with the durations of occurrence of 17, 12 and 69 min/day, respectively. These values in snowy winter were larger than those in summer and non-snowy winter ($P<0.01$). In conclusion, the fallen snow of 40 cm deep affected the grazing behaviour and intake by horses on woodland. Furthermore, the snowy-winter grazing of horses on woodland had larger impact on the trees than summer or non-snowy winter grazing.

Behaviour and welfare of chinchillas in commercial farming: a preliminary study

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The present study aimed to investigate the behaviour and welfare of chinchillas on commercial farms. Breeding animals are usually kept in polygamous systems, in which 1 male has access to 210 individually caged females. A collar prevents the females from entering the male's raised tunnel, which runs along the females' cages. In the rearing sections chinchillas are kept individually in smaller-sized cages.

At 3 commercial chinchilla farms in the Netherlands behavioural data were collected by timelapse video recording (19 animals, 24 h/animal). In addition, data were gathered on fur chewing, fur fungus, injuries and reproduction.

Two (of 19) chinchillas performed stereotypies, mostly involving rapid and repeated locomotion along 1 of the cagewalls. Seven (of 19) animals exhibited so called 'routine behaviour', consisting of a combination of several behaviours repeated for long periods of time. Although there were variations in the frequency and sequence of behavioural elements, these 'routine behaviours' can probably be considered as stereotypies. As well as most other active behaviours, stereotypies and 'routine behaviours' were largely confined to the dark period.

The percentage of chinchillas with evidence of fur chewing was 3.1% (farm 1, n=448), 5.9% (farm 2, n=358) and 7.1% (farm 3, n=898), with significant differences between farms (χ^2=7.92; P<0.02). It is suggested that factors, such as attention from human caretakers and management (e.g. availability of hay and access to sandbath) are associated with the development of fur chewing. Few chinchillas suffered from fur fungus (<1%) or injuries (1-3%). The number of animals weaned per breeding female per year was 2.5 on average, which is lower than the theoretically possible number of 4 weanlings.

It is concluded that there are welfare problems in commercial chinchilla farming. To investigate the full extent of the problems and to improve housing conditions and management, further investigation will be required.

Applied ethology and experiments with small animal numbers: statistical evaluation by log-linear models, single case randomisation tests and meta-analysis

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Members of the International Society for Applied Ethology (ISAE) mainly work on the behavioural problems of farm animals. Their know-how is based on experimental work, especially concerning abnormal behaviour in relation to housing conditions. For instance, there is much knowledge about the causation and function of stereotypies. In zoos an enormous amount of expertise - partly anecdotal, partly scientific - on behaviour, behavioural problems and the solutions for behavioural problems is available. Both groups can certainly benefit from each other's know-how. However, the experimental approach mainly used by applied ethologists is difficult to execute in zoos, because interference with the animals and normal maintenance is not wanted. Also, the number of available animals is often low. Furthermore, the public dislikes experiments on the animals, except for experiments aimed at amelioration of the welfare of animals by environmental enrichment. Concerning the low number of animals in zoos adequate statistical methods are thus necessary for evaluation of the effect of enrichment.

Nowadays statistical techniques are available, for instance log-linear analysis, single case analysis and meta-analysis, that - sometimes in combination - could replace analysis of variance and needs only a minimum of 3 subjects. Characteristic of these techniques is the careful preplanning of the experiment, i.e., the number and the order of treatments given to the subjects. We used these statistical techniques in our farm and zoo animal research. A number of examples will be presented: use of analysis of variance, log-linear (1) and correspondence analysis (2) of time budgets of zoo animals; log linear analysis of feeding enrichment in bears (3), single case analysis and meta-analysis of the effect of food deprivation on crowing in the rooster (4); and single case analysis and meta-analysis of feeding enrichment in a group of 3 orangutans (5).

In conclusion, comparing time-budgets of animals between zoos with different keeping conditions gives indications of their welfare related to housing and keeping conditions. Carefully planned experiments, statistical tests at the level of the individual and combining results of these tests in meta-analysis provide sophisticated methods for evaluation of environmental enrichment in zoos with only few subjects.

Behavioural differences between chicken lines selected for high and low humoral responsiveness to sheep red blood cells

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Genetic selection of food animals for immune responsiveness using harmless, and easy to administer antigens may add to improving resistance to various kinds of (infectious) disease agents. Two chicken lines (*Gallus gallus domesticus*) had been divergently selected during 13 generations for high (H line) and low (L line) antibody responses to sheep red blood cells (SRBC). Little is known of the effects of such selection on parameters of animal welfare, such as stress responsiveness. Tonic immobility is measured as an indication of a stress or fear response in the chicken lines. In 4 experiments tonic immobility was induced by securing an animal 15 s on its back and releasing it slowly. Time until righting was the TI duration. Heterophil/lymphocyte (H/L) ratio was measured in 1 experiment before and after TI. Heart rate were measured in 2 of the experiments during TI. In 2 experiments no differences in TI were found (exp 1: H line 544 ± 109 s vs L line 596 ± 83 s; P=0.947, exp 3: H line 271 ± 60 s vs L line 190 ± 60 s; P=0.489). In 2 other experiments highly significant differences between the lines were found (exp 2: H line 760 ± 111 s vs L line 1054 ± 106 s; P=0.007, exp 4: H line 141 ± 26 s vs L line 378 ± 106 s; P=0.011). Meta-analysis showed that significantly more birds selected for low antibody response to SRBC (L line) showed long TI duration as opposed to birds from the high antibody producing (H) line (P<0.05). Heart rates during the first min after TI induction were found to be significantly different between the lines (exp 1: H line 341 ± 18 bpm (beats per minute) vs L line 393 ± 8 bpm; P=0.016, exp 2: H line 362 ± 11 bpm vs 389 ± 5 bpm, Duncan, alpha=0.05). Although an increase in H/L ratio overall indicated that during TI the animal was stressed (P=0.030), no differences in H/L ratios in the blood between the lines were found (P=0.307). The present results suggest that divergent selection for either enhanced or decreased humoral responsiveness to SRBC affected fear responsiveness of chickens. Failure (exp 1 and 3) or success (exp 2 and 4) in finding line differences in TI may be caused by different experimenters, suggesting that humans differ in inducing fear responses in chicken. Overall, higher fear responsiveness was found in birds selected for decreased immune responsiveness.

The spacing behaviour of mares in Hokkaido native horses kept outdoors all year around

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Previous observations have been conducted on spacing behaviour of suckling foals and their dams of Hokkaido native horses on grazing pasture. It was observed that foals were frequently observed near their dams and that this spatial distribution was significantly different from the dam-dam distributions up to 4 to 5 mo of age. These specific spatial patterns of foals and dams were affected by the gender of the foal, with the spatial relationship disappearing earlier in male foal-dam relationships.

In this study, spacing behaviour of adult female horses was studied in 2 experiments. In Experiment 1, the spacing behaviour of 4 female horses (born in 1986, 1987, 1990 and 1991) were observed during the day (0600-1800 h) once a mo from June to November on 4.8 ha of grazing pasture with other female horses. In Experiment 2, three female horses (born in 1977, 1987 and 1987) were observed during 4 h periods during daytime on grazing pasture in summer, woodland in winter, snow-covered woodland in winter and on open dry lot fed hay with other horses. As a measurement of spacing, the distance from each focal animal to the nearest neighbour was estimated by eye-determination using their body-length as a unit and estimates were taken at 15 min intervals in each observation period. Results were analyzed by the Kolmogorov-Smirnov test.

On grazing pasture (Experiment 1), there seemed to be no seasonal variation in spacing behaviour, and 65-87% of the observed distances between horses were within 3 units of body-length. Furthermore, 85-98% of the observed distances were within 5 units of body-length. Spacing behaviour differed between the resting and grazing phase, with horses more dispersed when grazing than when resting.

On pasture, woodland and dry lot (Experiment 2), spacing behaviour of focal horses at rest was similar. Focal horses were more frequently observed within 1 body length distance when eating hay in the open dry lot than in other grazing situations ($P<0.05$).

While spacing behaviour between mares and their foals changed during through the suckling period, the spacing among adults on pasture did not change over the same period. Spacing behaviour was divided into 2 categories i.e. the grazing-eating phase and resting phase, although spacing behaviour in resting phase was similar when on a grass pasture, woodland pasture and dry lot throughout the year.

Response surface model to analyze the behaviour of broilers subjected to feeder space and feed ration restrictions

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Insufficient feeder space and restriction of feed ration can negatively affect the wellbeing of livestock. Social competition may cause increases in aggression and injuries and decreases in flock and herd uniformity. This study employed 3 week-old male broilers as a model to determine the effects of decreased feed availability on agonistic behaviour during feeding, demand for access to the feeder, and weight gain. Various levels of feed restriction and feeder space were assigned to 12 groups of 30 chickens (n=360, r=2) over a period of 3 weeks. Feed rations varied from *ad libitum* to 60% of *ad libitum* while feeder space varied from allowing 35% to 100% of birds to access the feeder simultaneously. The response surface design implemented in this study generated three-dimensional images of the treatment effects to determine maximal and minimal combinations.

Feeder space and feed ration significantly affected both agonistic behaviour and the number of birds that would attempt to access the feeder. Birds fed *ad libitum* had the lowest aggression ($P<0.01$) and the lowest degree of competition for feeder space ($P<0.01$). The highest rates of aggression were found in the groups with the most severe space restrictions ($P<0.05$). The number of birds attempting to access the feeder increased as both feeder space increased ($P<0.05$) and feed ration decreased ($P<0.05$). Finally, decreases in feeder space correlated with decreased uniformity within feed restricted groups ($P<0.05$). Groups given feed rations of 94.14% of *ad libitum* and feeder space restricted to 44% produced individuals that were heavier than *ad libitum* fed birds ($P<0.05$), while similarly rationed birds with 90% of full feeder space did not. This finding indicates that competitive, dominant birds can exceed *ad libitum* feed intake during periods of severe resource restriction. Adequate feeder space must therefore be provided during periods of feed restriction to minimize agonistic behaviour and maintain flock uniformity.

Branding in foals: Effects on β-endorphin, cortisol and heart rate

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Branding of foals is a procedure routinely used in many countries to permanently identify horses. As alternative methods, such as using implantable microchips, have been developed and tested in recent years, there is an increasing public debate on whether branding should be banned for welfare reasons. The aim of the current study was to measure some physiological responses to branding in comparison to hoof trimming.

Twenty foals, aged between 2 and 7 mo were allotted to 3 treatments: A, control animals, subjected only to sample collection (n=6); B, foals subjected to branding and to hoof trimming 1 week later (n=7); and C, foals subjected to hoof trimming and to branding 1 week later (n=7). Heart rate was recorded continuously using Polar Sport Tester devices. Blood samples were collected on the 2 experimental days before treatment as well as 15 min, 60 min and 120 min post manipulation. Control animals were sampled at the same time intervals. β-endorphin and cortisol concentrations were determined in plasma by radioimmuno assay.

Comparing basal samples and samples taken 15 min after manipulation, cortisol concentrations showed little change (103, 126 and 156% for controls, hoof trimming and branding, respectively), while β-endorphin increased, particularly in response to branding (88, 179 and 372%, respectively). Mean heart rate, recorded from 5 min before to 5 min after starting the manipulation, increased to 115% after branding and to 171% after hoof trimming. However, none of these differences between treatments were significant (Kruskal-Wallis, P30.05).

Both, β-endorphin and cortisol concentrations after hoof trimming were significantly higher in the foals branded 1 week previously when compared to foals with no pre-treatment (Mann Whitney U-test, P=0.04 for β-endorphin and P=0.01 for cortisol). No such effect was found after branding in foals pre-treated by hoof trimming or among the controls.

Although, the acute stress response to branding was not different from that to other routine management procedures, the results reported here provide evidence for a long-term sensitisation of the foals' physiological response to subsequent management procedures.

What about us? Is there a future for the young Hamadryas baboons?

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The Hamadryas baboon group at the Antwerp zoo is characterized by a strong male-biased sex ratio among the young animals (11 males and 3 females). Since 3 males started to develop the first signs of a mantle, it is expected that before long they will try to establish their own harems. Because there are already 2 harems and because of the limited space and the small number of females, this would definitely cause a lot of (probably severe) aggression. In order to avoid such aggression, it is therefore important to consider all possible management strategies and their probable consequences. A detailed questionnaire was sent to about 50 zoos and institutes (in Europe, northern Africa and the Near East) that kept Hamadryas baboons in captivity. The questions considered colony structure, housing conditions, management interventions (removal of surplus animals, castration, sterilization, introduction of new animals, etc) and their evaluation of the practices on such aspects as aggression level and social organization.

Based on the responses to the questionnaire, we will try to evaluate all possible management strategies and choose the best solution for our colony. Although the aim of this project is to improve the situation of the Antwerp hamadryas baboons, the results may be useful for other captive colonies as well.

Genetic and parity effects on the behaviour of ewes at lambing in extensive areas

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Extensive rearing conditions lead to a decrease in contact between caretaker and animal. These few contacts are often limited to invasive acts, giving rise to stress reactions in the animal. In addition limited human contact means the animals are more autonomous and have to present more adaptive abilities. Breed and experience are known to influence adaptation and stress reactions that may be responsible for troubles in social behaviours, such as maternal bonding, that may have harmful consequences for breeding. Genetic and parity effects on maternal behaviour was studied in ewes reared under extensive areas. Four genotypes were used: Lacaune (n=31), Romanov (n=28) and crossbreeds RxL (n=24) and LxR (n=23). As all Romanov ewes were multiparous, they were excluded from the analysis on parity. For this reason, only multiparous ewes (n=66) were used for genotype analysis. The behaviour of ewes towards their offspring and a human was recorded at lambing. Genotype effects were found in relationship with the reactivity to human beings. For ewes that lambed during daytime, only 3 of 11 LxR lambed in areas frequently visited by a human compared to 10 of 12 RxL (χ^2=7.34; *P*=0.01) and 1 of 12 Lacaune escaped when a human approached compared to 5 of 9 LxR (χ^2=5.62; *P*=0.02). Reactivity to a human depended also on parity. For ewes that lambed during daytime, primiparous ewes escaped more than multiparous ewes in response to an approach by a human after parturition (16 of 29 vs 8 of 27; χ^2=3.72; *P*=0.05). When the lambs were moved by the human, multiparous ewes followed their offspring better than primiparous ewes (22 of 27 vs 4 of 29, χ^2=26.3; *P*=0.001). Therefore, genotype differences occurred concerning the selection of lambing spots, which might be due to a difference in reactivity: LxR crossbreed might try to avoid contact with humans. When a disturbance was invoked by the human presence, the parity was important since primiparous ewes expressed a lower attachment to their neonates than multiparous ewes.

Occurrence of cross-sucking in group housing system for lactating sows

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Group housing systems for lactating sows with piglets enable the animals to behave more naturally than traditional restrictive systems. However, piglets can occasionally suck alien mothers. The goals of this study were to investigate which litters were affected by sucking alien piglets and examine the relationship between cross-sucking and the absence of a sows own piglets at nursings.

The observations were carried out in 6 groups of 3 or 4 unrelated sows with their piglets at the age of 19 to 32 days post-partum. We chose groups with small variability of litter age.

The data were analysed with the help of the SAS GLM procedure. We used the subsequent model: number of alien piglets present at the nursing = group identity, group size, litter size of the nursing sow, age of piglets, parity number of the nursing sow. Two further dependent variables (percent of own piglets present at the nursing, percent of own piglets absent) were analysed using the same model. The presence of a sows own piglets was negatively related to her litter size (P=0.0001). Piglets from older litters were more frequently present at their own mother's nursings (P=0.0091). Suckings of older litters were less frequently attended by alien piglets than those of younger litters ($0.1>P>0.05$). The number of alien piglets present at the nursing was positively related to the proportion of own piglets absent (P=0.0423). Piglets from groups of 4 sows missed their own mother's nursing more frequently than piglets from groups of 3 sows (P=0.0002). Piglets showed 4 different sucking strategies. Out of the 207 piglets, 123 sucked only their own mother. Forty six piglets sucked their own mother and occasionally 1 or more alien sows, 21 piglets sucked solely 1 alien sow and 11 sucked 2 or 3 alien sows.

In conclusion, the occurrence of cross-sucking in group housing systems apparently may be affected by the size and age of the sow's litter. Alien piglets sucked more frequently at the suckings of younger litters. Piglets from bigger litters often missed their own mother's nursings and alien piglets took advantage of their absence for cross-sucking.

The 'Human Approach Test' - a test of fearfulness or investigatory behaviour?

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The 'Human Approach Test' has been used to assess the fear responses of animals to humans. This experiment aimed to determine the responses of 71 Large White x Landrace gilts to a standard approach test followed by a test in which the experimenter approached the pig. At testing, each group of 3-5 gilts was moved to a handling area. Here, each gilt in turn was fitted with a heart rate monitor and moved to a 2.4 x 2.4 m test arena. After 2 min acclimatisation, an unfamiliar experimenter entered the pen and stood for 3 min against 1 wall. After this, the experimenter approached the gilt and touched her on the snout. Behaviour and heart rate were recorded continuously. Although all animals were from the same source and were similar in terms of genotype and exposure to human contact, there was wide variability in approach behaviour. Five gilts did not approach within 0.5 m of the experimenter and a further 13 gilts approached but did not make contact. The median time to approach was 13.6 s. The gilts were arbitrarily divided into 2 groups on the basis of this median value and their behaviour and physiology compared. Quick-approaching gilts spent more time within 0.5 m of the experimenter ($P<0.001$), made contact more quickly ($P<0.001$), had more interactions with the experimenter ($P<0.001$) and performed more locomotory behaviour during acclimatisation ($P<0.05$) and the experimental period ($P<0.001$) than slow-approaching gilts. One interpretation is that gilts which showed more avoidance and immobility in the presence of humans were more fearful. However, there were no significant differences between quick and slow-approaching gilts in heart rate responses to the experimenter entering the pen or to the experimenter's approach. In addition, quick-approaching gilts performed more short vocalisations ($P<0.05$) which may be associated with investigation. In the standard approach test, the human behaves atypically and the animal has control of whether or not to interact. In our second test, the human behaves in a more usual manner and the animal loses control over the interaction. Therefore, the standard approach test may determine the motivation to investigate rather than fearfulness of humans.

Vocalisations of the adult domestic pig during a standard human approach test

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Vocal communication in the domestic pig is generally not well-documented. This experiment aimed to categorise the vocalisations of 67 Large White x Landrace gilts during a standard approach test. At testing, each group of 3-5 gilts was moved to a handling area where each individual in turn was fitted with a heart rate monitor and introduced individually to a 2.4 m x 2.4 m test arena. After 2 min acclimatisation, an unfamiliar experimenter entered the pen and stood for 3 min against one wall. Behaviour and sound were recorded continuously with sound recordings transferred onto computer for analysis. Three categories of calls were initially identified: single grunts; squeals; rapid repeated grunts. All gilts performed single grunts, whereas the other 2 categories were performed by only 28 and 16 gilts, respectively. All single grunts were analysed (n=2112) and these were sub-divided into 2 types based on amplitude structure. These types differed in duration (292 ms vs 883 ms, $P<0.001$). Gilts performed more short and long grunts during the 3 min test compared with acclimatisation ($P<0.001$ in both cases). The duration of short calls did not change with human presence. 74.8% were performed with the head lowered and the rate of short vocalisations during the test period correlated with the time taken to make contact with the experimenter (r=0.30, $P<0.01$), the amount of locomotory behaviour carried out (r=0.25, $P<0.05$), the total number of interactions with the experimenter (r=0.48, $P<0.001$) and the total time spent within 0.5 m of the experimenter (r=0.35, $P<0.01$). The duration of long calls increased with human presence (813 ms vs 898 ms, $P<0.01$). 73.6% were performed with the head raised and the rate of long vocalisations during the test period correlated with amount of locomotory behaviour (r=0.50, $P<0.001$) and heart rate, with the effect of activity removed, (r=0.49, $P<0.001$). The results indicate that the domestic pig performs a number of distinct vocalisations during isolation. Short single grunts appear to be clearly associated with investigation. Long single grunts may be a form of contact call, the rate of which is related to physiological and behavioural activity. With further research, certain pig vocalisations may be identified as providing useful additional information about an individual's welfare.

Heart rate as an indicator of adaptation to farming practices in Red deer calves

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Behavioural observations were carried out once a week for 15 weeks (3 five-week periods, at 1 week interval between periods) on 54 female red deer calves (4-8 mo of age) housed in group pens (9 deer/group) in a shed, immediately after weaning. During each observation session, all aggressive interactions were recorded continuously for 4 h and heart rate (HR) was monitored at 15 s intervals; at the same time, environmental cues such as presence of people in the pen or in the shed and noise inside or outside the shed were also recorded. Mean HR values over the 4 h periods were analyzed using the Kruskal-Wallis test in order to detect period effects. As 60-90 bpm is considered a normal value for deer resting quietly in pen, HR peaks above 90 bpm were considered "abnormal" and were therefore counted and associated with the calves' behaviour and environmental cues. HR was significantly higher in the first period (mean 68.4 bpm) than in the other 2 periods (mean 49.8 and 49.5 bpm in the second and third periods, respectively; $P<0.001$). This might be due to seasonal or age effects and/or habituation to housing. The percentage of HR peaks associated with human presence (in the pen or in the shed) decreased from the first to the other 2 periods (first period: 33.8%; second period: 18.9%; third period: 18.5%; χ^2 test: $P<0.001$) and this might be interpreted as a further evidence of the progressive adaptation of deer to the contact with man. As the percentage of HR peaks due to human presence decreased, the number of peaks due to interactions between animals increased (first period: 1.2%; second period: 10.4%; third period: 17.2%; χ^2 test: $P<0.001$). This increase in peaks associated with animal interactions was related to an increase in the level of aggression. The number of aggressive interactions (per group, per h) significantly increased from the first (19.48) to the second (21.93) and third periods (26.95; Kruskal-Wallis test: $P<0.05$).

Development of a semi-feral pony herd as a model for study of equid physiology and behaviour

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Since 1994 our laboratory has been developing a semi-feral pony herd for the study of physiology and behaviour of equids on-site at our southeastern Pennsylvania clinical, teaching, and research facility. Initially, 26 mixed-breed Shetland-sized pony stallions (n=16) and mares (n=10) were enclosed together in a 20 acre system of interconnected pastures. The ponies immediately exhibited harem social organization and behaviour described for free-running feral and wild horses. The site includes meadows with patchy light forest and a stream traversing diagonally. Natural vegetation supports the herd from early spring through late autumn. During winter, grass hay is hand-distributed daily to each social group. Human-animal contact is limited to that necessary for research measures, health care, and reasonable acclimation to human observers. The ponies remain remarkably disease and injury-free compared to traditional horse management systems. The particular terrain allows for detailed observation from outside and within the enclosure with minimal disturbance of the herd. Most animals remain approachable on foot for blood sampling, physical measures, and health care with minimal restraint or disturbance. Catch-pen feeding stations are used as back-up to ensure non-traumatic interaction with less approachable animals. Since initial stocking of the herd, several ponies have been added or removed, and foals have been born. The population now includes approximately 50 ponies, with the enclosure expanded to approximately 25 acres.

There are distinct advantages of such an on-site model herd. The most important is continuous accessibility for study. Also, the domestic stock is easily maintained as feral, yet approachable for observation and semi-invasive measures. The herd can also be manipulated to test hypotheses. The herd has attracted positive interest of the scientific and veterinary communities, the equine industry, and the local public. It has provided unique educational opportunities for veterinary and graduate students, local high school students and equine groups. A significant disadvantage is that semi-feral management varies in several aspects from truly feral or wild conditions, and interpretations are accordingly limited.

Acknowledgment
This is a Dorothy Russell Havemeyer Foundation Project conducted at the Georgia and Philip Hofmann Center for Animal Reproduction Research with partial support from NIH-K04-NS01537.

Behaviour of feedlot cattle in a commercial environment

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A total of 1,202 steers in 8 pens were observed for 24 h periods during warm weather to quantify their behaviour. Live observations were collected from a platform that was about 4 m above the ground. Night vision scopes were used to record nocturnal behaviour, thus avoiding the use of artificial lights that might disturb behaviour. Cattle fed mostly in the morning and did not feed after sundown, even though the air temperature exceeded 37° C during the day. Steers spent less time walking as days on feed progressed ($Y=2.4102-0.008629x$, $R^2=0.46$; $P<0.05$). Most morning activity was feeding behaviour and evening activities were primarily social and aggressive behaviours. Buller behaviour increased in the evening along with agonistic and other social behaviours ($P<0.05$). Under typical feedlot management practices, cattle being mounted (not the ones riding other steers) are removed from their pens and placed in a "bulling pen". It is thought by feedlot managers that this reduces the behaviour. The rate of bulling was 7 fold higher in the bulling pen than other pens (1.17 vs 0.16% for the buller pen vs control pens, respectively; $P<0.05$) A regression analysis was calculated with distance from the buller pen used to predict rate of bulling. The pen nearest the bulling pen had a greater ($P<0.05$) rate of bulling than pens further away. A relationship between agonistic behaviour and bulling behaviour was also observed ($r=0.49$; $P<0.0001$) indicating that pens of steers showing more bulling behaviour showed more agonistic behaviours (butting, pushing). These data provide the first undisturbed 24 h summary of commercial cattle behaviour in this region and support the idea that buller behaviour is primarily a form of agonistic behaviour.

Studying of macaque behaviour during formation of multi-male groups

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Group fission, the introduction of new breeders and other manipulations of the composition and structure of groups are of great importance and ensure successful breeding of monkeys in captivity. The evolutionary function of group fission (sociotomy) and the transfer of members of groups under free-ranging conditions, e.g. when the group reaches critical size, have been elaborated. On the one hand this process assures the necessary level of gene exchange in the population, and, on the other hand, provides a smooth, “bloodless” way of reducing social strain. The natural mechanisms that regulate group composition completely disappear in captivity due to the limitation of space. Our investigation was aimed at developing an optimal strategy of substituting male breeders into multi-male macaque groups. Taking into consideration the possibility of severe aggression among animals, 3 techniques were tested:

1. Newly introduced males which had never had contact with each other before.
2. Newly introduced males which had lived in the same cage or compound before introduction.
3. Newly introduced males which were close relatives and were acquainted with each other.

It was found that inter-male aggression was minimal during the 2 mo after their introduction, in those groups where males were relatives. There was a significant difference between relatives groups compared to both the males just acquainted with each other and strangers. The number of affiliative behaviours and interactions between males was also significantly higher among male relatives than in the 2 other groups.

Extreme aggression in male broiler breeder fowl

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Concerns have been raised by the broiler breeder industry regarding increased levels of aggression in males of certain strains. Males have been reported to savage and even kill females. Our previous work indicated that broiler breeder males were deficient in courtship behaviour and forced copulations more frequently than did commercial laying strain males. To investigate the problem of high levels of aggression, a 3 x 2 factorial was used to compare males of 3 genetic strains (2 broiler breeder lines and 1 commercial laying strain) at 2 feeding levels (restricted and *ad libitum*) during the breeding phase. All birds were reared according to the management guidelines for each strain. At 22 weeks of age, 12 pairs of males per strain were each penned with 20 females of a broiler breeder strain. Behaviour was sampled from each pen for 6 ten min periods at weeks 25, 27, 29, 33 and 37.

Results indicated that broiler breeder males performed significantly more aggressive behaviour than did laying strains males ($P<0.0001$). As behaviour was not found to change significantly over time, data was pooled across age. Mean incidences of aggressive behaviour directed at males per 10 min period were 0.24 n 0.03 (SE), 0.52 n 0.06 and 0.49 n 0.05 for the laying strain and broiler breeder strains A and B, respectively. Full fed males were significantly more aggressive toward males than were restricted males ($P<0.0001$). Broiler breeder males showed more aggressive pecking directed at females than did laying strain males, with mean incidences per 10 min period of 0.09 ± 0.02, 0.85 ± 0.12 and 0.53 ± 0.06 for the laying strain and broiler breeder strains A and B respectively ($P<0.0001$).

From this study, broiler breeder males were found to be more aggressive toward males and extremely aggressive toward females when compared with commercial laying strain males. Full fed males were the most aggressive. Few significant differences were found between the 2 broiler breeder strains.

Resting, social and eating behaviour in heifers kept in small homogeneous or large heterogeneous groups in a deep bedding system

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This experiment investigated the effects of behaviour of the interactions between heifer weight and housing in a small homogeneous versus a large heterogeneous group in a deep bedding system. The behaviour of 120 Danish Friesian heifers at 6 commercial dairy farms was studied. Three farms fed silage *ad libitum* and 3 farms fed ammonium-treated straw *ad libitum* supplemented with concentrates fed restrictively. At each farm, 20 heifers were split into 10 light and 10 heavy heifers according to live weight ("light", average weight of 200 kg (s.d. of 39 kg) and "heavy", average weight of 315 kg (s.d. 41 kg)). At each farm, 3 groups were formed: One large heterogeneous group which included 5 light and 5 heavy heifers and 2 small homogeneous groups which included either 5 light or 5 heavy heifers.

The behaviour and position of the individual heifers were recorded at 5 min intervals during 24 h using direct observations at the end of the experimental period. The effects of group homogeneity within heifer weight and feeding systems on resting, social and eating behaviour were tested.

When heifers were fed silage, light heifers had fewer lying periods (P=0.04), but had the same lying and eating times in the heterogeneous group than in homogeneous groups. Heavy heifers had less lying time (P=0.03), more total eating time (P=0.04) and more aggression (butting and forcing to stand up P=0.004) in the heterogeneous group than in the homogeneous groups. Resting behaviour was less synchronised in the heterogeneous group than in homogeneous groups (P=0.09). When heifers were fed straw supplemented with concentrates, light heifers spent less time eating concentrates (P=0.01), had less lying periods (P=0.03) but the same lying time in the heterogeneous group compared to homogeneous groups. Heavy heifers spent more time eating concentrates (P=0.10), but less time eating in total (P=0.06), had more lying time (P=0.0001), less aggression (butting P=0.12) and less abnormal behaviour (barbiting P=0.01) in the heterogeneous group than in the homogeneous groups. Synchronisation of the resting behaviour was not affected in the heterogeneous group. The welfare of light heifers seems to be adversely affected by housing in a large heterogeneous group compared to a small homogeneous group. Contrary to expectation, this negative effect could not be diminished by offering mixed ration *ad libitum* to the heifers.

Dogs' disturbed behaviour and behaviour therapy: dog, owner and environment effects

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Many authors have studied disturbed behaviour in dogs, which may be related to individual traits and/or to environmental variables. The aim of this research was to study the relationships between characteristics of dogs, their owners and their environment and disturbed behaviour and behaviour therapy of these dogs.

One hundred and eighty dogs were studied. A questionnaire was constructed to gain a complete case history from owners on each subject. Answers, according to an ordinal scale, were obtained on the dogs' behaviour traits and their environment.

The subjects' traits were as follows: mainly male dogs (70%), with an age range of 2 - 6 months (26.1%), 1 - 2 years (23.3%) and 2 - 5 years (34.4%). The dog was the only animal living in the household in 73% of cases, and had been taken as a pet or a guard dog from a breeder or pet shop. The owner's family included more than 2 people in 68.9% of cases. Most of the dogs had not been trained (84.4%), while the others had been trained in courses (11.2%) or left at a training school (3.9%).

The main disturbed behaviour complaints by the owners were: aggression (51.7%), disobedience/hyperactivity (21.7%), fear-separation anxiety (15.6%), housebreaking/ elimination problems (5.6%), stereotypies (4.4%) and sexual abnormal behaviour (0.6%). Principal Component Analysis (16 variables) on the dogs' disturbed behaviours resulted in 3 main components (38% Cumulative Variance): 1) dominance/submission; 2) shyness/fear; and 3) obedience/disobedience and hyperactivity. Age and sex of the dog and reason for acquisition were more related to disturbed behaviours than breed and training. Regression analysis showed that the dog's age and the behavioural complaint are good predictors of disturbed behaviour (R^2=0.93). Behaviour Therapy was more successful in younger animals, mainly less than 2 years old.

The results of this study show that a detailed case history together with good cooperation with the owner can be a good aid in identifying and treating disturbed behaviour of dogs.

The effect of two training strategies on learning efficiency of beef steers to operate the Calan gate feeding system

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The Calan Gate feeding system offers an effective method to obtain individual feed intake data from group-housed steers. A total of 24 Charolais steers with an initial average weight of 250 kg were used to study their behaviour when subjected to 1 of 2 reward training strategies: A - indiscriminate reward training (all feeder gates open for 3 days) followed by discriminate reward training (all feeder gates closed for 3 days and each steer can open only its own specific gate) and B - Indiscriminate reward training (all feeder gates open for 3 days) followed by a modified indiscriminate reward training period (all feeder gates closed for 3 days but each steer can enter any feeder) followed by discriminate reward training (all feeder gates closed for 3 days and each steer can open only its own specific gate). The A schedule is referred to as a 2-stage strategy and B a 3-stage strategy. Observations via time-lapse video recording were made during the first, third and fifth days after the initiation of discriminate reward training. Recordings were collected on each steer and analyzed on a pen basis for frequency of eating/day, number of feeders entered, average length of each eating bout, total eating time/day and time to successfully complete training. Each pen group of 6 steers served as the experimental unit. Data obtained were subjected to regular analysis of variance. The analyses of the video recordings indicated no significant differences for the effect of training strategy on the recorded variables. For practical purposes, the simpler training strategy (A) would be preferred to reduce the total time to complete training. Distinct signs of an approach-avoidance conflict behaviour was observed with 4 steers during the training period. This behaviour was characterized by orienting the body towards the feeder, indicating motivation to eat, but avoiding close approach to the feeding gate and exhibiting displaced grooming.

Relation between teat order and food competition behaviour in pigs

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There is a growing interest in the possible existence of consistent individual differences in behavioural responses of pigs. It would be very beneficial for the breeder if sows, which are not able to cope with the demands of modern husbandry, could be debarred from reproduction early in life. In order to investigate the consistency in social behaviour in sows, the teat order (TO) of 4906 two week old female piglets of 5 synthetic lines was determined. At 6 weeks and at 7 months, the animals were selected independently by specialists of the pig-selection farm. The selection criteria were general development, body conformation, backfat thickness, and body weight. In this way 197 gilts were selected as breeding pigs.

These gilts were housed in groups of up to 8 animals. In a food competition test, a small quantity of food was dropped in a corner of the trough. During a 6 min period it was noted which animals could displace others and which ones were displaced. This food competition test was started 1 week after grouping and repeated twice a week during 2 weeks. A dominance index (DI) was calculated for each individual: i.e. the ratio of the number of interactions won and the total number of interactions of each individual, multiplied by 100.

The frequency distributions of the TO of the selected and the non-selected piglets were not significantly different (χ^2, P=0.44). TO apparently hasn't a predictive value for the selection chances of the piglet. The regression between DI and TO was calculated in a model without intercept. Determination coefficients varied between 0.43 and 0.58 (P<0.0001).

Hence, based on these calculations we can conclude that 50% of the variation in dominance index is explained by teat order. Further analysis and other methods to calculate DI will elucidate if this linear relationship has a biological meaning.

Acknowledgments: F. Mulkens is financially supported by the IWT (Brussels) and R. Geers is a research director of the FWO (Belgium)

Reductionism versus holism in assessing the welfare of lambs in transit

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Little data exists that describes the structure of the journeys taken by lambs from farm to slaughter. Data from a survey of livestock markets, electronic auctions and abattoirs will be presented which illustrate the diversity and complexity of journey structures that lambs experience.

Although there is a considerable body of published evidence detailing the impact of different elements of the journey on lamb welfare, little work has been published that examines the effect of journey complexity itself. Whilst it is essential to understand the welfare implications of the individual elements of a journey, reliance on a reductionist approach does not allow the full welfare assessment of the various livestock distribution systems as a whole. In the light of the survey results, there is a need to incorporate a consideration of journey structure into any assessment of livestock welfare in transit. The objective of this paper is to present a synthesis of evidence in relation to lambs and to highlight the deficiency of the reductionist approach in assessing the welfare of lambs during their journey from farm to slaughter. This will demonstrate very clearly the need to adopt an holistic approach to the study of lamb welfare in transit.

A study on the ecology and ethology of the wild boar (*Sus scrofa*)

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The wild boar, *Sus scrofa* is one of the most destructive vertebrate pests of agriculture in the high ranges of Kerala, India. Feeding behaviour, food preferences and activity pattern of the wild boar were studied in Periyar Tiger Reserve, India.

Despite their nocturnal habits, 2 major feeding peaks, 1 in the predawn hours and the other, late in the evening were noticed. Olfaction is the major sense used during foraging and the wild boar is an omnivore. The major food item consisted of tubers of the grass *Panicum repens*, but they also feed on other grasses and roots. While it is the root of *Panicum repens* that the boar eats, they preferred the grains of *Dinebra retroflexa*. When the small grains became brown in colour they licked it off, leaving behind the stack.

They spent most of their time digging in wet areas where they, obtained plenty of earthworms. Their feeding behaviour consisted of digging the ground, lifting the mud on their snout, tossing it on to one side and feeding on organic materials in the soil. They ploughed the area during foraging activities, usually digging to a depth of 15 to 25 cm. They also fed on carcasses and left overs of wild dog kills. During the dry months when the marshy areas were dry, they shifted their feeding grounds to the lake shore where it was wet.

The common plants and grasses observed in stomach contents were: 1. *Dinebra retroflexa*, 2. *Panicum repens*, 3. *Cynadon dactylon*, 4. *Panicum maximum*, 5. *Manisurius granularis*, 6. *Cyrtococcum oxyphyllum* and 7. *Pasaplum compactum* and 8. *Cynadon dactylon*. Parts of the following 6 species were recorded in the scats during dry season: 1 *Dinebra retroflexa*, 2. *Panicum repens*, 3. *Eragrostis* sp., 4. *Penneisetum hohenackeri*, 5. *Eleusine indica* and 6. *Pasaplum compactum*. The following 11 species were observed in the wet season: 1. *Panicum repens*, 2. *Themeda triandra*, 3. *Helecteres isova*, 4. *Eragrostis* sp., 5. *Oplismenus compositus*, 6. *Urena lobata*, 7. *Cyanodon dactylon*, 8. *Kyllinga monocephala*, 9. *Apluda aristata*, 10. *Digitaria sanguinalis* and 11. *Pernisetun hohenackeri*.

Agricultural crop raided by wild boars was observed in all seasons in human settlements near forests. They destroy tapioca and other tuber crops, paddy, plantain and pineapple. In the absence of protection, the rate of destruction increased to 56% of the standing crop of tapioca, 18.09% of plantain and up to 82% of pineapple, whereas solar powered fencing reduced the level of destruction to about 10%. Trenches with vertical sides were also found to be effective in controlling crop raids by the wild boar.

The welfare implications of social isolation among laboratory rats

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Experimental protocols often require that animals are housed singly. We examined whether social contact with neighbours altered the consequences of single housing for the behaviour and pathophysiology of rats. Male and female rats were examined in separate replicates. Each replicate used 144 rats housed either as singletons or in groups of 3 in units of 2 cages. Units were divided by different types of barrier (steel sheet, clear Perspex, perforated clear Perspex, cage mesh) that allowed different degrees of social contact across the barrier. Singletons were established either with another singleton or with a group of 3 rats on the other side of the barrier.

The data were analysed for each sex using appropriate parametric and non-parametric analyses of variance and regression. Singletons spent more time than grouped rats in behaviours apparently related to escape attempts (males $P<0.005$, females $P<0.01$), directing attention outside the cage (both sexes $P<0.001$, however females spent considerably more time than males in this behaviour) and tail chasing (males $P<0.001$, females $P<0.05$). Males which had more exposure to neighbours through a barrier when housed singly were less aggressive when introduced into an unfamiliar group ($P<0.05$), suggesting that a degree of social contact (separation but not isolation) may have welfare benefits depending on procedures. Lower corticosterone concentration (males only, $P<0.05$) and pathology scores (heart (males only) $P<0.05$ and thymus (both sexes) $P<0.05$) in singletons compared to grouped rats suggest that separation may remove social stress. Responses to contact with neighbours and correlations between behaviours and organ pathology do, however, suggest that rats actively seek social interaction. Sex specific behavioural and physiological responses are interpreted in the context of how naturally selected responses have designed them to respond to situations and how these responses may be compromised by laboratory housing.

Effects of genotype, feed, and parity on the time budget of dairy cows

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Observations were carried out on 4 days to determine the time budgets of 16 Holstein Friesian heifers (n=8) and cows (n=8). The animals were of either high (S; selection, n=8) or U.K. average (C; control, n=8) genetic merit, and allocated equally to 1 of 2 complete mixed silage-based diets (H; 50%, and L; 25% concentrate inclusion). The studied animals were part of 2 groups of 60 dairy cows kept in loose-house, conventional cubicle pens and observed from feeding at approximately 0900 h until milking at approximately 1500 h using a 5 min time sampling technique. Data were analysed using REML in Genstat. All results are given as percentage of scans and no interactions were found between genetic line and diet. Time spent eating was significantly affected by diet (24.7 vs 35.9 for H vs L respectively; sed=3.41; $P<0.01$) and genetic line (27.4 vs 33.2 for C vs S respectively; sed=3.55; $P<0.05$). Animals offered the L diet also spent more time ruminating (25.0 vs 30.7; sed=3.20; $P<0.05$) and less time lying inactive compared to H animals (17.6 vs 9.2; sed=3.29; $P<0.01$). Animals of average genetic merit (C) spent less time standing than S (65.7 vs 75.6; sed=5.61; $P<0.05$). No differences were found between genetic lines in time spent ruminating, but S animals performed a higher proportion of their rumination while standing than C animals (0.56 vs 0.38; sed=0.10; $P<0.05$). These results reflect the different production levels of the animals with more eating and general activity in animals either of high milk yield potential or when given a fibrous diet. Heifers spent more time on comfort behaviours, such as grooming (3.9 vs 1.5; sed=0.65; $P<0.001$), and were observed in social interactions more frequently than cows (2.4 vs 0.7; sed=0.68; $P<0.01$). Out of 61 aggressive encounters recorded, 45 were initiated by heifers ($\chi^2=6.89$; $P<0.01$). The social activity of heifers may reflect the establishment of a hierarchy, as well as increased investigatory behaviour.

Adaptability of an acoustic emission sensing system for monitoring chewing behaviour of cattle

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Acoustic emission (AE) sensing systems are widely used to analyze the sounds induced by distortion or break of solid materials. The AE sensing could be adaptable to monitor chewing behaviour of cattle. The objectives of this study were (1) to select an inexpensive microphone sensor to be attached on a halter without imposing excessive stress on animal, and (2) to assess the adaptability of the AE sensing system which consists of sensors, a telemetry system, a digital audio tape (DAT) recorder and a fast fourier transform (FFT) Analyzer. First, we analyzed the frequency requirements of microphone sensors to detect the chewing sounds induced by 4 head of cattle. Chewing sounds of hay were recorded in front of tied cattle using the Finely Tuned Sound Level Sensor with a frequency range from 0 to 5 kHz. The sounds were transformed into a sound spectrogram by the FFT analyzer at 0.0078 s intervals after A/D conversion. The AE profile during chewing hay had 3 major peaks in the ranges 270-300 Hz, 850-950 Hz and 1160-1200 Hz. This result indicates the useability of ordinary and inexpensive microphone sensors covering the frequencies from 0 to 2 kHz to analyze the chewing sounds of cattle. We developed a halter combined with 2 microphone sensors (which are commercially available at low cost). Secondly, the new halter is now being tested under practical conditions. Chewing sounds are being recorded in a cow shed by the DAT recorder connected to the sensors and then being analyzed. The outcome of recording with the new halter is likely to be suitable for sound analysis, although full data are not presently ready for statistical analysis. This result indicates that the AE sensing system can be adaptable to monitor chewing behaviour of cattle especially at a short distance in the cow shed. Investigations are in progress for useability of this system for monitoring chewing behaviour of grazing cattle.

Ontogeny of perching behaviour in domestic chickens with and without a mother hen

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It is easy to imagine why perching behaviour has developed in fowl, but very little is known about when this behaviour is first seen during ontogeny and what the role of the mother hen is in the development of perching behaviour.

Danish Landrace hens, an original breed with an appearance very much like the Red Jungle Fowl, the wild ancestor of the domestic hen, were kept in outdoor pens and allowed to lay and incubate eggs naturally in a nestbox. On the day of hatching, the resulting 7 broods were split in 2 groups each. One group remained with the hen, while the other was transferred to a similar pen, with a heating plate in the nest box. Each pen was equipped with a standard rack with 3 horizontal perches placed 25, 50 and 75 cm above ground level. At 8 days of age, time lapse video recordings of the chicks' activities related to the perches were made during daytime.

The results show that the chicks start to use the perches at 8-12 days of age. Surprisingly, the groups without their mother were often the first to utilize the perches (1 group from 8 days of age, 2 groups from 9 days). In the groups with a mother hen, the hen was seen visiting the perches briefly when the chicks were 9 days old. One or 2 days later the chicks were seen to follow her up, at the earliest when they were 10 days old (2 groups). The first day the chicks were seen on the perches, they used them very little (0.5 - 1.5 visits/chick/day). From the second day, there was a marked increase in activity related to the perches, and at 12 days of age the chicks visited the perches at an average rate of 11.7 ± 3.6 (SEM) visits/day. When the chicks were 8-14 days old, the hens on average visited the perches 2.1 ± 0.5 times/day, while the chicks with their mother had 4.0 ± 1.4 visits/day and the chicks without their mother had 7.1 ± 2.0 visits/day. The results indicate that the development of perching behaviour to a high degree is guided by the hen, but when no hen is present, this behaviour seems to develop faster. It is suggested that the chicks' motivation to explore perches may be developed earlier when no mother hen is present.

Comparison of head movements between cows kept in the barn with a neck chain and a stanchion

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Tie stall barns and stanchion barns are the most common housing system for dairy herds up to about 80 cows. The cows in these barns are fastened or stanchioned for many hours with some restriction on behaviour and possible discomfort.

In this study, head movements were compared in milking cows kept in stall barns with a neck chain (comfort stalls; n=6 cows) and with a stanchion (n=11 cows). Head movements were measured for 24 h with accelerometers attached under the jaw for vertical and horizontal (right and left) movements. Movements registering less than 3 G were not recorded because of the high frequency of the movements and the difficulty in analyzing 'minor' movements.

A histogram showed that the number of recorded events decreased with increasing acceleration (power) in both vertical and horizontal movements. The average number of recorded events in the chained cows was 2.4 times more than the stanchioned cows. Chained cows moved their head more or less at anytime, while the stanchioned cows moved their head almost only during meals. A greater number of vertical compared to horizontal head movements was recorded in both types of stalls (Tie, 919 vs 223, $P<0.01$; Stanchion, 436 vs 31, $P<0.01$). The average percentage of horizontal movements was 18% in the chained cows, while the value was only 7% in the stanchioned cows. In the stanchion stalls, horizontal head movements seemed to synchronize with vertical head movements. However, it seemed to be more independent of vertical movements in the chained cows. Vertical and the horizontal head movements tended to be biased toward one direction in both stalls. The results suggest that the tie stalls permit greater head movements than the stanchion stalls.

Different kinds of roughage as additional rooting substrates for slaughter pigs

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Pigs perform rooting behaviour for a considerable part of the time in which they are active. In barren environments without rooting materials, pigs will often redirect their rooting behaviour as oral manipulation of equipment and penmates (Spoolder, Burbidge, Edwards, Simmins, and Lawrence, 1995). Provision of straw as a foraging substrate reduces the development of excessive chain and bar manipulation in food restricted sows (*Appl. Anim. Behav. Sci.*, 43: 249-262). To avoid this, straw is frequently applied as rooting material. In Denmark, however, organically raised slaughter pigs must have access to both straw and roughage. This rule has been imposed in order to give the pigs an additional rooting substrate besides straw.

In order to evaluate roughage as additional rooting substrate, the effect of 6 different kinds of roughage on the pigs' behaviour was examined.

Pairs of 11-week-old pigs (1 male and 1 female) were placed in specially designed pens. Each pen (of 4 m^2) contained a self-feeder, a water bowl, a box for roughage and a straw bedded area. There were 4 replicates, each consisting of 7 pairs of pigs (n=56). For each replicate, 7 pairs of pigs were offered either 1) silage of oats, vetch and lupine (OVL), 2) silage of barley and peas (BP), 3) silage of clover and grass (CG), 4) green meal (GM), 5) hay (H), 6) beets (B) and 7) no roughage (the control treatment) (CON). The pigs were allowed to habituate themselves to the pen and the roughage for 6 days, after which video recordings were made over 4 days. The video tapes were analysed for the time spent by the pigs on manipulating roughage, straw, concrete floor, penmate and equipment, respectively, as well as for posture and activity and for feeding and drinking behaviour. All analyses were made by means of the GLM-procedure (SAS).

The pigs spent most time manipulating the roughage in the early morning and in the afternoon. Compared to all other treatments in this investigation the pigs manipulated OVL most frequently (P=0.0001). If this roughage was omitted from the analysis, B were manipulated more than H and CON (P=0.015; P=0.028). B furthermore tended to be manipulated more than GM (P=0.077). BP tended to be manipulated more than H and CON (P<0.15). No other differences in manipulating roughage were found.

Time spent on manipulating each type of roughage (s/24 h) (mean (SE)).

OVL	BP	CG	GM	H	B	CON
1039.2	393.9	207.6	317.1	34.3	349.6	89.6
(137.2)	(146.6)	(137.1)	(136.3)	(137.1)	(137.3)	(147.6)

There were no effect of roughage on the postures and the activity of the pigs, neither no effects on the time the pigs were eating, drinking or manipulating straw and penmate were found. However, the pigs offered GM and CON manipulated equipment more than pigs offered B (P=0.016; P=0.017). Furthermore, there was a trend for pigs in these 2 treatments to manipulate equipment more than the pigs offered OVL (P=0.053; P=0.065) and H (P=0.073; P=0.107). Pigs offered GM manipulated concrete floor more than pigs in all the other treatments (P<0.05).

These results not only indicate that pigs will manipulate different kinds of roughage depending on the type of roughage offered. Also the extent by which the pigs will manipulate other elements in the pen will depend on the type of the roughage offered which again may be due to the characteristic (e.g. texture, smell and taste) of the roughage. Therefore, the type of roughage may be the decisive factor as to which extent the roughage will do as an enrichment of the environment.

Rearing and social stress in pigs: the effect of poor rearing conditions on reaction to social confrontation

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Rearing conditions affect behaviour later in life, and barren rearing conditions may lead to abnormal behaviour patterns and also reduce the ability to cope with stress. In previous experiments we have found that pigs reared under poor conditions (the commercially used standard farrowing crate) developed symptoms of chronic stress and showed more aggressive behaviour in the interactions with familiar individuals than pigs from enriched rearing conditions (group of free-ranging sows with piglets).

In the present experiment we studied pigs from "poor" (n=21) and "enriched" (n=11) rearing conditions in social confrontations, using the resident-intruder paradigm. This provides a method of studying social behaviour under more standardized conditions than in the group. The animals were confronted with each other in pairs of unfamiliar individuals, enriched vs enriched and poor vs poor. Half of the piglets were assigned "residents" and remained in their home pen in all confrontations, whereas half were "intruders" and were always introduced into the home pens of others. Wounds (number and severity) after confrontations were registered as well as aggression 1 day later. The outcome of confrontations ("winning" or "losing") was determined on the basis of wound scores.

In the group from the enriched rearing, residents won a higher percentage of confrontations than intruders did (100 ± 18.9 vs 0 ± 18.9; Mann-Whitney U-test; Z=2.95; $P<0.05$), whereas no such difference was seen in poorly reared animals (50 ± 27.9 vs 50 ± 27.9; M-W; Z=0.5435). Similarly, in the enriched group, residents showed more aggressive behaviour than intruders (frequency 9.2 ± 2.2 vs 1 ± 1.5; M-W; Z=2.74; $P<0.01$), whereas in the poor group residents and intruders did not differ (6.2 ± 2.85 vs 5.150 ± 2.86; M-W; Z=0.8114). Pigs from poor rearing caused more wounds on their opponents than pigs from enriched rearing (1.50 ± 0.24 vs 0.75 ± 0.28; M-W; Z=2.05; $P<0.05$).

Thus, in a resident-intruder situation there is a clear difference in terms of aggressive behaviour between residents and intruders from enriched rearing, whereas no such difference can be seen in poorly reared animals. Furthermore pigs from poor rearing conditions inflict more wounds on each other. We suggest that this indicates a difficulty in establishing a dominance relationship in poorly reared pigs.

Reproductive success and periparturient behaviour in farmed blue foxes (*Alopex lagopus*)

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This study aimed at providing basic data for the different components of reproductive performance of blue foxes under farm conditions. Reproduction was studied during 4 subsequent years by inspecting the nest boxes for the number of liveborn and stillborn cubs, abnormalities at parturition, cub mortality and infanticide (n=2413 vixens, 22,941 cubs). Abnormal birth and abortion of a part of a litter contributed most to cub losses. Infanticide played a minimal role as a cause of postnatal cub mortality (0.3%). Only in a very few cases was the whole litter lost (1.3%), but there were some cub losses in almost one half of the litters (47%). Postnatal mortality (Y, % of total deaths) decreased with age of the cub (X, days) and can be described by a simple equation: $Y=15.3 - 11.2 \log X$, $R^2=0.933$. The litter size was smaller and cub losses were higher for primiparous vixens than for multiparous vixens, while no significant differences were found between age classes 2 to 5. The age of the father had no effect on litter size or cub mortality.

Periparturient behaviour of vixens was video-recorded inside the breeding box. Vixens were more active inside the box the day prior to parturition than 5 days prepartum ($P<0.05$). Births were distributed around the clock. The parturition period lasted 272 ± 88 min (mean ± SD) while the interval between subsequent deliveries was 28 ± 21 min. Some vixens delivered first cubs on the wire net floor of the cage and then carried them into the nest box. Vixens gave birth to several cubs rapidly, one after the other and then had a longer period for resting and cub-care. In total, the parturient period included 30 ± 15% resting and 41 ± 11% cub-care. The percentage of time spent outside the nest box was only 2.2 ± 1.7%. Three days after parturition, vixens spent 81 ± 2% of their time resting or sleeping. The time spent outside the box increased postpartum, while the time spent for cub-care decreased.

The present results show that postnatal cub losses are generally small. Futhermore, infanticide as a cause of cub mortality was very rare. This result differs markedly from those in silver foxes in which infanticide contributes a significant proportion of total cub losses. This emphasizes the importance of making a difference between fox species when considering practical or ethical problems of fox farming.

The effects of housing conditions, piglet diet, and weaning method on sow maternal behaviour and piglet growth

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We report the results from 2 experiments in which sows were housed in either confined pens or get-away pens, where the sow could leave her piglets by crossing a barrier. In both experiments, sows in get-away pens varied greatly in time away from piglets. For analysis, get-away sows were divided into either (1) "leavers" which spent more than 40% of their time away by day 28 or (2) "stayers" which spent less than 20% of their time away by day 28. Stayer sows behaved like confined sows; therefore results presented compare leaver sows to confined sows. In Experiment 1, 54 sows were housed in either confined (n=26) or get-away (n=28) pens and piglets were provided with either a complex diet (i.e., more palatable and digestible) or a more basic diet. Leaver sows (n=18) nursed less frequently than confined sows on day 28 (18 vs 25 nursings/day, $P<0.001$). Piglets on the complex diet nursed less frequently on day 28 than piglets on the basic diet (21 vs 26 nursings/day, $P<0.001$). Feed consumption was higher for leaver piglets and piglets on the complex diet both before and after weaning ($P<0.01$, in all cases). Before weaning, leaver piglets gained less weight than confined piglets (200 vs 220 g/day, $P<0.05$). Weaning occurred by removing piglets at 28 days of age. On the day after weaning, leaver piglets lost less weight than confined piglets (-133 vs -238 g/day, $P<0.05$) and piglets on the complex diet lost less weight than piglets on the basic (-142 vs -248 g/day, $P<0.01$). In Experiment 2, there was no piglet diet treatment, but weaning took place on day 28 by removing the sows (n=27) and leaving the piglets in their farrowing accommodation for an additional week. Patterns of nursing and feed consumption were similar to the first experiment. Leaver sows (n=7) nursed less than confined (n=14) on day 28 (20 vs 27 nursing/day, $P<0.05$). Leaver piglets consumed more solid feed than confined piglets before weaning (100 vs 45 g/day, $P<0.05$) and performed better on the day after weaning (+70 vs -3 g, n.s.). The results of both experiments support our previous conclusions that get-away housing improves both sow and piglet welfare and that there is large variation in maternal behaviour. The improvement in post-weaning gain in the second experiment suggests that factors associated with piglets being moved to a new location have a major effect on post-weaning growth check and require further investigation.

Seasonal variation and individual differences on thermoregulatory behaviour of grazing sheep in the southeast of Brazil

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Escape to shade and drinking water behaviours are important thermoregulatory responses in free-ranging animals. The time spent under shade (TUS) and time drinking water (TDW) were measured in 23 one year old Corriedale wethers. They were raised in a 0.18 ha paddock with 1.4% of the area shaded by trees. The observations were taken during 5 days from 0800 to 1600 h in each season of the year at the Faculdade de Ciencias Agrárias e Veterinárias/UNESP in Jaboticabal-SP, Brazil (21°15'22''S; 48°18'58''W and an altitude of 595 m). The season of the year, day within season and animal were considered in the statistical model for data analysis. All variables affected TUS and TDW (P<0.01), except day within season for TDW. The highest air temperature occurred in the spring, followed by summer, winter and autumn, respectively. There were significant coefficients of correlation among TDW and air temperature and humidity (0.211 and - 0.128, respectively; P<0.05); the same occurred with TSH (0.214 and - 0.275, respectively; P<0.01). TDW was higher in spring than winter (72.9%), which did not differ significantly from other seasons. The highest values of TSH occurred in the winter and spring, they were 10.5% higher than the values in summer and autumn. The animals presented a daily pattern for shade seeking: they remained in the shade from 0800 to 1000 h, then they started to graze out in the sun; between 1300 and 1500 h some animals suddenly stopped grazing and moved to shade, where they remained standing, with a high respiratory rate. Other animals remained grazing in the sun.

The following conclusions were drawn: (1) measurements of shade seeking and water drinking behaviours were effective in order to assess the thermoregulation by sheep at pasture, (2) it is important to consider individual differences in studies on thermoregulation, (3) the fleece may have promoted an efficient thermal insulation of the sheep, leading the animals to present thermoregulatory responses only after a lapse of time, thus in animals with thick wool coats, measurements related with the thermoregulatory process should not be made immediately after heat exposure.

Socialization to humans of pigs at different ages

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In pig production, frequent interactions between sows and the stockperson are necessary during breeding periods. The quality of the social relationship that exists between pigs and stockpeople is therefore particularly important for breeding sows. In order that the stockperson achieves effective social contact with breeding gilts, it may be necessary to increase social interactions with the animals. However, the period when handling is most effective (i.e. in which period of life) is not well documented in the literature. Therefore, the goal of the present study was to investigate whether a period exists early in life, in which pigs are easily socialized to humans, resulting in a permanent effect of reduced fear at puberty.

The study comprised 65 female pigs from 13 litters. The pigs were randomly distributed within each litter to 1 of 5 treatments: daily handling during 10 days at birth (HB), daily handling during 10 days at puberty (HP), daily handling during 5 days at birth plus 5 days at puberty (HBP), no handling-testing at 2 weeks of age (CB), and no handling-testing at puberty (CP). The pigs were pleasantly handled individually for 6 min each day. Observations for 3 min daily of latency to, duration of and character of interactions with the handler, were made. After each handling period fear of humans was tested in the home pen and in a novel arena. In addition, fear of a novel object was tested at puberty.

Reduction in fear of humans was obtained in both handling periods. For example the latency to interact with the observer for HB pigs was 70 s vs 175 s for CB pigs (P=0.003). At puberty, the latency to interact for HP pigs was 8 s vs 60 s for CP pigs (P=0.01). The reduction in fear of humans in HB pigs was, however, not permanent. This was illustrated, among other measures, by the latency to interact at puberty (63 s). This interaction time was not significantly different from that of CP pigs. In addition, the HP pigs were in general less fearful when handled compared to HB pigs. During the first 5 days of handling, HP pigs had longer mean interaction times compared to HB pigs (86 s vs 7 s, P=0.001), shorter mean latency to interact (44 s vs 153 s, P=0.0001) and longer mean latency to standing immobile (146 s vs 80 s, P=0.006). These results may indicate that fear in general is lower around the time of puberty compared to at 2 weeks of age. The results also implicate that even though a sensitive period for socialization may be present in pigs, handling closer to the period of puberty may have larger effects on fear response towards humans during reproduction.

Welfare monitoring of piglets in relation to transport

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Transport introduces a very complex environmental change to farm animals as compared to housing conditions. An important variable is vibration, characterized by direction (horizontal, vertical), magnitude, acceleration and frequency. Experiments were commenced to define comfort zones for pigs in relation to welfare during transport. One hundred and twenty piglets having a body weight of 15-20 kg were vibrated at frequencies of 2, 4, 8 and 18 Hz, in combination with root mean square (r.m.s.) acceleration magnitudes of 1 or 3 m/s^2. Other environmental conditions during vibration were standardized. Welfare and stress were quantified by comparing heart rate characteristics during a control period (2200 - 0600 h) before vibration exposure and during vibration (1000 - 1100 h). Behaviour before and during vibration was recorded and analysed. During vibration, heart rate increased (mean heart rate was 133 ± 2 bpm during vibration and 126 ± 2 bpm at the same time in control animals) and the animals were restless, resulting in a longer duration of standing (median of 600 s out of 600 s without vibration vs 476 s/600 s during vibration). Behaviour and the level of maximum heart rate and number of ventricular ectopic beats (VEB) during vibration at 2, 4 and 8 Hz in combination with a r.m.s. acceleration of 3 m/s^2 indicated a larger fear response to these treatments. Differences between accelerations were clear, while responses to vibration at 2, 4 and 8 Hz tended to be higher than at 18 Hz. Isocomfort contours based on these parameters showed the greatest specific sensitivity of the piglets during vibration at a frequency of 4 and 8 Hz, especially in combination with a r.m.s. acceleration change up to 3 m/s^2. Hence, for transport r.m.s. acceleration should be lower than 3 m/s^2 to protect piglets' welfare, because piglets are more sensitive to acceleration than to frequencies within the treatments investigated.

Acknowledgment

Funding was provided by the EC(AIR 262). R. Geers was supported by FWO-Vlaanderen (Belgium)

Inter-male sexual behaviour among bachelor and harem stallions in a semi-feral pony model herd

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Inter-male sexual behaviour, similar to the species typical male-female precopulatory and copulatory sequences, has been documented in species that form male-affiliative social groupings, including primates and ungulates. Among the harem-breeding equids, it is known that the all-male bachelor stallion bands engage in considerable inter-male sexual behaviour, as do harem stallions to a lesser extent. Little is known about the details and possible patterns of these interactions. In an initial study, 17 bachelor stallions and 10 harem stallions within a semi-feral pony herd were observed for a total of 40 h over a period of 21 days. Inter-male sexual interactions were recorded using a conspicuous behaviour observation method. A total of 301 inter-male sexual behaviour interaction sequences, composed of 706 specific responses, were observed, involving 74% of stallions. Observed inter-male sexual interactions fell into 2 distinct categories. Aggressive type inter-male sexual interactions (52.8% of total) involved an apparent dominance struggle, with more than 1 stallion competing for the “male” role. In contrast, affiliative type inter-male sexual interactions (47.2% of total) were characterized by apparently pre-established sex roles of the participants. Interestingly, stallions which participated in inter-male sexual interactions each exhibited both “male” and “female” roles intermittently over the period of study. In a follow-up study of the 24 h time budget of 8 bachelor stallions, inter-male sexual behaviour accounted for approximately 48% of all inter-male interaction (fighting, 14%; other affiliative, 38%). The frequency of inter-male interaction appears to vary considerably with season, weather, and diurnal environmental variables. Results to date clearly indicate that both bachelor and harem stallions engage in inter-male sexual behaviour with considerable frequency, and that individual stallions engage in both male and female roles. Further study is underway to compare rates of various types of inter-male interactions among harems stallions, among bachelor stallions, and between harem and bachelor stallions, as well as possible seasonal variation in the frequency and patterns of inter-male sexual interaction.

Acknowledgment: This is a Dorothy Russell Havemeyer Foundation Project conducted at the Georgia and Phillip Hofmann Center for Animal Reproduction Research with partial support from NIH-K04-NS01537

Feeding test as a measure of fear in farmed foxes

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A hungry animal is motivated to eat. However, it can be hypothesized that fear of humans prevents it from doing so, if the human remains close to the animal. In the present study validity of the feeding test as a fear test was assessed in farmed blue and silver foxes. In this test feed was delivered by hand on the roof of the cage. After feed delivery, the person feeding the animal remained in front of the cage (0.5-0.7 m away) and recorded whether or not the animal started eating within 30 s. In both species, blood samples were taken and 24 h urine samples were collected from 40 animals (20 males and 20 females) which did not eat in any of the 3 successive feeding tests and from 40 animals (20 males and 20 females) which ate in at least 2 of these 3 tests. Each fox was caught from its home cage and the blood samples were drawn from the cephalic vein within 2 min of capture (base level) and 20 min after the first sample (response level). The increase in cortisol production 2 h after ACTH administration was analysed in another test. The concentrations of serum and urinary cortisol (nmol/l) were analysed by a competitive immunoassay technique and the concentration of urine creatinine (mmol/l) by kinetic Jaffe's reaction.

Base levels, response levels and increases in cortisol production after ACTH administration for silver foxes eating and not eating in the feeding test were; 86 ± 57 vs 134 ± 96 (P=0.06), 153 ± 40 vs 173 ± 69 (P>0.05) and 600 ± 111 vs 728 ± 113 (P<0.01), respectively. Corresponding values for blue foxes eating and not eating in the feeding test were; 49 ± 29 vs 58 ± 31 (P>0.05), 84 ± 35 vs 82 ± 37 (P>0.05) and 389 ± 51 vs 371 ± 54 (P>0.05), respectively. Urinary cortisol:creatinine ratio for silver foxes eating and not eating were; 4.4 ± 1.1 vs 6.0 ± 3.0 (P<0.05) and for blue foxes 5.9 ± 1.3 vs 7.4 ± 2.0 (P<0.05), respectively.

The present results confirm the hypothesis that hesitation of eating in the presence of human is due to fear. In blue foxes, however, this conclusion is based on urinary cortisol only. It is necessary to realize that in measuring basal levels that the use of a single blood sample is subject to error, and probably less reliable than urinary cortisol which is based on a sample integrated for 24 h.

Foxes in urban and rural environments

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The co-existence of foxes and humans has become more common in recent decades as foxes have adapted to urban environments. Increased availability of food supplies (e.g. waste food scraps and prey animals such as small rodents) and protected and heated hiding places (e.g. underground chambers for hot water supplies, electricity or gas) associated with high-density dwellings in urban areas may produce greater fox densities in urban compared to rural environments. This phenomenon was studied in the 1980s by a comparison of 16 hunting grounds in Prague city (PA) with 56 hunting grounds in the district of Pøíbram in central Bohemia (PB). The average number of foxes killed per km^2 in the years 1966 to 1988 in the hunting grounds of PA was 0.45 ± 0.12 and in those of PB 0.42 ± 0.08 (t=0.45, NS). The increase in the number of foxes killed between the first and last year of the period studied was 361% in PA and 241% in PB (t=2.4, $P<0.05$). The average number of foxes living permanently (i.e. the permanent population) per km^2 has been estimated at 0.76 ± 0.3 in PA and 0.50 ± 0.1 in PB (t=1.76, $P<0.05$). The average number of litters per km^2 was determined to be 0.28 ± 0.01 in PA and 0.17 ± 0.02 in PB (t=2.44, $P<0.05$). The number of cubs per km^2 in PA was 1.52 and 0.77 in PB (t=2.75, $P<0.05$). These results reflect the greater density of foxes in urban environments as well as the greater number of permanent shelters for foxes and the greater number of dens with cubs.

The circadian rhythm of salivary cortisol in growing pigs: effects of age, gender and stress

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This experiment examined circadian rhythmicity of cortisol in saliva of growing pigs, in relation to age, gender and (time of) stressor application. Additionally, the acute cortisol response to a stressor was studied. Five groups, each consisting of 3 castrates and 3 gilts, were involved in the experiment. In a control group, saliva samples were taken at 1 h intervals at 12, 16, 20 and 24 weeks of age. Within 1 week, rhythmicity of cortisol was assessed during two 24 h periods (Monday and Friday). Rhythm characteristics were evaluated by cosinor analysis, describing the rhythm by several parameters. In 2 groups at 12 weeks and 2 other groups at 20 weeks of age, a stressor was applied (4 h of isolation) on Thursday morning or evening. Again, rhythmicity was assessed on Monday and Friday by sampling at 2 h intervals. Acute cortisol effects were studied by sampling at several time points during isolation. Between 12 and 24 weeks of age, basal cortisol concentrations significantly (P<0.05) decreased from 1.19 ± 0.05 to 0.71 ± 0.06 ng/ml (mean ± sem) and a rather stable and adult circadian rhythm was reached at 20 weeks of age. Average basal cortisol concentrations were significantly (P<0.05) higher in castrates than in gilts (1.01 ± 0.05 vs 0.86 ± 0.04 ng/ml, respectively). Furthermore, after isolation, the amplitude of the rhythm significantly (P<0.05) increased in castrates (mean±sem: basal circumstances: 0.32±0.03 ng/ml; after isolation: 0.44 ± 0.05 ng/ml) but was unchanged in gilts (mean±sem: basal circumstances: 0.34 ± 0.03 ng/ml; after isolation: 0.32 ± 0.04 ng/ml). The rhythm was more unstable and the time point of the occurrence of the highest value tended to shift (P=0.06) only after evening isolation (mean ± sem: basal circumstances: 11.44 ± 0.41 (clock) hours; after evening isolation: 9.26 ± 1.02 (clock) hours). Stressor timing, but also age, was found to affect average cortisol levels. Moreover, stressor timing was important for the acute cortisol response: the increase was significant (P<0.05) and 1.38 ± 0.46 (mean ± sem) ng/ml higher in the morning than in the evening. In conclusion, this study showed that the temporal dynamics of circadian rhythms of salivary cortisol were affected by age, gender and (time of) stressor application. Moreover, differences were shown in acute salivary cortisol responses depending on time of the day of stressor application.

Dairy cows' fear of people reduces milk yield and affects behaviour at milking

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We examined how cows' fear of people affects milk yield and milking efficiency. Lactating cows (14) were each handled by 2 people. One handled the cows gently (brushing or offering food) while the other treated them aversively (hitting or occasional use of a cattle prod). After 12 aversive and 12 gentle treatments over 3 days, the cows stood further from the aversive than from the gentle handler in a standard test ($P<0.05$). Thus, the cows could distinguish between handlers and had learned to associate the treatments with a specific person. During 4 milkings, at intervals of 2-3 days, we recorded duration of milking, milk yield and behaviours affecting the efficiency and safety of milking. After milking, the cows were injected i.v. with oxytocin and re-milked. During 2 milkings either the gentle or the aversive handlers stood in front of the cows. During 2 other baseline milkings the handlers were not present. The presence of the gentle handler did not change milk yield or residual milk compared to the baseline milkings. The presence of the aversive handler reduced milk yield by 10% compared to the baseline milkings, and doubled residual milk compared to the baseline milkings and to when the gentle handler was present at milking ($P<0.05$). The presence of both handlers decreased the amount of kicking ($P<0.05$). Duration of udder preparation and incidence of detachment of the milking machine were not affected. Dairy cows' fear of a specific person, who is present at milking, can substantially reduce milk yield, possibly by reducing oxytocin secretion, but may not make the cows more difficult to handle at milking.

An algorithm for the automatic processing of recordings of foraging behaviour by cattle

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An algorithm has been developed which can automatically process jaw movements recorded using the automatic system developed at North Wyke. The automatic system records the amplitude of the animals jaw movements as an eight bit integer (i.e. a value between 0 and 255) at 20 Hz for a period of up to 26 h.

The algorithm first identifies all of the peaks in the jaw movement recording that are above a minimum noise threshold (specified by the user). The distribution of the peak amplitudes is then used to categorise each peak as either a jaw movement (large amplitude) or a jaw movement sub-peak (small amplitude). Bouts of jaw movement activity are then identified. The minimum inter-bout interval is fixed at 3 s to ensure that each individual bolus mastication bout is identified. The minimum number of jaw movements per bout can be specified by the user, and is typically 10 jaw movements. The bouts of jaw movement activity are then categorised as either eating or ruminating. Eating bouts are characterised by having a high variance of jaw-movement amplitude, a high proportion of sub-peaks and a relatively low mean interval between peaks (i.e. jaw movements and sub-peaks). Ruminating bouts are identified by having a low peak amplitude variance, a low proportion of sub-peaks, a relatively high mean interval between peaks and typically between 20 and 100 jaw movements per bout. Jaw movements during eating are then categorised as either bites (a jaw movement with a sub-peak) or non-biting jaw movements, principally mastications (without a sub peak). Finally, consecutive boluses can be combined to form longer bouts of ruminating behaviour.

Physiological responses to visual and tactile isolation in Holstein calves

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Milk production of dairy cows is largely affected by environment. However, effects of environmental stress are difficult to determine because responses to the stress are various and complicated. Developing a method to assess sensitivity of individual cows to environmental stress is needed. Cortisol concentration is one physiological parameter used to assess the effects of stress. In this study, we measured body weight and cortisol concentration to ACTH injections in calves exposed to general treatment and visual and tactile isolation. Five Holstein female calves 3 mo of age (107 ± 4 kg in body weight) were used. They were fed 0.6 kg calf starter, 0.3 kg concentrated feed and 2.0 kg hay fed twice a day at 0900 and 1600 h. A jugular vein catheter was implanted in each calf at 1 week before isolation. Calves were first reared in general tie stalls for 1 week (the first period). Then the calves were exposed to visual and tactile isolation for 1 week (the second period). Each calf was reared in experimental tie stalls divided from others with 1.8 m high wall. After the isolation period, the calves were reared in the general tie stalls for 1 week (the third period). Blood samples were usually collected twice a day over the periods. The calves were subjected to 2.0 IU/$W^{0.75}$ ACTH injections at the last day in each period. Blood samples were collected from 40 min before the ACTH injection until 180 min after injection. Dry matter intake was 3.64 kg/day, 3.37 kg/day and 3.64 kg/day for the first, second and third period, respectively. Dry matter intake was linearly increased (R^2=0.996) with time. Body weight gain decreased significantly (P<0.05) from 1.4 kg/day in the first period to 0.2 kg/day in the second period. Body weight gain recovered as much as 1.3 kg/day in the third period. The results show that even 1 week of the visual and tactical isolation is stressful for calves. The cortisol responses to ACTH injections were analyzed by the area under the response curve (AUC). The AUC of cortisol decreased significantly (P<0.05) from 26.5 μg/dl in the first period to 22.8 μg/dl in the second period and the AUC of cortisol recovered to 23.7 μg/dl in the third period.

Time budget and use of cover in Japanese quail (*Coturnix japonica*) kept in semi-natural aviaries

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In caged Japanese quail there are several welfare problems such as pre-laying restlessness and head-banging as a consequence of escape responses. The aim of this study was to improve the knowledge of the behaviour of this farm animal species for the design of adequate housing systems. Eight groups of 8 or 9 quail of a domestic strain were housed in aviaries (19.1 m^2) containing natural soil and vegetation. Focal animal sampling was used to quantify the time budget. In the analysis, the amount of time the quail spent in cover and on elevated structures was compared to the percentage of the floor area that was covered with plants or artificial shelters and elevated structures, respectively. These percentages were estimated per square metre of the floor after completion of the time budget records in a given aviary. The quail spent 35% of the observation time on passive behaviour, 24% on locomotory behaviour, 8% on exploratory/foraging behaviour, 14% on comfort behaviour (dustbathing and preening) and 4% on ingestive behaviour. In 15% of the total observation time the focal animal was in dense vegetation or behind a shelter and therefore not visible. The percentage of time the quail stayed in cover (mean 48%) was significantly higher than the proportion of the floor area that was covered with plants and artificial shelters (mean 17%, Wilcoxon matched-pairs signed ranks test, n=8 pens, T=36, $P<0.01$). On the other hand, the time spent on elevated structures (average 0.5%) was significantly lower than the percentage of the floor area that was covered with elevated structures (mean 12%, Wilcoxon matched-pairs signed ranks test, n=7 pens, T=28, $P<0.02$). During continuous observations on 12 evenings none of the quails perched for rest at night. The percentage of eggs found in cover (mean 91%) was significantly higher than expected (Wilcoxon matched-pairs signed ranks test, n=7 pens, T=28, $P<0.02$). These results are of significance for the development of alternative housing systems. These should contain a substrate for scratching, pecking and dustbathing behaviour. The data suggest that while perches are not necessary, both cover and nest boxes (as an equivalent to natural cover) should be provided as quail show a preference to both stay in cover and lay eggs in cover. Cover and nest boxes might reduce the incidence of head banging and pre-laying restlessness, which would improve quail welfare.

Salivary cortisol as a stress parameter in piglets

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Physiological indicators play a central role in the scientific assessment of animal welfare. This approach requires very often blood sampling which can be a stressful procedure. In such circumstances the measures obtained and subsequent interpretation may be of limited value. Saliva sampling is less invasive and frequent samples can be collected by untrained personnel with no risks for animals. The relationship between salivary and plasma levels of total and free cortisol was monitored in male piglets subjected to castration, a common procedure carried out in commercial pig farms.

Total and free plasma cortisol and salivary cortisol were measured in 97 piglets, aged 2 - 4 weeks, 10 min before (basal value) as well as 1, 2, 3, 4 and 24 h post castration. Samples were taken at the same time intervals from a control group of 17 animals which did not undergo surgery. Two days before castration an indwelling catheter was inserted into the jugular vein and an extension was laid subcutaneously to the piglet's ear ground under general anaesthesia. For castration, which lasted about 2 min, the animals were hanged in a "Niedeck" castration hook. After 2 skin incisions the testes were removed separately using an emasculator. Simultaneously to blood withdrawing saliva was collected by 2 cotton swabs, which were placed one after another into the buccal pouch. Two min before saliva collection procedure 0.5 ml lemon juice was applied to the mouth to increase saliva flow rate. Cortisol levels were measured by radio immunoassay (RIA) preceded by extraction with organic solvent.

A highly significant increase in total, free and salivary cortisol was found within the first 4 h after castration compared to the control group. Twenty four h after operation, values were again close to basal levels. The percentage increase above basal values was highest in free plasma cortisol (21.08 nmol/l vs 61.26 nmol/l; 290.6%), and lowest in total plasma cortisol (177.33 nmol/l vs 374.09 nmol/l; 211.0%), whereas salivary cortisol showed an 255.7% increase (10.46 nmol/l vs 26.75).

Total cortisol included 11.9%-16.4% free cortisol and 5.9%-7.5% salivary cortisol. Correlation between total and free cortisol measured in plasma was highly significant at all times ($r>0.7$; $P<0.01$). The highest correlation between total plasma cortisol and salivary cortisol occurred 1 h after castration ($r=0.57$; $P<0.01$), although correlations were significant ($P<0.05$) for all values. The correlation between free and salivary cortisol was lowest for basal values ($r=0.27$; $P>0.05$), whereas correlations for the remaining time points were highly significant ($0.41<r<0.61$; $P<0.01$).

For the control group a highly significant correlation was found between total and free cortisol in plasma with the exception of the basal value. High correlations were found between salivary and total plasma cortisol ($0.58<r<0.89$; $P<0.05$) and between free and salivary cortisol ($0.63<r<0.92$; $P<0.05$).

In agreement with previous studies carried out in adult pigs, lambs and calves, the present work indicates that the measurement of salivary levels of cortisol reflects the concentration of this hormone in plasma samples. The present data showed that castration induced a significant long lasting increase in plasma and salivary cortisol levels.

Exercise frequency in Italian saddle horses: effects on behaviour and some blood parameters

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The growing interest in horse breeding for sporting, recreational and rehabilitative purposes, makes it necessary to acquire more information about the behaviour of the horse when housed in confinement. So, we studied the effects of exercise frequency on behaviour and some blood parameters on 6.5 year old saddle horses. The animals, divided into 3 groups, each consisting of 6 subjects, were housed for 3 weeks in individual square boxes, area (3.55 x 3.10 m), on wood shaving litter and subjected to a roundabout-exercise frequency: group A = every day; group B = every other day; group C = every 4 days. Exercise was conducted on 3 horses in the morning from 1000 - 1200 h and in the afternoon from 1430 - 1630 h. Exercise was divided into 3 phases, the first lasting 5 min, at 2.7 km/h, the second, lasting 26 min, at 4.2 km/h, and the third, lasting 2 min, at 2.7 km/h. The horses were fed 8 kg hay and 4 kg concentrate daily, administered in 3 meals at 0800, 1230 and 1700 h. Three blood samples were taken from each horse at the beginning of the trial, on day 11 and at the end of the experimental period. Blood samples, taken anteprandial (0730 h) from the jugular vein, were collected in 10 ml vacuum test-tubes and immediately centrifuged. Throughout the trial, the horses in group A showed significantly higher (P<0.01) feeding and resting times, markedly lower (P<0.01) standing times and less frequent (P<0.01) abnormal behavioural activities, such as stereotyped pacing, crib-biting and litter-eating. Blood glucose concentrations progressively increased (P<0.01) from group A to groups B and C, while blood non-esterified fatty acids (NEFA) diminished (P<0.01). Horses in the group C also showed significantly higher (P<0.01) blood total cholesterol values. However, there were no differences in blood cortisol between the experimental groups. Therefore, on the basis of the results relative to behavioural activities, it seems to be advisable for saddle horses to be subjected to daily exercise, in order to prevent a deterioration in well-being when housed in confinement.

The stereotypies of adult humans doing IQ tests are associated with reduced heart rates and increased heart rate variability

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A relationship between stereotypies and stress reduction has been suggested for a range of species, including humans. For example, the leg-swinging of children doing maths homework correlates with a decrease in heart rate (Soussignan & Koch 1984). As leg-swinging seems largely restricted to children (Rago & Case 1978; Thelen 1979), the aim of this study was to see if the more diverse stereotypies exhibited by adults doing a difficult mental task are also linked with reductions in heart rate. Eighteen adults were set an IQ test lasting 1 h, during which they were videoed and their heart rates recorded with a Polar Advantage Sports Tester.

Fifteen of the subjects performed stereotypies. Leg-swinging was seen, along with foot-tapping, foot-rolling, leg-joggling, pen-sucking, pen-waggling, chair-swivelling and hair-stroking. All subjects performed more than one of these actions. The time spent performing stereotypies ranged from 0 to 39.2% of the testing period. Levels were greatest in the subjects whose final scores suggested they found the test most difficult (Correlation between score in test and stereotypy frequency: $r=-0.41$, $n=18$, $P<0.05$). Stereotypy frequency and average heart rate did not correlate, but there was a trend for high stereotypers to have a greater heart rate variability ($F=3.31$, $df=15$, $P<0.10$). Heart rate traces were analysed in more detail for the 7 highest stereotypers: the average heart rate during a bout of stereotypy was calculated and compared to the baseline. This showed that during a bout of stereotypy, heart rate significantly decreased ($t=6.48$, $n=7$, $P<0.001$). Following a bout of stereotypy, heart rate immediately returned to baseline levels. These results suggest that in adult humans under pressure, transient stereotypies result in transient reductions in stress.

A framework within which to assess the impact of specific stimuli on an animal's welfare

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Animals are adapted to live in fluctuating environments. Some stimuli to which they are exposed will be ignored, some will be avoided and others will be approached. Therefore to determine if an animal's welfare is compromised in a particular situation e.g. transportation, its perception of all stimuli needs to be determined. There are a variety of techniques available to the ethologist in order to do this, however the suitability of each technique depends on the strength of aversion to the particular stimuli, in addition to a multitude of other factors. This paper illustrates a suitable framework, using assessment of pigs' responses to acoustic stimuli as an example, within which aversion can be assessed.

Firstly, the characteristics of the stimuli to which the animal could be exposed were determined. This involved carrying out a survey using appropriate equipment in all locations that the subject species was found. A technique which allows the strength and length of the initial physiological and behavioural response to similar stimuli was then utilised. The technique used involved exposing the subject to the stimulus in a standardised arena, to which the subject was familiar. Activity, behaviour and heart rate responses were measured. Heart rate significantly increased by 13 bpm at onset of the auditory stimulation, and the pigs' behaviour changed from resting to aroused and attentive ($P<0.05$). These changes indicated that the stimulus had the potential to be aversive, although there was the possibility that it could have been merely arousing. A modified one-way avoidance test was then carried out. In this technique the subject was able to escape from the stimulus if it was motivated to do so. Pigs did not avoid uniform sound with a long rise time but did avoid intermittent sound with a short rise time 68% of the time ($P<0.05$). When avoidance of the stimulus was found, a final experiment was carried out to determine the strength of this avoidance. A concurrent operant technique with non-independent schedules was used to determine the strength of avoidance to sound stimuli. It was found that pigs are prepared to work 2.7 times harder for food to avoid sound of 97 dB(Lin) during initial exposure ($P<0.01$). Avoidance then decreased exponentially with subsequent experimental sessions.

The role of visual, auditory, and olfactory stimuli in teat seeking behaviour of piglets

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Experiments were conducted to investigate the role of sensory stimuli in teat seeking behaviour of piglets. Thirty seven piglets from 5 litters were used. Teat order was established by 5 days of age. All piglets were tested from 5 to 12 days of age in the conditions as follows: control (C), interception of visual stimulus by masking the piglets' eyes (V), interception of auditory stimulus by putting stoppers in the piglets' ears (A), interception of olfactory stimulus by spraying a smell remover in the piglets' noses (O), interception of 2 out of these 3 stimuli (VA, VO and AO), and interception of all 3 stimuli (VAO).

Control group piglets (Group C) took 34.5 s to reach their dams' teats. Piglets with each of the above treatments tended to prolong the time spent in teat seeking behaviour, and Group VAO took 4 times longer to reach the teats. In treatments where 1 sensory stimulus was intercepted, Group O took 39.9 s and showed no significant difference from Group C. The Groups V and A, however, took significantly more time than Group C, 94.7 and 61.8 s, respectively ($P<0.001$ and $P<0.05$). In comparisons of Group A with Group VA, Group O with Group VO, and Group AO with Group VAO, the piglets in the groups with visual interception took significantly more time to reach their dams' teats in all cases ($P<0.01$or $P<0.001$). On the other hand, the differences between Group V and Group VO, Group A and Group AO, and Group VA and Group VAO were not significant. In comparisons of Group V with Group VA, Group O with Group AO, and Group VO with Group VAO, the piglets added auditory interception took significantly more time except in the first case ($P<0.05$).

These results show that the visual stimulus is the most important for teat seeking behaviour in piglets, and olfactory interception has less effects than the other two senses.

How do miniature pigs discriminate between people? The effect of exchanging cues between a stranger and their familiar handler on discrimination

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Behavioural tests using operant conditioning were conducted to examine how miniature pigs discriminate between people. During a 3-week handling period, six 8-week-old pigs received daily handling from their handler. During these sessions, pigs were touched and fed raisins whenever they approached the handler. They were then trained to receive the reward from the handler in a Y-maze. In subsequent experiments, the handler and a stranger wearing different coloured coveralls and different perfumes sat at each end of the maze. Pigs were rewarded with raisins if they chose the handler. Successful discrimination occurred when the pig chose the handler at least 15 times in 20 trials ($P<0.05$: Chi Square test). When all pigs exhibited discrimination under standard conditions, they were exposed to these treatments: (1) Experimenters exchanged colours of coveralls; (2) experimenters exchanged perfumes; (3) experimenters exchanged both cues; (4) both experimenters wore coveralls of the handler's original colour: (5) the handler wore coveralls of a new colour; (6) 2 novel people wore coveralls of the original colours of handler and stranger; (7) the test was conducted under the original conditions but in a novel place. All pigs could discriminate between handler and stranger, but the stranger was chosen significantly more often following the exchange of coverall colours and the exchange of both coveralls and perfumes. However, the handler was chosen significantly more frequently following exchange of perfumes only. Two pigs successfully identified the handler when both experimenters wore the same coloured coveralls. Pigs successfully identified their handler wearing a new colour of coveralls. Between novel people, the one wearing the handler's original colour of coveralls was preferentially chosen by the pigs. Only one pig significantly preferred the handler when the experiment was conducted in a novel environment. Results suggest that visual cues influence discrimination among people by pigs.

Evaluation of learning ability in developmental ethopharmacology

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In human therapy perinatal pharmacotherapy is very important for saving high-risk or preterm newborns. However at this advanced stage of development, there exists a drug teratogenicity risk, especially the risk of drug-induced delayed functional defects.

The aim of this study was to investigate the functional teratogenic risk of perinatal drug treatment in rats. The animal model chosen involved longitudinal study of rats till senescence, with regular monitoring of behaviour and other parameters.

The effects of perinatal diazepam treatment on cognitive processes were investigated by 2 methods, an object discrimination (different degree of interest between the known and the novel object) and a social recognition (repeated exposure to a rat pup) test. We have previously conducted experiments using these 2 methods for the evaluation of learning ability in diazepam-treated rats.

The results suggest that the “object discrimination” test was less suitable for screening the level of cognitive processes, because motivational attractivity appeared to be less than interest toward live conspecific juveniles.

Effects of social rank on the immunocompetence of weaned pigs

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Mixing unfamiliar animals is common in livestock production systems. This management in pig production is accompanied by increased agonistic behaviour and may result in social stress. The aim of our study was to investigate the effects of an established social rank order on parameters of the immune system of pigs (content of immunoglobulins in blood, mitogen-stimulated proliferation of peripheral blood lymphocytes, natural killer cell activity). The study was carried out using 10 newly mixed groups of unfamiliar German Landrace pigs consisting of 9 pigs (12 weeks of age). Immediately after mixing, the agonistic interactions of dyads were recorded by direct observation for 3 days (10 h daily continuous sampling). An individual dominance value (DV) was calculated by the number of wins and defeats in relation to all decisive fights (variation between -1, subordinate and +1, dominant). Blood samples were taken before mixing pigs and after behavioural recordings.

After the establishment of social rank order, dominant pigs (DV>0) showed significantly (P=0.05) higher lymphocyte responses to different mitogens than subordinate pigs (DVΛ0), whereas lymphocyte responses in blood samples of the same individuals taken before mixing did not differ significantly. Dominant pigs had greater natural killer cell activity than pigs holding intermediate or subordinate social positions (regression slope: 36.3; P=0.02).

The results indicate that stress occurring during the establishment of rank order influences the cellular immunocompetence such that it is enhanced in successful individuals whereas it decreases in low ranking animals. Thus, a combination of immunological and behavioural indicators may provide complementary information for the assessment of animal welfare.

Introduction of the group of Hamadryas baboons from zoo to the island: individual changes of behaviour

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A group of 6 Hamadryas baboons (*Papio hamadryas*) from Leningrad Zoo (St. Petersburg, Russia) was introduced in 1995 to an island during the short summer period. Quantitative and qualitative changes of behaviour and locomotion of all members of this group were recorded before and after introduction. We observed that the frequency of locomotor behaviour after moving the group remained at the same level, but the character of the locomotion changed. We observed more terrestrial locomotor patterns on the island than in the zoo. The social behaviour on the island increased to 23 fold in all adult animals. We recorded the change in hierarchal position between 2 adult males on the island. An Alphamale who dominated in the zoo, lost his position during first several days after introduction to the more natural conditions on the island. In the zoo, the young juvenile male spent a lot of time in social contacts and he frequently played with his aunt. After introduction to the island the frequency of play behaviour of this juvenile male and his aunt rapidly decreased. This male spent significantly more time with his mother on the island than in the zoo. We also recorded decrease in the individual distance between animals on the island. We conclude that all animals in the group can adapt very quickly to the new conditions in the wild. Changes of hierarchical position in the group can occur in this situation. We found that the individual experience of baboons are very important for the adaptation to the wild conditions.

The ape's picturemaking activity

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The picture-making activity of 5 orangutans, 6 chimpanzees and 2 gorillas from Ústí nad Labem, Dvùr Králové nad Labem and Liberec Zoos were studied. The main aims of the study were to analyze the biological and behavioural basis of the picture making including the ontogenetic aspects and cognition and learning abilities of the great apes. At the Ústí and Liberec Zoos, the researchers were in the cage during the drawing session with the orangutans and chimpanzees. The other apes were in cages without researchers during drawing sessions. In both cases the aim was not to interfere with the spontaneous activity of the apes, however, there was a marked human influence during the sessions. However we are continuously improving our methods to diminish the human influence. To initiate a drawing session, paper and pastels were passed through the bars. A typical drawing session lasted about 20 min. Usually 1 drawing session occurred per week and apes produced between 1 to 14 pictures during the session . The results of the drawing sessions, differed according to the individual features of the different apes. In parallel we made video records of all drawing sessions. In our study we analyzed the influence of type of tools used (pencil, marker pen, pastels, gouache and water colours) on the techniques of drawing, the preference for right or left hand, the calligraphy and the balance of pictures. For analysis of pictures we used the classification of calligraphic development by Kellogg (1970), which classified 20 basic scribbletypes. All apes used right and left hands for drawing, and sometimes both hands. One young chimpanzee almost exclusively used its lips. Use of the hand and leg together for picturemaking activity was observed very rarely. We determined the influence of tool used for drawing on the technique for picturemaking. During the drawing sessions our apes used pastels, pencil, fix and colours. The following reactions to boldly drawn lines and dots was observed: a) vertical line when a vertical line was in the centre of the paper, orangutans preferred to draw on the left or right part of paper, b) horizontal line drawings by orangutans crossed a horizontal line in 9 out of 10 cases, c) diagonal line orangutan drawings crossed diagonal lines in 4 out of 12 cases; in the other cases drawings did not cross the diagonal line. In our tests with a single central dot, orangutans restricted their drawing activity to the area around the object. If the dot was on the other part of the paper, the drawing was usually on the opposite side of the paper. In the situation with 2 dots in vertical alignment on the paper we observed a tendency for drawing in the central part of paper i.e. between the dots. We have found similar results also for chimpanzees and gorillas.

How to recognize adoption in farmed Red deer

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Our previous study induced doubts as to whether identifying adoption by occurrence of massaging of the ano-genital region, of the calf by a non-maternal hind, is reliable. The aim of this study was to test this suggestion on a larger amount of data. The investigation was conducted between 28th May (day of the first delivery) and 2nd September (weaning of all calves) on a red deer farm at Vimperk, Czech Republic. Fifty hinds and their calves were observed, but only suckling bouts with complete information were taken into consideration. Massaging occurred mostly during the first month of the calf's life. All filial calves (n=36, Group A) were massaged repeatedly. Non-filial calves received ano-genital massage at least twice (n=12, Group B - assumptive adoption), or on a single occasion or not at all (n=35, Group C). Calves of Groups A and B behaved in a similar way, suckling in such a position as to allow the hind to lick their ano-genital region, in more cases (Group A, 100%, n=36, Group B, 100%, n=12) than calves of Group C (48.57%, n=17, Groups A and B vs Group C $P<0.001$). This occurred even when 2 calves were involved in the bout (Group A, 75.00%, n=27, Group B, 75.00%, n=9, Group C, 31.43%, n=11. Group A vs Group C $P<0.001$, Group B vs Group C $P<0.01$). When 2 calves were involved in the suckling bout, calves of Group C (65.71%, n=23) suckled from behind, between the hind's hind legs, more frequently than did the calves of Groups A (5.56%, n=2, $P<0.01$) or B (25.00%, n=3, $P<0.001$). It is concluded, that repeated allonursing accompanied by a massaging of the ano-genital region of the suckling calf by the hind can be considered as a sign of adoption.

Comparison of dustbath behaviour of female broiler breeders in group cages and in a traditional system

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In order to reduce ammonia emissions, group cages without litter for broiler breeders are under development. To establish the influence of such systems on broiler breeder welfare, dustbathing behaviour of hens in a group cage system (Commune System, with artificial grass) was compared to a traditional system (litter floor and slatted area).

In the traditional system hens dustbathed on the litter. Hens in the Commune System also attempted to perform dustbathing behaviour (as expected from literature with litter deprivation). In the latter treatment, hens performed not only behaviour patterns belonging to the introductory, but also to the consummatory dustbathing stage. Interestingly, incidences of dust bathing that started with, or consisted of only behaviours of the second stage, were not observed.

However, hens were unable to reduce feather lipid content in the Commune System. Further, hens seemed to have more difficulty proceeding to the next stage of dust bathing in this system: Incidences of dustbathing in the Commune System were more often short, although disturbances occurred less frequently than in the traditional system. Side rubbing (consummatory stage) occurred during a lower proportion of the dustbaths. Longer dustbaths without side rubbing occurred only in the Commune System.

Head rubbing, scratching with one leg and shaking out also occurred in a smaller proportion of dustbaths observed in the Commune System compared to the traditional system. The consequences for well-being, however, are unclear.

It is concluded that although hens dustbathed frequently in the Commune System and performed behaviours belonging to the consummatory stage, artificial grass was a less suitable dustbath substrate than litter. Therefore, well-being of hens in the Commune System was considered to be diminished compared to hens in the traditional system.

Dominance relationships of foals and mares

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This study examined some of the many influences on foal and mare social hierarchy.

Five dominance heirarchies were determined in herd Kladruby black horse (*Equus caballus*) located at the Slatioany Stud Farm (Czech Republic). Herd sizes varied from 5 to 11 animals. The herd was observed from August 1995 to February 1997 for a total of 67 h.

The subjects of this study were 11 foals weaned on 7 August 1995 and 8 mares with foals weaned on 29 November 1996. The 1995 herd consisted of 11 foals (7 fillies and 4 colts) observed shortly after weaning. The second observation of this herd was conducted 18 mo later, at age of 2 years, and the subjects were 6 fillies. The 1996 herd of 8 foals (5 fillies and 3 colts) was observed before weaning and with their dams. Furthermore 5 fillies of these foals were observed shortly after weaning.

All observations were made while horses were held in free-stables, 1-5 h daily. Dominance and subordinate relationships between horses were ascertained on complete herds, and a pair feeding test was not used. The dominance hierarchy was calculated from agonistic interactions with clear winners and losers only.

To test for any correlations between the rank order and exact age, weight and body size and between single rank orders, the Spearman's rank order correlation coefficient was calculated. The rank order of the foals before weaning was positively correlated with the rank order of their dams ($r=0.81$; $P=0.03$). There were no significant associations between the rank order of the foals after weaning and the rank order of their dams or between the rank order of the foals before and after weaning. There was a tendency for rank order to be correlated with age in mares ($r=0.60$, $P=0.10$) but the associations between rank order and body weight and size were not significant. The large number of rank order ties in the foal herds both before and after weaning indicate that immaturity may influence the establishment of dominance hierarchy.

The importance of spatial position of fixed ratio costs to laboratory mice

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Recent consumer demand studies have required subjects to pay a price to move to a resource chamber, rather than payment resulting in direct resource delivery. Some studies allow the subjects free exit from a chamber once they have entered, but others require the animal to pay another cost to return to its original position. If switching decisions are affected by the position of operant costs, studies that offer free return routes will result in different behaviour from those that split payment between entry to and exit from resources. This experiment aimed to assess the extent of any differences by comparing the results from 4 required number schedule treatments. Two treatments (RN 80/0 and RN 0/80) required full payment in 1 direction only (in RN 80/0 the cost was 80 lever presses to enter the food cage, but free exit: in RN 0/80 entry to the food cage was free, but exit cost 80 lever presses). One treatment (40/40) split the RN 80 cost between the 2 levers. The fourth treatment (40/0) required an RN of 40 to be paid on entry to the food cage, and exit was free. Male Balb/c mice were exposed to each treatment in a closed economy system. Their behaviour differed between treatments in the amount of time spent in the food and home cages (repeated measures analysis of variance, $F=26.29$; d.f=3, 15; $P<0.001$), in the mean length of bouts in each (home cage: $F=4.16$; d.f=3,15; $P<0.05$; food cage: $F=5.73$; d.f=3,15; $P<0.01$), and also in the number of bouts undertaken under different treatments $F=21.62$; d.f=3,15; $P<0.001$). Mice responded to the immediate costs of entry to the cages, rather than the overall costs of a round trip. The behaviour of the mice was affected by the magnitude of the cost, and the way in which this cost was imposed, but subjects also behaved differently according to the resource to which they were travelling, even when paying identical costs. These differences in behaviour may be attributable not only to the resource related behaviour (feeding in the food cage and drinking or sleeping in the home cage), but also to the varying costs and benefits of monitoring the different resources. These results therefore have important applications for future demand studies.

The post-weaning behaviour of indoor bred and outdoor bred pigs

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The U.K. pig industry has a significant proportion of outdoor bred animals, the majority of which are weaned into indoor, intensive housing. The prior experience of pigs has been shown in experimental situations to influence subsequent behaviours. This study examined whether differences in the neonatal environment, within a commercial farming situation, would lead to behaviour differences of pigs from weaning to 8 wk post weaning.

The study utilised a farm with both indoor (crated) and outdoor farrowing. From weaning, all animals were housed in straw filled pens with *ad-libitum* food and a covered sleeping area. Group size at weaning was 60 - 80 animals and from 5 weeks post weaning was 30 to 40 animals. Six pens of mixed indoor bred (IB) and outdoor bred (OB) animals were used; from each of these 10 IB and 10 OB animals were ear tagged and marked at weaning. Scan samples of behaviour of these pigs were made at 2 min intervals from weaning to 1800 h. At day 1, and weeks 1, 2 and 8 post weaning, scan samples were made at 2 min intervals from 0600 to 1100 h.

Rooting behaviour was more frequent in the IB than the OB animals at 1 day post-weaning (68 ± 42 vs 41 ± 33, mean observations per pen ± standard deviation, $P<0.05$). Subsequently, the OB animals displayed more rooting behaviour that the IB animals, although differences were not significant. OB animals were observed to be feeding more than the IB animals on the day of weaning (96 ± 31 vs 55 ± 18, $P<0.05$). Observations of drinking and of aggressive behaviour did not differ between the 2 groups.

Differences in the behaviour of pigs from different neonatal environments, expressed at weaning specifically in the feeding and rooting behaviour of the animals, were not significant from 2 days post weaning. Thus, the differences in behaviour caused by differences in the neonatal environment were negated within the ‘enriched’ post-weaning environment. Whether or not this would hold true within a ‘barren’ post-weaning environment remains to be tested.

The behaviour of piglets between birth and twelve days old; evidence against stable differences

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The existence of individual variation in the behaviour of piglets depends upon there being consistent, relative differences between animals, over time (Webster & Jones, in press). It is suggested here that such differences, if they exist at all, will arise through a combination of both innate and environmental influences. Further, environmental influences will have both immediate (e.g. hunger) and chronic (e.g. learned fear) effects. This study examined consistency in the behaviour of piglets over the first few days of life in order that the effects of chronic environmental influences would be minimised.

Four litters of piglets (n=7, 7, 9, 11) were used. Animals were teeth clipped, tail docked, iron injected and weighed at birth and marked for identification. Immediately subsequent to the first day of observations animals were individually tattooed. All were housed with their (crated) sow in partially slatted pens. Observations of behaviour were made on the first full day postpartum and on the 3-4 (i.e. either the third or the fourth), 5-6, 7-8, 9-10 and the 11-12 day postpartum. Observations took place for a full 90 min beginning at either 0730 h or 0930 h. Instantaneous sampling was used with a 3 min sample interval. Consecutive animals were recorded at 5 s intervals in a pre-determined random order. For the purpose of analysis all behaviours excluding feeding and sleeping were grouped as one, termed 'active'. Data was analyzed using Spearmans Rank Order correlations over consecutive days. The experimental unit was the individual piglet.

For the behaviour 'active' there were no significant correlations over consecutive days. For the behaviour 'feeding' a negative correlation was found between day 9-10 and day 11-12 ($r=-0.42$, $P<0.05$). For the behaviour 'sleeping' a positive correlation was found between day 5-6 and day 7-8 ($r=0.37$, $P<0.05$) and a negative correlation was found between day 9-10 and day 11-12 ($r=0.41$, $P<0.05$).

The results of this study do not support the existence of 'individual variation' in the behaviour of piglets over the first days of life. Time spent feeding, sleeping and active relative to other animals was not, on the whole, consistent. It is suggested that consistent, relative differences in the behaviour of pigs, if they are to be found at all, will be found in older animals for whom the chronic environmental influences have differed.

The behaviour of piglets within indoor and outdoor farrowing systems

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Differences in the environment of piglets born into an outdoor farrowing system (OFS) and that of piglets born into an indoor farrowing system (IFS) might be expected to lead to differences in their behaviour. This study compared the behaviour of piglets within a commercially run OFS with that of piglets within a commercially run IFS.

Six piglets each from an OFS and an IFS, located adjacent to each other on the same farm, were used. Sows in each system were of the same breed. Each piglet was from a different litter and was marked approximately 30 min before observations began. Behaviour was recorded using instantaneous sampling and a 5 s sample interval, for a continuous 4 h period, from 1000 to 1400 h at 1, 8 and 15 days postpartum. For the first 2 h post weaning, at approximately 28 days of age, behaviour was recorded using a 10 s sample interval. Summed observations of each behaviour for each piglet on each day were used as raw scores in the analysis of data and comparisons of each behaviour were made between the 2 groups using t-tests (two-tailed) for independent samples.

At day 1 postpartum, behaviour did not differ significantly between the 2 groups. At day 8 postpartum, the OFS group displayed significantly greater amounts of lying-exploratory (2.9 ± 2.0 vs 0.0 ± 0.0, mean percentage ± standard deviation $P<0.005$) and rooting behaviours (5.2 ± 4.8 vs 0.8 ± 0.7; $P<0.05$) and, at day 15 postpartum, significantly greater amounts of rooting (6.5 ± 3.2 vs 1.2 ± 1.1; $P<0.005$) and aggressive (1.4 ± 1.3 vs 0.1 ± 0.1; $P<0.05$) behaviour. Over the first 2 h post-weaning, the OFS group continued to display significantly greater amounts of rooting behaviour (16.0 ± 10.5 vs 4.8 ± 5.5; $P<0.05$). The IFS group showed greater amounts of suckling behaviour (8.9 ± 4.3 vs 18.7 ± 9.8; $P<0.05$) at day 15 postpartum.

Differences between the two groups were expressed principally in rooting behaviour. These differences are explained by 2, compatible hypothesise (i) that the presence of a suitable rooting substrate in the OFS stimulates the rooting behaviour of the piglets and (ii) that the physical restraint of sows in the IFS allows piglets to express their exploratory motivation specifically at suckling/massaging the udder.

An analysis of feather pecking interactions in individually marked laying hen chicks

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The aim of the present study was to investigate whether individual birds specialise in feather pecking. Laying hen chicks (white Lohman Selected Leghorn hybrids) were individually marked and reared in groups of 30 or 31 in pens with a slatted floor. Feather pecking interactions were recorded when the chicks were 4-6 weeks of age.

In experiment 1 (10 groups), on average 83% of all group members were recorded at least once as initiator of a feather pecking interaction. In each group, 2 to 6 individuals had a feather pecking rate that was more than twice as high as the average rate for the group. These birds were defined as “high rate peckers”. They made up 12% of all chicks observed in this experiment but initiated 39% of the recorded feather pecking interactions. Every feather pecking interaction was classified (with increasing intensity) as pecking, pinching, pulling or plucking. Compared to the other group members, “high rate peckers” had a significantly higher proportion of their feather pecking interactions classified as plucking and a lower proportion classified as pecking. There was no evidence that individual birds specialised in pecking at a few selected group members. In experiment 2 (3 groups), chicks that had just pecked at the feathers of a conspecific, initiated significantly more feather pecking interactions during a subsequent 2 min focal animal protocol than control birds that had not pecked at a pen mate before the start of the protocol.

It is concluded that the feather pecking interactions of individual growers are clustered in time and that the behaviour is not performed by just a few specialised members of a group. However, in comparison to the other group members, some individuals are characterised by relatively high rates and more severe forms of feather pecking.

The effect of reversal of the day- night routine on drinking behaviour of horses

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Dehydration effects the performance of horses in competition (Andrews et al., 1995, *Equine Vet. J. Suppl*. 18: 294 - 297). It is therefore essential that total body water levels are optimised prior to work. In most cases this depends on voluntary drinking behaviour; this is usually adaptive and varies with the supply of water in the environment, the physiological state of the individual, the behaviour of conspecifics and possibly endogenous rhythm. It is not uncommon for sports horses to undergo frequent changes in management in association with their work and, in the case of international travel, this may involve considerable temporal shifts in the normal routine. This study reports the impact of a controlled shift in management on voluntary water consumption.

Using a related design experiment, the water intake of 6 mature Thoroughbred horses (3 mares, 3 geldings) within an established yard routine was monitored for 7 days prior to and 7 days starting with a 12 h shift in their normal management regime (periods I and II, respectively). Water intake was recorded every 2 h. Period I management consisted of box rest with 30 min exercise in a horse walker between 0915 h and 1030 h (mares were exercised first) and feeds at 0700 h, 1300 h and 1900 h. Period II management was with a 12 h shift, so that the horses were exercised between 2115 h and 2230 h and fed at 1900 h, 0100 h and 0700 h. The meals at 0700 h and 1900 h were identical for any given individual throughout the study. Data were analysed using Wilcoxon matched pairs test and found to be significant at $P<0.01$ or not significant at $P>0.05$.

During period II, all horses showed a significant decrease in their 24 h water intake (mean daily intake for period II was 25.5 l vs 27.5 l during period I). This reduction in 24 h water intake was largely due to a significantly lower water intake during the day (0700 h to 1900 h). The mean intake recorded for these 12 h was 15.7 l during period I and 13.1 l during period II. Night time water intake (1900 h to 0700 h) showed no significant difference between periods. There was no significant difference in water intake during the periods which included exercise (0900 h - 1100 h for period I and 2100 h - 2300 h for period II). This may reflect a negligible level of fluid loss from sweating during the exercise period at the low ambient temperatures of the trial (mean 2^{o}C, range to 8.4 - 12.5^{o}C). The results also showed that during period II, significantly less water was drunk around the 4 h including the second feed (0100 h) with a mean of 1.8 l compared to 3.7 l during the equivalent time (1300 h) in period I.

These results suggest that the change in time of feeding was an important variable affecting the total daily voluntary fluid intake of horses. Feeding is accompanied by a period of increased drinking, but a 12 h shift in feeding time is associated with a reduction in the level of periprandial water intake. This was not compensated for within the 7 d within this study.

The behaviour, public perception, and welfare of sheltered dogs

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In Northern Ireland, approximately 12,000 dogs end up in animal shelters every year; the majority are destroyed. The chances of a sheltered dog becoming purchased, and consequently its welfare, are dependent upon a visitor finding it appealing. People prefer dogs which are at the front rather than the back of the cage, quiet as opposed to barking, and alert, i.e. standing, sitting, moving, rather than non-alert, i.e. resting, sleeping (Wells 1996; Wells & Hepper 1992). This research examined the behaviour of sheltered dogs to determine whether they behaved in ways which could be perceived as undesirable by potential purchasers. One hundred dogs sheltered by the Ulster Society for the Prevention of Cruelty to Animals were studied over a 4 h period. The dogs' position in the cage (front, middle, back), vocalisation (barking, quiet, other), and activity (moving, standing, sitting, resting, sleeping) were recorded. Dogs spent significantly ($F_{2,196}$=144.85, P<0.001) more time at the back of the cage (67%). This may reflect negatively upon visitors1 perceptions, given their preference for dogs at the front of the pen. Dogs spent very little time (2.4%) barking ($F_{2,196}$=5876.55, P<0.001). Given peoples' preference for dogs which are quiet, this behaviour may promote positive public perceptions. Dogs spent significantly ($F_{3,392}$=103.79, P<0.001) more time standing (52%). This may have a positive effect on public perceptions, given their liking for dogs which are alert. Findings indicate that a sheltered dog's vocalisation and activity may promote positive public perceptions. The dogs' position in the cage is more concerning. The chances of sheltered dogs being purchased, and consequently its welfare, might be improved by modifying the cage environment to entice dogs to the front of the pen.

Efficacy of synthetic feline facial pheromone analogue for the treatment of chronic non-sexual urine spraying by the domestic cat

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"Feliway" (Sanofi Sante Nutrition Animale) is a synthetic analogue of the feline facial pheromone F3 (Pageat, 1996, *XXIst Congress of the World Small Animal Veterinary Association*, Jerusalem, Israel). A 96.7% efficacy for the elimination of recent onset (less than 3 mo) urine spraying has been reported (Pageat, 1996). The current study reports the results of a clinical trial involving 57 cats in 46 U.K. households possessing 5 or less cats, where urine spraying had been a consistent problem for at least 4 mo.

All cases were either neutered male cats, entire or neutered female cats and were classified as reactionary sprayers. The average age of cats in the trial was 7.3 years (range 8 mo to 17 years) with a mean problem duration of 56 mo (range 4-120 mo). The trial was divided into 6 periods, during which the domestic environment remained consistent: weeks -1, 1, 2, 3, 4, 5. Progress was monitored centrally on a weekly basis. None of the recruited cases were on medication relevant to the condition. For the first 7 days of the trial (week -1), the owners were required to record the incidence of urine spraying over each 24 h period without the use of "Feliway". Treatment commenced on Day 0. One depression of the "Feliway spray" was applied to the urine mark, from a distance of 10 cm, about 20 cm above the ground. Other prominent areas thought likely to attract the cat's attention were also treated at this time. On average around 8-9 areas were treated in each household. Single applications were made in single cat households. If more than one cat was present in the household, "Feliway" was applied twice daily, 12 h apart. Owners were asked not to modify their routine or attempt to implement any other behaviour modification for the duration of the trial. Use of "Feliway" continued until Day 35, week 5.

Fifty-two out of 57 cats (91%) had reduced their rate of spraying by day 35, representing 42 out of 46 households (91%). These results were significant at $P<0.05$ (urine marks per cat weeks -1 and 5). Thirty cats from 24 households (57%) had not sprayed during the last 7 days of the trial. Neither the number of cats in the household, age of cat nor duration of problem was predictive of the degree of improvement obtained.

Unpublished placebo controlled trials by Pageat have demonstrated that application of the carrier used for F3 in "Feliway" has no significant effect on the incidence of urine spraying by cats. The results therefore suggest that "Feliway" is effective in the management of long-standing cases of urine spraying in the home by domestic cats.

The foraging behaviour of *ad libitum* compared with restricted fed sows housed in dynamic groups

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The food restricted sow exhibits high levels of foraging behaviour in the post-prandial period. This behaviour has been shown to contribute to the development of stereotypies and may also, through increased activity levels or frustration, lead to aggression. Providing sows with a high fibre diet *ad libitum* may reduce hunger, thereby reducing foraging motivation and the need for straw to be provided as a foraging substrate. The aim of this experiment was to compare the foraging behaviour of sows fed a high fibre diet *ad libitum* (A) with that of restricted (R) fed sows. Over a period of 10 mo, 10 groups of 5 gilts were entered into 2 existing groups of sows housed in adjacent straw-bedded pens. Non-experimental gilts and sows were used to maintain group size at approximately 35 animals throughout the experimental period. R gilts were fed 2.2 kg (second parity: 2.4kg) of a conventional pregnancy diet (12.6 MJ DE/kg) daily via an electronic sow feeder. Gilts on the A treatment had free access to a high fibre diet (11.4 MJ DE/kg) containing unmolassed sugar beet pulp (60%) from 5 single space hoppers. Subgroups were observed on 5 occasions during their first and second gestation every 20 min, from 0900 to 1100 h and 1130 to 1230 h and from 1300 to 1500 h and 1530 to 1630 h. The total number of skin lesion was scored 8 times during each gestation (days -1, 1, 3, 7, 14, 28, 42 & 56 relative to the day of introduction).

Sows on the A treatment spent significantly more time feeding (R vs A; 0.7 vs 7.7%, $P<0.001$) than R fed sows. After adjustment for the time spent feeding, A sows spent significantly more time inactive/asleep (R vs A; 63.9 vs 74.2%, $P<0.05$) than R sows, but only during the first parity. In addition, A sows spent significantly less time manipulating straw (R vs A; 12.8 vs 7.6%, $P<0.010$) and spent less time manipulating substrates other than straw (R vs A; 8.8 vs 5.5%, $P<0.001$) than R sows. Sows on the A treatment also had fewer skin lesions on the first day following introduction (R vs A; 97.2 vs 63.5, $P<0.05$) than sows on the R treatment. The *ad libitum* feeding of a high fibre diet appeared to be more successful in satisfying feeding motivation than restricted feeding of a conventional diet. Such a feeding regime may, therefore, be instrumental in mitigating the development of aggressive or stereotypic behaviours, especially in systems in which a foraging substrate is not provided.

Individual variation in the voluntary intake of different flavoured solutions by Thoroughbred gelding horses

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Taste is believed to be important in the selection of foods by horses (Fraser, 1992, "The Behaviour of Horses") and it is generally presumed that horses perceive similar taste modalities to man (Waring, 1983, Horse Behaviour: The Behavioural Traits and Adaptations of Domestic and Wild Horses, including Ponies) Randall et al. (1978 *J. of Anim. Sci.* 47: 51-55) have previously reported on the responses of immature horses to sweet, salty, sour and bitter solutions. They noted individual variation in response to the test chemicals. Intake is however more likely to be affected by the more complex quality of the food flavour. Hence particular flavour additives are employed in both horse feeds and electrolyte solutions in order to increase intake. The perception of this requires the integration of olfactory and gustatory stimuli. The current experiment aimed to assess the effect of particular flavours on intake.

Six mature geldings were offered 1 of 6 flavoured solutions (apple, blackcurrant, honey, orange, mint, vanilla) for 4 consecutive days using a 2 choice preference test flavoured solution vs tap water (Goatcher and Church, 1970, *J. of Anim. Sci.* 30: 777). During the course of the trial, each horse was exposed to every flavour and this was prepared to the same concentration for each individual. Management practices were constant throughout the test period.

Since individual daily fluid intake in horses has a large variance, a relative measure of preference was used; this was based on a mean intake of 60% or more for either of the 2 fluids offered during a test period. No flavour was consistently preferred or rejected by all test subjects. Individual preferences were apparent. Apple was rejected by 4/6 and preferred by 1/6, blackcurrant was rejected by 5/6 and preferred by 1/6, honeyed water was rejected by 4/6 and preferred by 1/6, orange was rejected by 4/6 and preferred by 0/6, mint was rejected by 1/6 and preferred by 2/6 and vanilla was rejected by 3/6 and preferred by 1/6. Three individuals expressed no preference towards the flavoured solutions and rejected apple, blackcurrant, honey and vanilla, 2 of these also rejected orange and 1 mint. The data suggest that intake by some individuals may be affected by an element of neophobia and that this may be overcome with a longer test period and the voluntary intake of any product may also be improved by providing it in a variety of flavours. Both of these factors may be of commercial significance.

Effects of age at weaning on belly-nosing behaviour in piglets

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Segregated early weaning (SEW) is a swine management system where piglets are removed from the sow at an early age and transported to a separate growing facility. Average weaning ages in SEW systems range from 16-17 days to as low as 7-10 days postpartum. North American commercial swine operations are rapidly shifting to SEW systems with very little information about the behavioural implications. The objective of this study was to observe the possible behavioural effects of early weaning. Piglets were weaned at 7, 14 and 28 days of age. Three trials were conducted with 9 litters in each trial. At random, 3 litters were assigned to be weaned at 7 days, 3 at 14 days and 3 at 28 days. Litters were mixed and the piglets were grouped in pens of 10, giving 2 pens per weaning age per trial. The piglets were videotaped for 5 periods of 48 h during days 7-8, 11-12, 14-15, 28-29 and 42-43. Additional quantitative information such as feed intake, body weights and skin integrity scores were recorded weekly.

Belly-nosing, an oral-nasal behaviour directed at other piglets, may induce skin lesions and stimulate aggression. Belly-nosing occurred infrequently on the first 2 days after weaning at all 3 weaning ages (Table 1). Piglets weaned at 7 days spent a large percentage of their time belly-nosing 4 days after weaning. This increased level of belly-nosing continued until 4 weeks after weaning. At 6 weeks of age piglets weaned at 7 and 14 days continued to spend more time belly-nosing than the piglets weaned at 28 days ($P<0.05$). Throughout the period of observation, piglets weaned at 7 days belly-nosed 10 times more than piglets weaned at 28 days of age. Piglets weaned at 14 days however belly-nosed only 3 times more than the 28 day weaned animals. This suggests that the relationship between belly-nosing and age at weaning may look more like an exponential curve than a linear relationship. These very early weaned piglets (7 day) also exhibited escape behaviour immediately following weaning, exhibited low levels of exploratory behaviour and spent less than 1% of their time at the feeder 2 days post-weaning. These results suggest that early weaning causes significant behavioural differences over a prolonged period.

	Day Observed				
Age at weaning	Day 7&8	Day 11&12	Day 14&15	Day 28&29	Day 42&43
7 days	1.3 ± 0.3	10.7 ± 1.3	10.3 ± 1.0[a]	6.4 ± 0.92[a]	2.4 ± 0.29[a]
14 days	-	-	1.2 ± 1.1[b]	1.9 ± 0.97[b]	1.6 ± 0.35[a]
28 days	-	-	-	0.61 ± 0.69[b]	0.44 ± 0.27[b]

Table 1: Percentage of time piglets spent belly-nosing (± s.e.m.) per piglet per 48 h. Numbers within columns with different letters are statistically different ($P<0.05$).

Stereotypies revisited: the dynamic view

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Stereotypies are perhaps the most striking behavioural symptom of intensive housing. They occur in a wide variety of zoo, farm, and laboratory animal species and are considered to reflect severe behavioural disorders. Research on stereotypies has thus become one of the major issues in applied ethology. Over the last 10 years considerable efforts have been undertaken to unravel the causal as well as the functional aspects of stereotypies. They have been associated with pathological neuronal functioning, coping with chronic stress or self-narcotization through the release of endogenous opioid peptides. Experimental research, however, has not yet produced satisfying evidence to support any of these ideas. An important reason for this may be the use of inadequate animal models. Stereotypies are defined as repetitive, invariant behaviour patterns without obvious goal or function. Though widely accepted, this definition has repeatedly given rise to controversial discussions, mainly because it covers a far wider range of behaviours than was presumably intended. Revisiting stereotypy reviews and conceptual papers for the nature of stereotypies reveals a picture that goes far beyond the definition presented above. In contrast to the static view expressed in the definition, there is wide agreement on additional characteristics that are used to refer to the dynamic, developmental processes that shape the final form of stereotypies throughout ontogeny. These include increasing performance, decreasing flexibility, and emancipation from the causal factors with age. Nevertheless, since these dynamic features are not defining criteria, theoretical ideas on stereotypies will continue to be tested using animal models (behaviour patterns) that do not apply (e.g. many redirected behaviours, displacement activities, intention movements etc.). This hampers identification of both the mechanisms underlying stereotypy development and the consequences for the individual. For example, after replicating an experiment Schouten and Rushen (1992, *Appl. Anim. Behav. Sci*. 33: 17-26) rejected Cronin, Wiepkema and van Ree, (1985, Neuropeptides 6: 527-530) original finding that the opioid-receptor blocker naloxone disrupted stereotypic behaviour by sows. Only Schouten & Rushen's (1992) category of stereotypy included all forms of oral chain manipulation (redirected feeding/foraging) whereas Cronin et al. (1985) had defined individual sequences of stereotyped behaviour prior to testing. As a result of such inconsistency, stereotypies may appear essentially heterogeneous. Understanding stereotypies means to understand the processes by which a given behavioural response (the 'source behaviour pattern') is shaped into the stereotyped form. The dynamic characteristics of stereotypies implicitly relate to such processes. Increasing performance, decreasing flexibility and emancipation from the eliciting stimuli are behavioural changes that suggest the existence of underlying neuronal correlates. To be able to detect them and assess their significance (e.g. in terms of animal welfare), it is essential to use appropriate animal models. The consensual definition of stereotypies is no guarantee for that. Therefore, using the dynamic characteristics of stereotypies to redefine them in a more rigid manner would substantially reduce the range of behaviour patterns considered as stereotypies to form a more coherent and meaningful category. The implications of this for both stereotypy research and the use of stereotypies as indicators of poor welfare will be discussed.

Behavioural and physiological effects of intracerebroventricular infusion of corticotropin-releasing factor in sheep

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Considerable evidence suggests that corticotrophin-releasing factor (CRF) has an important role in mediating stress responses, i.e. changes in behavioural, autonomic, neuroendocrine and immune functions following stress, but its effects on these functions have not been evaluated in an integrated whole animal model. To extend this concept to sheep we examined acute changes in behavioural, autonomic and endocrine functions following intracerebroventricular infusion of ovine-CRF (oCRF). Four sheep were infused with either oCRF (0.5, 5 and 50 μg dissolved in 0.5 ml artificial cerebrospinal fluid [aCSF]) or 0.5 ml of aCSF into third ventricle over 30 min. Serial blood samples for cortisol measurement were collected via indwelling jugular catheters. Heart rate and rectal temperature were recorded by a telemetry system. Three of 4 sheep bleated 21, 80 or 89 min after the onset of 5 μg of oCRF infusion, and 3 of 4 bleated 46, 47 or 68 min after the onset of 50 μg of infusion. Five and 50 μg oCRF elicited a dose-related decrease in rectal temperature over 70 to 120 min period after the onset of infusion. 0.5 - 50 μg oCRF elicited a dose-related increase in plasma cortisol values over 20 to 90 min period. These findings indicate that oCRF is involved in the sheep's behavioural, autonomic and endocrine responses in a dose-related manner. Further study is needed to assess the effect of oCRF considering various stressful contexts to establish the integrating neurobiological model of stress responses.

Effects of omission of reward after classical and operant conditioning on vocal behaviour of the laying hen (*Gallus gallus domesticus*)

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Diminished welfare in laying hens partly arises from thwarting of biologically significant behaviour (=frustration) under intensive husbandry conditions. This frustration is probably vocally expressed through a specific vocalisation, the laying-call. If diminished welfare is actually expressed through the laying-call, it should be possible to use this vocalisation as a reliable welfare-indicator of laying hens in a particular system. However, 2 requirements have to be met: first, when a hen is thwarted in a certain behaviour an increase in the laying-call has to be found. And second, some features of the laying-call must vary consistently with a change in the animal's welfare state.

Concerning the first requirement the following study was carried out. In automated Skinnerboxes 20 hens of 2 commercial laying strains (10 ISA Brown Warrens, 10 ISA White Leghorns) were subjected to classical conditioning; 3 red lights made the hens approach the feeder, the feeder went up and they were allowed to eat for 5 s. After training the hens were divided in 2 groups; 1 group first got a control session (FOOD) and after that a frustration session (NO FOOD=empty feeder), for the other group it was the other way around. During frustration we found a significant increase in the number of laying-calls ($F_{1,18}$=14.16, P=0.002) compared to the control situation.

Concerning the second requirement the effect of deprivation on frustration of feeding behaviour was tested. This was done by training the hens to peck a key for a food reward. After reaching baseline criterion each hen was randomly subjected to 4 different durations of food deprivation (0, 8, 23 and 47 h) and tested as in the previous experiment. The first results show that the change in deprivation is expressed in variation in the rate of the laying-call. There was a gradual increase in number of laying-calls and the mean duration and number of elements per laying-call increased with increasing time of deprivation.

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