UNIVERSITY OF AGRICULTURE, ABEOKUTA
COLLEGE OF ANIMAL SCIENCE AND LIVESTOCK PRODUCTION
DEPARTMENT OF ANIMAL PHYSIOLOGY

ANP507: Comparative Animal Behaviour (2 Units)

Definition

Animal behaviour is the sum total of habits, actions and reactions of animals in a particular environment. The study of animal behaviour is called **ethology**.

Animal behaviour and livestock production

Applied ethology has important implications for livestock production, especially for animal productivity and welfare, as well as safety on the farm.

Basis of behaviour

Behaviour can be inborn (innate or instinctive) or acquired (learned). Ultimately, the underlying basis of behaviour is genetic, manifested as physiological responses which may be endocrine, neural or neuro-endocrine. Behaviour is moderated by both the internal and external environments of an animal.

Course content

In this course, the behavioural profiles of the following species of domestic livestock will be studied:

- Sheep
- Goats
- Cattle
- Pigs
- Poultry

Aspects of behaviour to be discussed in each species are:

1. Vision and other special senses
2. Social organization and dominance hierarchies
3. Sexual behaviour
4. Maternal – offspring behaviour
5. Abnormal behaviour.

The topics to be treated under learning theory are:

a. Imprinting
b. Non-associative learning
c. Classical conditioning
d. Operant conditioning
e. Extinction
f. Positive reinforcement
g. Negative reinforcement
h. Punishment
i. Shaping.

The course will also cover animal training, welfare and safety.

BEHAVIOURAL PROFILES OF DOMESTIC ANIMALS SHEEP

VISION AND OTHER SPECIAL SENSES

Sheep have **panoramic vision (a sight that gives the user wide angled view)** of 330°–360° and **binocular vision (using both eyes)** of 25°–50°. They are thought to have colour vision and are able to distinguish between a variety of colours: black, red, brown, green, yellow and white (Alexander and Shillito, 1978). They have no accommodation (automatic adjustment of the focus of an eye to give clear vision), so must lift the head to see distant objects. This also means that they are unable to judge depth.

Sheep eyes possess **very low hyperopia** (far sightedness) with **little astigmatism (imperfect image or blurred vision).** Such physiological optics is likely to produce a well-focused retinal image of objects in the middle and long distance (Piggins, et al., 1996).

Sight is a vital part of communication and **when sheep are grazing they maintain visual contact with each other** (Crofton, 1958; Kilgour, 1977). Each sheep throws its head to check the position of the other sheep. This constant monitoring is probably what keeps the sheep in a mob (**noisy crowd)** as they move along grazing.

Psychological stress induced by isolation is reduced if sheep are provided with a mirror, indicating that the sight of other sheep has stress-reducing properties (Parrott, 1990).

Work has been done by Franklin and Hutson (1982a,b,c) to find what stimuli attract sheep to move along a path. **They found that olfactory (relating to smelling) stimuli were of no use as attractants and that there was no practical advantage in using sheep calls to attract sheep to move along a race.** The use of a decoy (distractor) sheep was effective in attracting sheep to move out of a pen and along a race, and sheep moved out of a pen faster towards a mirror that reflected the countryside, or towards open-wire mesh than towards a covered race ending.

Deprivation of the senses of smell, sight and hearing on the mating behaviour of rams indicated that the absence of sight has the most inhibitory effect on behaviour and reduced the oestrus detection activity and dexterity of mating. The loss of hearing has no marked effect on mating behaviour (Smith, 1975).

Taste is the most important sense in establishing forage preferences, with sweet and sour plants being preferred and bitter plants being more commonly rejected. Touch and sight are also important in relation to specific plant characteristics, such as succulence and growth form (Krueger, et al., 1974).

SOCIAL ORGANISATION, DOMINANCE HIERARCHIES AND LEADERSHIP

***Dominance* (power exerted over other). In a flock of grazing sheep there is little or no sign of dominance**. In small domestic flocks, sheep will compete for small amounts of food by pushing and shoving rather than active bunting. Dominance–subordination relationships were assessed in Merinos and Border Leicesters by Squires and Daws (1975). They found an almost linear hierarchy in Merinos and a less rigid structure in Border Leicesters when a competitive feeding situation was created.

***Social groups*. Sheep form strong social groups that are stable and the social organisation of the flock influences grazing patterns.** Animals are not randomly dispersed in any environment and free-ranging groups may exhibit extreme non-randomness in the use of resources, particularly vegetation. Young lambs form strong social bonds with each other or other objects (e.g., goats, humans, dogs, cattle). Sometimes a strong bond forms between two animals and they become mutually dependent.

The number of dominance fights within flocks is higher in single-sex, single-age groups than in mixed-sex groups of varying ages (Stolba *et al*., 1990).

The social system of sheep appears to have been shaped by anti-predator and foraging strategies that rely upon learned traditions (Festa-Bianchet, 1991).

Age-effects studies on cohesive and aggressive behaviour in sheep indicate that older animals are more likely to be involved in fights (Stolba *et al*., 1990).

Family groups are less likely to display fighting and attention-seeking behaviours, indicating that a socially stable flock may be less affected by environmental heterogeneity than groups that are not as well integrated socially (Stolba *et al*., 1990).

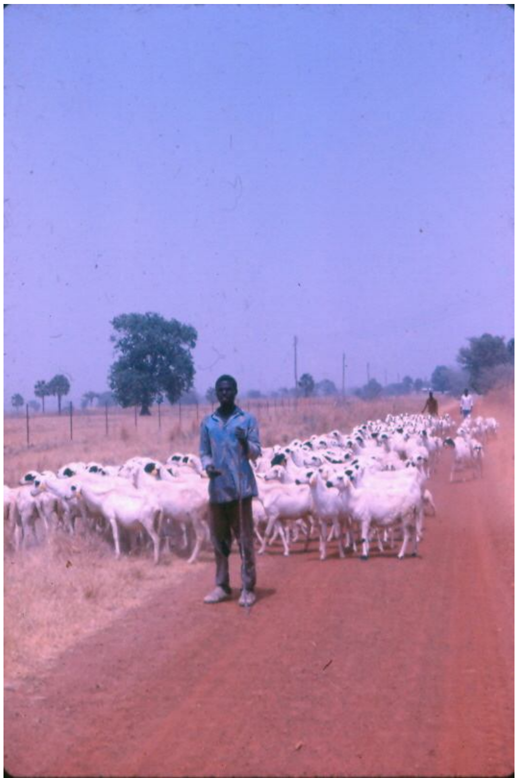
Characteristics of flock structure. Research has shown that different breeds have different flock structures (Arnold *et al*., 1981):

1. Merinos are a tightly knit flock and rarely form sub-groups. They graze close to each other and disperse into sub-groups only under extreme food shortage, when sex and age groups segregate out.

2. Southdowns usually form a few sub-groups and are closely associated when grazing, but not when camping.

3. Dorset Horns always form many sub-groups.

In cases where sub-groupings occur, the flock maintains a social entity because membership of sub-groups is constantly changing. The identification of a flock structure is important to understand when managing sheep. One important aspect is that, irrespective of breed, flocks of sheep drawn from different sources do not readily integrate into a socially homogeneous group (Winfield *et al*., 1981). This means that if the paddock is large enough, each group will use a different area, even if the food is better in one part. This can lead to some sheep being under-nourished.



In a gregarious breed, such as Merinos, the flock moves as a unit and is unsuited to grazing in pastures that are not uniformly abundant. The net effect of such behaviours, particularly on an extensive scale, is that to increase or decrease stocking rate will not necessarily lead to improved animal production of an area. This is because the non-random spread of animals in that grazing area makes some sectors virtually psychologically unavailable to some individuals.

Sheep have a strong bias for associating with others of their own breed both when grazing and camping (Arnold *et al*., 1974).

Observations in undisturbed flocks show that group identity develops when small flocks are established. Breed identity perception also exists within flocks composed of groups of sheep of different breeds (Arnold *et al*., 1974).

Leadership. Squires and Daws (1975) found that position in a moving flock was highly correlated with social dominance, but there is no definite study to show consistent voluntary leadership by an individual sheep.

Under mixed-stocking situations, sheep do not usually associate with cattle. However, sheep will stay close to and follow cattle when forced into close association with cattle at an early age, with wethers staying nearer to cattle than ewes (Anderson *et al*., 1996).

Sheltering behaviour. If shade is available in summer, sheep use it, but if it is not available they stand about in groups, shading their heads under the flanks or between the hind legs of adjacent lambs rather than lying down (Schreffler and Hohenboken, 1980). A major problem in Australia is that about 20% of winter-born lambs die from lack of shelter. An important research project has looked at ways in which Merinos can be forced to take shelter before their lambs are born. Research has shown that it may be possible to train sheep to spend resting periods in sheltered areas by shearing during the cooler months; subsequently, a high proportion may lamb in shelter, thereby reducing lamb mortality (Lynch *et al*., 1980).

The use of-artificial wind-breaks—either a tall, relatively unpalatable hybrid phalaris or polythene shade cloth, provided protection from wind and reduced the death rate of single lambs from 35.5% without shelter to 8.8% with shelter, when the temperature was less than 5° during the 6 hours after birth (Alexander *et al*., 1980).

The selection of sites for shelters is important so the behaviour of the sheep must be considered and the shelters placed where the sheep naturally prefer. Sheep tend to graze into the wind on treeless plains, in hot weather, but on cold wet days they huddle in the down-wind corner of the paddock, so shelters can be put there. They also tend to camp on hilltops in cold weather, so shelters could be placed on ridge tops. Least-used shelters are typically near roads, human activity and paddock ends (Pollard *et al*., 1999).

Under most conditions, sheep tend to spend more of their time closer to trees than would be expected by chance. This effect is intensified in paddocks with trees planted at low density (Sibbald *et al*., 1996).

Camping behaviour. **Certain breeds of sheep have definite 'bedding habits', known as camping.** Choice of campsite is important and often the sites chosen for day camps differ from night camps. Sheep have clearly defined tracks leading from the water points to day campsites (Squires, 1981). Merinos camp on high ground during cold weather and near water or under shade during hot weather. In adjacent small pastures, camping is along the common boundary or adjacent corners. Because sheep camp, a large proportion of faeces is dropped at the campsite and so plant nutrients are transferred from the pasture to the campsite. The distribution of plants is also influenced and there can be a build-up of internal parasite eggs at the campsite. In the management of pastures it may be necessary to fence off campsites at times and force the sheep to move to other areas.

Grazing. **Grazing is a social behaviour like sheltering and camping.** Sheep tend to have **two primary grazing periods**, **during the early morning and again late in the afternoon. The period from mid-morning to mid-afternoon is the least active**. **Grazing time, which may range from about 5.5–10 hours a day, is affected by many factors, including day length and other environmental factors, breed, availability of pasture and water, and topography**.

The grazing patterns adopted by sheep in small experimental paddocks are likely to be affected by daylength, lack of grass, and rate of loss of liveweight (Lynch *et al*., 1979).

The satiety mechanism is of much greater importance in sheep than the hunger mechanism in stimulating grazing (Forbes, 1978).

Sheep have a cleft upper lip that permits very close grazing, lower incisor teeth and upper dental pad. As the animal grazes, it jerks its head slightly forward and up to break stems, leaves and grass blades against the dental pad and lower incisors.

FACTORS THAT INFLUENCE INTAKE OF HERBAGE BY GRAZING SHEEP

The intake of herbage by grazing sheep is influenced by the age, size, weight and physiological state of the animal, climatic conditions and the availability and quality of herbage on offer. Little is known, however, about the interactions between body condition, cold stress and pasture availability on the intake of grazing sheep (Arnold, 1970).

Sheep grazing and efficiency is affected by paddock shape. Ewes grazing in rectangular paddocks grazed for less time, had lower intake levels and used forage less efficiently than ewes in square paddocks (Sevi *et al*., 2001).

SEXUAL BEHAVIOUR

In a pen environment it has been shown that no relationship exists between dominance and mating behaviour (Schreffler and Hohenboken, 1974). **In open environments there are conflicting results and although the dominant ram can prevent others from mating, it did not necessarily have the highest scores for percentage of ewes mated, number of mounts per oestrous ewe, or total number of mounts. Also, competition of ewes for a ram may have an effect, although there is no evidence** (Squires, 1981).

Exposure to recently mated rams increases the sexual performance of other rams. **Odour cues associated with the ewe or mating per se is thought to enhance the sexual efficiency of unmated rams** (Maina *et al*., 1997).

The odour of the oestrous ewe stimulates the ram, although it is the ewe that seeks out the ram and stays close beside it. **The male responds to urination of the oestrous female by sniffing**, extending the neck and curling the lip. **This is the flehmen response**. **The tongue goes in and out and the male may bite the female's wool, and raise and lower one front leg in a stiff-legged striking motion. If the female is receptive she will stand for copulation.**

In sheep, the duration of sexual receptivity in the presence of the ram is reduced when the ram is continuously present with the ewes (Romano *et al*., 2001).

The continuous presence of a ram after the removal of progesterone sponges hastens oestrus onset and reduces the interval between sponge removal and ovulation, without modifying oestrus duration and time between oestrus onset and ovulation in ewes synchronised during the breeding season (Romano *et al*., 2001).

Ewes in oestrus will often display ram-seeking behaviour, defined as a ewe being persistent in staying at the common fence with attention focused on the ram to the virtual exclusion of grazing (Ortman, 2000).

Mating efficiency may drop if food is short and ewes disperse into small sub-groups. In this situation the rams may not be able to find them at the usual ratio of 4 rams per 100 ewes. **This is one reason that under-standing flock behaviour under various environmental conditions is so important.**

There are several advantages to using wethers, which include low cost and convenience of treatment compared to the cost of vasectomy of the ram, and the use of wethers to identify ewes for artificial insemination or in the post-mating period to detect non-pregnant ewes.

The use of wethers (castrated male sheep) treated with oestrogen or testosterone has been shown to be as good as vasectomised (vasectomy :surgical cutting of sperm duct) rams for inducing ewes to ovulate and for detection of ewes in oestrus (Fulkerson *et al*., 1981).

MATERNAL–OFFSPRING BEHAVIOUR

Some ewes remain with the flock during lambing and others seek isolation. Within seconds of birth the ewe faces the lamb and begins vigorous licking and eating of foetal membranes. The young must find the teat within 1–2 hours of birth, and it seems that visual cues are very important for successful teat location (Bareham, 1975). Strange lambs are accepted immediately after birth and some ewes adopt new-born lambs if they have lost one. Adoptions in sheep flocks are more common than is generally realised and has some consequences in genetic experiments where lambs are identified with their mothers many hours or even days after birth. From about 12 hours after birth, a strange lamb is actively rejected.

Add-on fostering is limited only by the inability to properly match odour-familiar cues on a ewe's own and alien lambs (Price *et al*., 1998).

Lambs recognise their mothers' voices by individual differences (Shillito-Walser, 1980) and ewes recognise their lambs by a variety of cues. These cues may be vocal recognition (Shillito-Walser *et al*., 1981). Other workers (Morgan *et al*., 1975) suggested that recognition depended mainly on **smell**, while other studies (Alexander and Stevens, 1981) showed that **ewes could recognise their lambs from auditory and visual cues alone, but that the correct olfactory cues are required for suckling to be permitted**. These cues may be of differing importance depending on the breed of sheep, size of groups, and the environment they are running in.

Litter size has a strong effect on the time spent grooming by the ewe. The birth of the second-born twin results in a dramatic reduction in grooming of the first-born twin (O'Connor *et al*., 1989).

Analysis of lamb behaviour found that singles were more active, lying for less time and having a greater number of suckling attempts than twins (O'Connor *et al*., 1989).

Offspring behaviour has no effect on the onset of bonding behaviours of the ewe, and neonatal lamb activity is largely independent of the behaviour of the dam (Dwyer *et al*., 1999).
Suckling behaviour is modified by ewe behaviour and this affects the strength of the bond between ewe and lamb (Dwyer *et al*., 1999).

The sheep is a follower species and in the first day of life the ewe remains within one metre of the lamb, so the placement of water, food and shelter is important. The distance between ewe and lamb when both are grazing increases rapidly over the next 10 days of life, reaching a plateau with an average distance of 20 metres. Accidental separation in the first few days causes great agitation of both lamb and ewe, and reunion is immediately followed by suckling.

In the first 24 hours after birth, lambs identify their mothers at close quarters only (less than 50 cm), and discrimination at a distance of several metres becomes established only when the lambs are between 2 and 3 days old (Nowack, 1991). This helps to account for the prevalence of cross-suckling and mis-mothering in the early days of life.

Suckling has strong rewarding properties in the establishment of a preferential relationship with the mother by the lamb but the maintenance of this preference does not rely strongly on suckling (Nowack *et al*., 1997).

The strength of the ewe–lamb bond is determined mainly by milk yield with a threshold level below which weaning occurs (Arnold *et al*., 1979).

Lambs become familiar with and recognise individuals (twins and non-twins) as a result of direct association. They also discriminate between novel scents and artificial odorants associated with their familiar age-mates, but such odours neither mask nor substitute effectively for lambs' individually recognisable phenotypes (Porter *et al*., 2001).

The management of the maternal-offspring bond is important in the husbandry of lambing ewes. The main objectives are:

1. To produce lambs capable of finding teats and suckling successfully;
2. To produce ewes whose behaviour facilitates suckling.

Some circumstances delay suckling which will reduce the chances of successful suckling. These include:

1. **Mother remains lying after birth;**
2. **Mother circles;**
3. **Mother is absent—she may be attending to one twin at the expense of the other; and**
4. **The weather may be too hot or too cold.**

The sheep producer can help to ensure that suckling is successful in several ways:

1. **Environmental control such as positioning of shade, shelter, food and water;**
2. **Supervision of lambing; and**
3. **Selection of suitable breeds which make good mothers.**

ABNORMAL BEHAVIOUR

The most important abnormal behaviour is concerned with maternal behaviour. Sometimes a ewe may wander away from her lamb, but the lamb or move away as the lamb approaches to suckle. These behaviours are more common in ewes with twins, which seem unable to recognise that they have more than one lamb.

Aggressive behaviours are preferentially directed towards members of the same flock (Ruiz-d-la-Torre *et al*., 1999).

A small percentage of rams commonly will not mate with oestrous females and, if given a choice, will display courtship behaviour towards another ram in preference to a female. This partner-preference behaviour of rams may be traceable to foetal development and could represent a phenomenon of sexual differentiation (Resko *et al*., 1998).

GOATS

VISION AND OTHER SPECIAL SENSES

Goats have prominent eyes, a **panoramic field** of 320°–340° and a **binocular vision** of 20°–60°. Tests have been done on male goats to determine their capacity for colour vision and they have been found to **distinguish yellow, orange, blue, violet and green from grey shades of similar brightness** (Buchenauer and Fritsch, 1980). They have a **well-developed sense of smell and a new food is investigated by sniffing it.**

SOCIAL ORGANISATION, DOMINANCE AND LEADERSHIP

In a herd of feral goats it is a **large male that is dominant and maintains discipline and coherence of the flock** (Mackenzie, 1980). He leads the group **but shares leadership on a foraging expedition with an old she-goat (flock queen), who will normally outlast a succession of kings.**

Horn size is a rank symbol and can designate dominance without combat. It has been suggested that **scent urination, a ritual where a male goat urinates on his beard, is an indicator of rank and physical condition.** O'Brien (1981) has reviewed some aspects of social organization and behaviour in the feral goat, including the importance of olfactory communication.

Agonistic encounters can be "non-contact" threat which includes staring, a horn-threat with chin down and horns forward, rush or rear as a challenge threat. Contact agonistic

encounters include pushing the forehead against another goat, butting (in which combatants engage horns), and the rear-clash, which is a high intensity encounter.

In feral groups, the group size and composition is highly variable and unstable. Family groups may include a dominant male, and a small number of adult females and their offspring. Males form large bachelor herds during non-breeding periods.

It is almost impossible to drive goats and when danger approaches, goats scatter and face the enemy, depending for safety on agility and maneuvering (Mackenzie, 1980).

Alarm behaviour is highly developed. The female stands rigid in a typical nursing posture with ears towards the source of alarm. This stimulates the young to run to the female. She may snort loudly several times to alert other goats. Depending on the source of alarm, the group may either take flight, move away slowly or return to previous activities.

Leadership**.** Early work (Stewart and Scott, 1947) showed that leadership orders did not seem to be related to age or dominance. Donaldson *et al*. (1967) found milking order was consistent, and that there was a correlation between entrance order and milk weight.

SEXUAL BEHAVIOUR

The male tests the urine of the female and performs flehmen. He then approaches the female with a slight crouch, head slightly extended, horns back and ears forward, the tail vertical and often with the tongue extended (Coblentz, 1974).

The female either remains still as the male approaches or begins to move away depending on her state of receptivity. If she is receptive the male does the ‘rush-grumble’, where he rushes towards the female and vocalizes. He then nuzzles her flank, back and anogenital area with his tongue extended.

The female signals her willingness to copulate by standing still with her head lowered and tail to the side.

MATERNAL-OFFSPRING BEHAVIOUR

Within a few minutes after parturition the mother begins actively licking and grooming (care taking) the kid. This not only cleans the kid but probably provides cues for neonate recognition by mother. These cues are a complex interplay of vocal, visual, olfactory and gustatory stimuli.

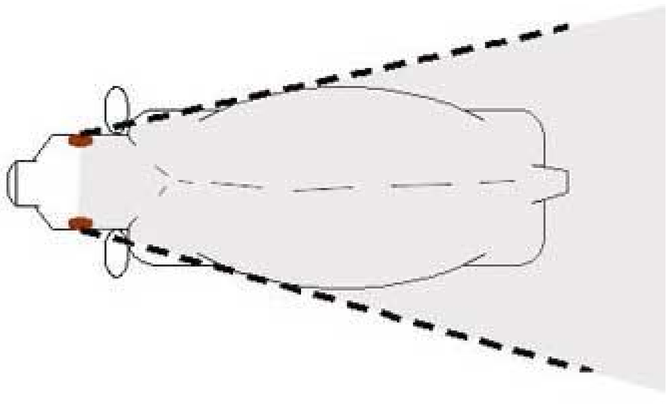
The maternal–offspring bond is very individually specific and the female aggressively rejects the suckling attempts of alien offspring.

Feral goats hide the neonate to prevent attack by a predator. This is similar to cattle behaviour, but the young of the sheep are followers.

CATTLE

VISION AND OTHER SPECIAL SENSES

With their eyes positioned on the side of the head, cattle have panoramic vision of 330° and binocular vision of 25°–50°, which allows for good predator awareness (Phillips, 1993). Despite the wide set of their eyes, however, they do have a blind spot directly behind them (see below).



Cattle have slit-shaped pupils (Smith, 1998) and weak eye muscles, which inhibits their ability to focus quickly on objects (Coulter *et al*., 1993).

Cattle can distinguish long wavelength colours (yellow, orange and red) much better than the shorter wavelengths (blue, grey and green), which may have aided their response and survival when a herd member was attacked and blood was spilt (Phillips, 1993). Cattle can distinguish all colours from a grey background except blue (Dabrowska *et al*., 1981), and have a poor depth perception. Because of this poor depth perception and lack of definition, cattle will often baulk and refuse to cross a shadow or drain grate and are best moved through diffuse light.

While grazing, cattle constantly sniff the pasture, but it is not known if plants are rejected on the basis of odour. Cattle can distinguish smell, e.g. they will baulk at the smell of blood and offal. The sense of touch is important in determining which herbage is rejected or preferred. The secondary/special olfactory system can detect pheromones, volatile chemicals that are important in reproduction and feed selection (Currie, 1995).

The ears of cattle are very sensitive. Cattle can be calmed by playing soothing music, or stressed by loud noises such as yelling (NSW Feedlot manual 1997). Dairy breeds are more sensitive to sound and touch than beef breeds, high-pitched sounds, such as the whistle used to control most farm dogs, will increase the animals' heart rates (Lanier et al, 2000). Hearing in cattle is important in inter- and intra-species communication (Phillips, 1993).

Cattle flight zones can vary greatly. Feedlot cattle may move away from people, especially strangers, entering their flight zone of 1.5m, whereas less handled range cattle have a flight zone of 30m (NSW Feedlot manual, 1997).

Cutaneous sensitivity can be used to calm cattle by scratching under the neck and behind the ears, areas they find difficult to access (Moran, 1993).

Sensory input at the level of the penis is important for sexual behaviour during mounting (Hafez, 2000).

Older cattle grazing on rangelands will spend less time grazing than younger cattle due to their experience and learned paddock patterns (Krysl *et al.,* 1993).

SOCIAL ORGANISATION, DOMINANCE HIERARCHIES AND LEADERSHIP

Under farm conditions the dairy herd is organized into a social hierarchy. Schein and Fohrman (1955) found age and weight to be significantly correlated with rank, and height at the withers is also a contributing factor in steers (McPhee *et al*., 1964).

Other workers (Reinhardt, V. and Reinhardt, A., 1975) have shown an inverted U-shaped relationship between dominance and age. They found that cows rose in rank up to about 9 years old as their weight increased; thereafter, dominance declined as weight was gradually lost.

In free-range heterosexual herds of cattle there are several hierarchies among adult males, adult females and juveniles. As they age, young males fight adult females and eventually dominate them.

The hierarchy tends to be linear and large herds probably break down into a series of smaller hierarchies (Hafez and Bouisson, 1975). There is evidence that dominance hierarchies in young beef steers are formed soon after weaning and that they remain stable even when the groups are moved to other pens (Stricklin *et al*., 1980).

Dominance and eating behaviour have been observed in beef cattle where only one animal at a time could eat, and it was found that high-ranking cattle had fewer meals but tended to spend more time per day eating. Also dominant cattle did not prevent subordinates from gaining access to the stall, and the lower-ranking cattle replaced higher-ranking cattle as frequently as they were replaced by higher ranking cattle. Dominance becomes important only when there is a very limited amount of food for which to compete (Stricklin & Gonyou, 1981).

Although early work has not shown a relationship between dominance and milk production, recent field observations on ten commercial dairy farms showed that cows yielding a higher amount of milk came earlier for milking and those yielding a lower amount of milk came later (Rathore, 1982).
Aggressive interactions in cows appear to be ritualized and occur in sequence: approach, threat, physical contact or fighting. Once the dominance relationship of any pair of animals is learned (Beilharz and Zeeb, 1982), it eliminates the need for further combat. The subordinate animal retreats from the dominant at the slightest threat and physical contact is of minor importance as long as the animals can see each other's posture.

Leadership. Until recently there appeared to be no evidence for a relationship between leadership and dominance. It had been suggested, but not substantiated, that the most dominant animals were in the middle of the herd (Kilgour and Scott, 1959).

A recent study looked at patterns of leadership during grazing movements (Sato, 1982), which were divided into following, independence and leading. It was found that high-ranking animals tend to lead, medium ranks tend to follow and low-ranking animals tend to be independent. An interesting suggestion was that it was the active movement of high-ranking animals and the independent movement of low-ranking animals that governed the voluntary formation in grazing patterns.

Grazing. Grazing occupies a large amount of time in both dairy cows (about 8 hours/day) and in beef cattle (about 9 hours/day). Grazing behaviour is affected by many factors, including environmental conditions and plant species.

Cattle usually stand to graze and the pattern of grazing behaviour of each herd member is relatively similar.

$$\frac{\text{ruminating hours}}{\text{grazing hours}} \qquad \frac{6}{9} \qquad = 0.6$$

The animal moves slowly across the pasture with the muzzle close to the ground, biting and tearing off grass, which is swallowed without much chewing. They ruminate when resting and time devoted to ruminating is approximately three-quarters of that spent in grazing.
This will be altered by the type of pasture.

A useful ratio is the R:G ratio, i.e. if grazing is not restricted by management and is influenced by abundance of pasture and environmental factors (Tribe, 1955). If pasture is good, ruminating time is short, and the R:G ratio is low (0.4); if the herbage is poor and fibrous, ruminating time is longer and R:G value is high (1.3).

Group cohesion. In open treeless areas, free-ranging cattle group into large mobs and the distances between individuals are smaller than in areas with sparse to moderate tree and shrub cover. This means that the mob is more tightly clumped in open areas (Dudzinski *et al*., 1982) and this affects the grazing pattern.

Resting behaviour. The amount of time cattle spend resting depends on environmental conditions, time spent ruminating and grazing, and on breed. Studies on Zebu cattle showed individual preferences for particular resting areas, which could be traced throughout 12 months. The consistency with which an animal lies on its resting place is independent of its dominance hierarchy, which indicates that no competitive situation arises with other herd members for particular resting sites.
The animals will avoid sources of noise and disturbance and choose non-habitual resting sites if the preferred ones are close to the noise or disturbance (Reinhardt *et al*., 1978). Zebus and Zebu crossbreds will remain out in the bright sunlight resting or grazing, while British breeds seek the shade (Kelly, 1959). In a dairy herd of Friesian cows it was found that there was a consistent order for lying down and standing up (Benham, 1982).

Cattle have long memories (NSW Feedlot manual, 1997). They can individually identify 50–70 other herd members (Fraser & Broom, 1997).

Cattle will follow the lead animal (not necessarily the most dominant animal) quietly (NSW Feedlot manual 1997, Fig 9.1). This animal may lead, but often does not have control over herd direction but rather if a change of flight direction is caused, will run forward to the front position. *Bos indicus* cattle are generally more excitable than the European *Bos taurus* breeds (NSW Feedlot manual 1997, Fig 9.1).

Subordinate status can lead to attenuation of sexual displays (Hafez, 2000).

High hair whorls on the face are found in reactive cattle (Grandin, 1995).

Cattle will graze pasture that is 5 cm above the ground, distinguishing plants while grazing (Hosokawa, 1990). The herd’s day involves maintenance behaviour: standing, walking, lying, feeding, drinking, self-grooming, allogrooming, agonistic behaviour and ruminating (Mitlohner *et al.,* 2001).

Grazing is affected by temperature. In very high temperatures cattle will graze predominantly at night (Krysl et al., 1993).

Cattle accustomed to a rotational system of paddock allocation will graze faster than cattle that are left in paddocks for longer periods; they will also tolerate lower feed supply, knowing that feed will be available in the next paddock in the rotation (Krysl *et al*., 1993).

Cattle in rangelands graze with younger animals in the centre of the herd, surrounded by the more aggressive members. Aging and weak cattle will often graze away from the herd, sometimes due to an inability to keep up; this exposes them to potential predator attack (Manning *et al*., 1998).

Dairy cattle that are placed in new herds and exposed to dominance struggles involving aggression will often show a reduction in milk production for several days (Fraser *et al*., 1997). Fear may contribute significantly to the establishment of dominance (Albright *et al*., 1997).
In an exchange between two animals where one is clearly larger, healthier, stronger and older than the other, it may take no more than a movement gesture or threat to make the smaller animal submit or yield space (Albright *et al.*, 1997).

An aggressive bull will turn his body perpendicular to a challenger to display his full height and length (Houpt, 1998). Aggression is expressed by bunting or striking a challenger with the head (Houpt, 1998).

Dairy bulls are generally more aggressive than those of beef breeds, as well as being larger (Houpt, 1998). The unpredictable nature of a bull's aggressiveness leads farmers to use artificial insemination techniques so they no longer have to house bulls on the farm.

There is a tendency in the milking hierarchy for more dominant cows to enter the dairy first, and these individuals are also more likely to produce higher yields (Phillips, 1993).

Grazing time will be increased with the introduction of cattle (both dairy and beef) into new pasture, as more time is spent exploring the paddock, which could be associated with search grazing (Krysl *et al*., 1993).

The grazing time of calves in the presence of experienced grazing cattle was significantly longer than that ruminating hours grazing hours of calves grazing by themselves (Fukasawa *et al*., 1999).

A study of 7 breeds of cattle indicated that in windy wet weather grazing occupied 48% of their time and in windless cloudy conditions, grazing occupied 67% of their time (Rogalski, 1975).

Cattle lie down to sleep, ruminate or drowse for nearly half of their day (Houpt, 1998).
When cattle lie down they hold their heads up or drawn back to the flank area (Albright *et al*., 1997).

Lying-down times of a lactating dairy cow depend on the type of housing, the comfort of the stall or lying out area, the type of diet, whether or not pregnant and climatic factors (Albright *et al*., 1997).

SEXUAL BEHAVIOUR

As the cow reaches oestrus the bull becomes very excited and follows her closely, licking and smelling her external genitalia and often exhibiting flehmen. Recent work has shown that the bull uses the tongue to transfer fluid (probably urine) to a short incisive spur located on the dental pad. It is then transferred to the vomeronasal organ (Jacobs *et al*., 1980) which is considered to be the site of pheromone identification. Pre-copulatory patterns include pawing the ground and snorting, chin resting on the cow's rump just before mounting and then copulation. Copulation is short (seconds) compared with horses and pigs (minutes).

Social ranking of bulls can influence their sexual activity, the most dominant animals mating the most. Chenoweth (1981) has written a useful review of libido and mating behaviour in bulls and other species.

The female becomes hyperactive when oestrus begins and the number of indiscriminate agonistic interactions and mounting attempts increase (Schein and Fohrman, 1955). A subjective measure of the intensity of oestrus from how ‘excitable’ a cow seems to be, can be designated as strong, medium or weak. Relative differences between breeds, ages and individuals can be fairly accurately rated (Hafez and Bouisson, 1975).

Castrated males (steers, bullocks) may display similar sexual behaviour as intact/complete males (e.g. mounting); the lack of androgens inhibits actual mating/copulation. After male cattle are castrated, erections are the last aspect of male sexual behaviour to be lost (Hafez, 2000). Female sexual behaviour depends on ‘the circulating endocrine balance’, controlled by ovarian secretions, primarily oestrogen (Hafez, 2000).

As cows become sexually receptive they may mount or be mounted by other cows, sniff males or become involved in mock fighting. Cows are receptive for approximately a day (Hafez, 2000). The level of sexual behaviour displayed is determined by genetics, environmental factors, physiological factors, health and previous experience, e.g., bulls of dairy breeds are generally more sexually active than those of the beef breeds. New herd members attract greater sexual attention. Therefore, their introduction to a breeding group can be a useful means of stimulating sluggish bulls (Hafez, 2000).

Testosterone and oestrogen enhance the libido of males and females respectively (Currie, 1995). Oestrous duration of cows is longer when there are many other cows in oestrus at the same time (King, 1990).

The bull detects the pro-oestrous cow about 2 days before oestrus and remains in her general vicinity (Albright *et al*., 1997). During the oestrus period the cow increases her frequency of urination so the bull can sample both the odours and the taste of her urine (Phillips, 1993). The period of sexual receptivity (mounting behaviour) ranges from 1 to 18 hours, with the average being about 4.4 hours (King, 1990).

Bulls that are used for AI or hand-breeding may have poor semen quality or poor reproductive behaviour, due to the lack of stimulatory effects that result from the prolonged courtship (Houpt, 1998).

Bulls commonly masturbate, especially at times of inactivity (Houpt, 1998).
Mounting causes an immobilization reflex (rigid stance) in the oestrous females that are being mounted (Albright *et al*., 1997).

MATERNAL-OFFSPRING BEHAVIOUR

Suckling behaviour begins 2-5 hours after birth and the mother must be standing. The calf vigorously butts the mother's udder with its head while suckling. It has been noted that heifers which had a difficult birth took longer to stand than cows which had already had several calves. Experienced cows usually stand within one minute of the birth of the calf (Edwards and Broom, 1982). The mother licks the young to stimulate breathing, circulation, urination and defecation. The cow is a ‘hider’ species so the young are hidden near the birth site straight after birth and the afterbirth is eaten, because it could attract predators.

Teat sucking by the calf is most intense soon after it stands up and it is common for suckling to occur first from a front teat (Edwards and Broom, 1982). The distance maintained between the cow and calf increases steadily with time after calving but they keep in contact by vocalizing.

Within the first week of life the calf begins to follow the cow, but for periods of the day, groups of calves will be found lying together for much of the day while the cows are grazing. It is in the period before calves are themselves grazing that ‘nurseries’ may form (Squires, 1981). There may be ‘guard’ cows left in charge and observations are reported from cows under extensive rangeland conditions. Fostering of calves is possible if a group of calves is placed with several nurse cows, but there is a large variation in the number of sucklings permitted by the cows (Kilgour, 1972).

A cow becomes restless 1–2 days before calving. If possible, she will leave the herd shortly before birth, finding a quiet place to calve. This is often not possible in most domestic contexts, so herd interference can occur at the birth, and bonding may be disrupted (Hafez, 2000).

If calves are removed from their mothers immediately after weaning, they can be pre-conditioned. This involves handling quietly, early castration and dehorning to accustom them to human handling, making them quieter to handle as they age. They will suffer less stress than cattle that have had less frequent human contact (Grandin, 1999). This is in comparison with calves that are left with their mothers and learn behaviours to avoid humans (NSW Feedlot manual, 1997).

Vision, olfactory and vocal senses are involved in cow and calf identification. Cows will groom their calves, ‘labeling’ them as their own (Hafez, 2000). Calves usually stand 45 minutes after birth, and are suckling 2–5 hours later; the mother aids suckling by positioning her body for easier access (Hafez, 2000).

Between birth and 7 months, the mean duration of suckling time for calves was seen to be 34 minutes, with the suckling frequency being 4.5 times per day (Hattori *et al*., 1995). Weaning studies in *Bos indicus* have shown that heifer calves are weaned at 8 months of age, whereas bull calves are weaned at 11 months (Houpt, 1998).

Twins may receive less grooming than single calves (Hafez, 2000). Cows will lick the urogenital/rectal areas to stimulate urination and defecation (Hafez, 2000).

Hormones regulate maternal behaviour (Currie, 1995).

At calving, cows should be allowed to seek isolation in a sheltered place, which will allow a dry and soft surface to lie on. Dairy calves should be licked by their mothers, but the duration must be controlled so that calves are able to suck (Lidfors, 1994).

The heritability of maternal behaviour is low in cattle (Houpt, 1998), so it is difficult for farmers to select for good mothering ability in bloodlines.

Contact between the cow and her calf for a period as brief as 5 minutes postpartum results in a strong specific maternal bond (Houpt, 1998).

ABNORMAL BEHAVIOURS

1. ***Mis-mothering***. This may be due to the mother having suffered a long and difficult birth and not being able to stand up for suckling. The calf may also be too weak to suckle. Cases of mis-mothering are common with cows calving in synchrony in intensively managed maternity groups (Albright *et al*., 1997).

2. ***Nymphomania***. Such cows behave like bulls, pawing and mounting but refuse to stand for mounting by other cows. It could be an inherited trait. Nymphomania is more common in high-producing dairy cows than in cows of beef breeds (Houpt, 1998). Nymphomania is usually associated with follicular cysts (Houpt, 1998).

3. ***Buller-Steer Syndrome****.* This common health and economic problem in feedlot operations (Ulbrich, 1981). The typical buller-steer sexually attracts his pen-mates who take turns following and mounting the abnormal animal. It does not seem to be associated with rank, and may be due to boredom. When detected, bullers are segregated and treated for injury or illness. Approximately 2% of steers in a feedlot situation are buller steers (Houpt, 1998).

4. ***Illness/disease****.* Cattle that are not healthy will show abnormal behaviour. Healthy cattle will appear alert, stretch on rising and be vocal – they often vocalize in response to pain or stress (Grandin, 2001). Unwell cattle often show little interest in their environment, have dull eyes, sluggish movement, poor grooming and poor appetite (NSW Feedlot manual, 1997). Other indicators of sickness include over-stretching of the neck, hunching the back, kicking the belly area (indicating abdominal pain), grinding teeth, star-gazing, etc. (Moran, 1993).
Atypical sexual behaviour, such as nymphomania, homosexuality, hyper-sexuality, masturbatory behaviour, may be caused by genetic flaws, endocrine imbalances, management problems, and in many cases may be reversed (Hafez, 2000).

Masturbation in males is common, especially in bulls on a high protein diet (Hafez, 2000). Humans may modify behaviour by processes such as castration, spaying and endocrine implants to increase production and ease of handling (Currie, 1995).

PIGS

VISION AND OTHER SPECIAL SENSES

Pigs have colour vision and a panoramic range of about 310°, and binocular vision of 35–50°. It is thought they have no accommodation (i.e., they cannot focus). Pigs are inquisitive and this must be remembered when moving them. If they are not hurried and can explore as they go along, they can be driven without effort. The extent to which pigs have colour vision is still a source of some debate. However, the presence of rods and cones with two distinct wavelength sensitivities in the blue and green frequencies (Lomas *et al*., 1998) suggests that at least some colour vision is present.

Pigs have a well-developed sense of smell and use is made of this in Europe where they locate underground truffles. Hearing is also well developed and localization of sounds is made by moving the head. Olfactory rather than visual stimuli are used in the identification of conspecifics (Houpt, 1998).

Pigs learn quickly to manipulate food and water devices, to turn fans on and off (Ingram and Legge, 1970) and to turn on a source of radiant heat (Ingram *et al*., 1975).

Auditory stimuli are used extensively by pigs as a means of communication in all social activities (Gonyou, 2001). Alarm or aversive stimuli are transmitted to conspecifics not only by auditory cues but also via pheromones (Vieuille-Thomas and Signoret, 1992).

SOCIAL ORGANISATION, DOMINANCE HIERARCHIES AND LEADERSHIP

The basis of the social structure in feral pigs is the matriarchal herd of several females and their offspring (Kurz and Marchington, 1972). Males are not permanently associated with such herds, and are often solitary or in bachelor groups.
In the domestic situation pigs may be kept together with littermates throughout their lives or be grouped with strange pigs of similar age and size. There are two types of social organization in the domestic pig (Signoret *et al*., 1975):

a. Teat order;
b. Dominance hierarchy.

Teat order. Within the first few hours to two weeks after farrowing, the piglets become capable of recognizing their positions on the udder and preferentially attach themselves to anterior rather than posterior teats. This was shown in the early work of Donald (1973a, 1973b) and confirmed by many later workers (Hemsworth et al., 1976). It has been shown that stimulation of the anterior teats appeared to be important in causing milk letdown (Fraser, 1973) so it might be to the advantage of the entire litter to have these teats occupied by healthy piglets. The teat order may function as a type of territorial spacing system which, in turn, means a stable family life with minimum competition.

Most fights that occur in young piglets are around the udder (Hartstock and Graves, 1976) and more fights were won at the permanent nursing site than away from it. They called this the ‘home-court advantage’ and found that fighting declined as the nursing order was established.

Using an artificial sow to rear groups of piglets, Jeppesen (1982) suggested that recognition of a teat in a particular area of the udder depended on visual orientation by means of reference points on the udder to find the area, and then the olfactory sense is used for the search within that area.

Dominance hierarchy. This is the social organization established in groups of weaned pigs. When a number of unacquainted pigs are mixed together for the first time, they fight to establish a dominance hierarchy, usually of a simple linear type. The fighting behaviour is generally mouth-to-neck attacks with strong thrusts sideways and upwards (McBride et al., 1964).

The establishment of the hierarchy occurs within 24 hours of mixing but the level of aggression drops dramatically after about one hour (Symoens and Van Den Brande, 1969). The dominance hierarchy is important as the social rank appears to influence productivity. It has been shown by some workers (Bielharz and Cox, 1967; McBride *et al*., 1964) that social rank influences growth, while others (Meese and Ewbank, 1973a) found that weight was not correlated with dominance or sex. The dominance hierarchy is important as a group stabilizer, but under adverse, intensive conditions, animals low on the hierarchy may be disadvantaged by lack of food and water.

The top-ranking pig can be removed from the group for up to 25 days and on return will still retain its position, but only if the social group it left was stable (Otten *et al*., 1997). A pig at the bottom of the hierarchy is treated as a stranger and attacked when returned after three days (Ewbank and Meese, 1971). Pigs probably recognize each other by sight and smell.

It is an advantage in a husbandry system to have a stable social organization so that the pigs can settle down and grow and it may be that a system of ‘birth-to-slaughter-weight-in-one-pen’, in which pigs remain members of the same unchanged social group from birth to slaughter, is a way to reduce disturbances (Ewbank, 1978; Sainsbury D. and Sainsbury, P., 1979).

Huddling behaviour. Pigs are very susceptible to hot conditions and the rate of sweating is very low, so there is inadequate thermoregulatory compensation by respiratory evaporative loss. In the feral state, pigs seek shade and wallow in mud or water and become more active at night (Mount, 1979). Young pigs are sensitive to cold and a behavioural feature retained through a pig's life is the stimulus to huddle with littermates (Mount, 1979). Nest-building activity in the natural state provides shelter from environmental extremes.

Leadership. The work of Meese and Ewbank (1973b) showed no clear relationship between leadership, exploratory behaviour or social rank in groups of pigs in an outdoor area. Dominant pre-weaned piglets have higher growth rates than subordinates due to suckling the more anterior teats (which secrete the most milk and have the lowest incidence of mastitis), allowing their dominance to be maintained through to post-weaning (Dyck *et al*., 1987).

Agonistic behaviour among piglets will decrease if they are regrouped during lactation rather than post weaning (Olsson and Samuelsson, 1993).

Instability of the dominance hierarchy increases with stocking density, thus increasing stress and aggression. This appears to depress the immune system and thus heighten the herd's susceptibility to disease (Turner *et al*., 2000).

Grouping pigs by weight heterogeneously rather than homogeneously, as is the current practice, may increase growth rate and reduce hierarchical conflict by allowing clear weight differentiation among littermates (Francis *et al*., 1996).

Odour masking, by methods such as creating a familiar odour on all pigs, masking the odour of unfamiliar pigs, and the use of pheromones and/or artificial compounds, has had little, if any, effect in limiting aggression and increasing hierarchical stability (Gonyou, 1997).

Isolation from a social group is very stressful for pigs and may result in stereotypes or attempts to escape (Gonyou, 2001).

SEXUAL BEHAVIOUR

Courtship behaviour lasts only a short time when a boar is placed in a small pen with an oestrous female. The sow plays the critical role of meeting sexual partners as boars show equal choice between an oestrous and an anoestrous sow. The male sniffs the female, noses sides, flanks and vulva, and emits a 'mating song' of soft guttural grunts (6–8 seconds). He foams at the mouth and moves his jaw from side to side as the female poses and bites the male's ears gently. When the sow becomes stationary the boar mounts. Androstenone within boar saliva aids in eliciting the standing response in the sow (Gonyou, 2001). Some sows are more attractive to boars than others and occasionally a sow may avoid and refuse to stand for a specific boar. Rearing females in isolation from males delays the standing response of the females once they are introduced to boars (Soede and Schouten, 1991).

Pheromones in boar saliva and preputial secretions induce oestrus in gilts and sows (this is known as the boar effect) (Pearce et al., 1988). The presence of stimuli from boars (namely odour) will induce earlier puberty in gilts than if no other stimuli were present (Hemsworth et al., 1988).

Because an oestrous sow will stand near the boar (Bressers *et al*., 1991), penning breeding females adjacent to a boar makes identification of oestrous sows easy.

The social environment that boars have been raised in influences their levels of sexual activity (Hemsworth *et al*., 1977). Boars that are raised individually with no visual contact with immature females, but who can hear and smell the females, have reduced copulation frequency and shorter average duration of ejaculation compared to those raised in all-male or male-female groups. Boars that engage in more courting activity, especially nosing of the sow's flanks before mating, have higher conception rates (Hemsworth *et al*., 1978). This study suggested that extra flank-nosing might stimulate oxytocin release from the sow's pituitary gland and this could increase sperm transport and the number of sperm in the oviduct and so increase the chances of fertilization.

Dominant boars cover the markings of subordinate animals with urine that is often contaminated with preputial secretions (Mayer and Brisbin, 1986).

MATERNAL–OFFSPRING BEHAVIOUR

In a paddock the sow will nest-build for up to six hours before parturition. She hollows out a depression and lines it with straw, grass, sticks, or other available material. While farrowing crates in intensive piggeries prevent much of this nest-building behaviour, many elements are still present and the sow will often perform similar activities to those of pigs provided with nesting material (Blackshaw J. and Blackshaw, A., 1982).

Pigs of lower social status tend to produce litters with piglets that are lighter in weight (Mendl *et al*., 1992).

Dominant sows give birth to more male piglets than do subordinate ones (Mendl *et al*., 1995). Compared to other mammals, pigs display complex nursing and suckling behaviour (Fraser, 1980; Signoret *et al*., 1975). Nursing is frequent, every 50–60 minutes, and the sow requires stimulation from piglets before milk let-down. Sensory inputs (vocalization, odours from mammary and birth fluids and hair patterns of the sow) are particularly important immediately post-birth to facilitate teat location by the piglets (Rohde Parfet and Gonyou, 1991).

Initially, the piglets jostle for position at the udder, then each piglet massages around its respective teat with its snout, during which time the sow grunts at slow, regular intervals. Each series of grunts varies in frequency, tone and magnitude, indicating the stages of nursing to the piglets (Algers, 1993). The phase of competition for teats and of nosing the udder, lasts for about one minute, and ends when milk flow begins. In the third phase, the piglets hold the teats in their mouths and suck with slow mouth movements (one per second), and the rate of the sow's grunting increases and lasts about 20 seconds. The grunt peak in the third phase of suckling does not coincide with milk ejection but rather the release of oxytocin from the pituitary into the bloodstream (Castren *et al*., 1989). Phase four coincides with the period of main milk flow (10–20 seconds' duration) when the piglets suddenly draw back slightly from the udder and start sucking with rapid mouth movements of about three per second. The sow grunts rapidly, lower in tone and often in quick runs of three or four, during this phase. Finally, the flow stops and so does the grunting of the sow and the piglets may dart from teat to teat and recommence suckling with slow movements, or nosing the udder.

Piglets massage and suckle the sow's teats after milk flow ceases as a way of letting the sow know their nutritional status. This helps her to regulate the amount of milk released from that teat in future sucklings. The more intense the post-feed massaging of a teat, the greater the future milk release from that teat will be (Jensen, Gustafsson and Augustsson, 1998).

It is often hard to tell if the nursing episode is initiated by the sow or the piglets and almost any disturbance causes the piglets to rise, squeal and then nurse. The sound of one litter nursing may initiate nursing among other litters. Fostering piglets from one litter to another is often carried out in the pig industry and it is recognized that sows may react aggressively to foster piglets and that suckling periods are disrupted. Horrell and Bennett (1981) exchanged three piglets between five pairs of litters at seven days of age after the teat order had been established. Compared with control litters, cross-fostering disrupted the teat order relationships of the whole litter. Weight gain of fostered piglets during the second week was reduced to 79% of that in their non-fostered littermates. If fostering has to be done, it has more chance of success if the piglets are only one to three or four days old. Cross-fostering of piglets should be undertaken before teat order is established and involve movement of larger piglets rather than small ones to minimize teat order disruption and associated mortality and production losses (Gonyou, 2001).

In the natural environment, farrowing nests are built at least 100 m from the communal nest to improve piglet survival (Jensen, 1989).

PGF_{2a} appears to be the hormonal regulator of nest-building behaviours such as nosing, rooting and pawing to create a depression, as well as the gathering of straw to line the nest (Burne, Murfitt and Johnston, 2001).

By the time piglets are 6 days old, they have begun to follow their mother (Stangel and Jensen, 1991). Recognition between the sow and her piglets is by olfactory and vocal cues (Jensen and Redbo, 1987).

Without human interference, weaning is finished by the time the piglets are about 17 weeks old, but it may begin as early as 4 weeks of age when the mother begins to reduce her nursing efforts (Jensen and Recen, 1989).

ABNORMAL BEHAVIOUR

Abnormal behaviours often found in pig units include:

1. Tail and ear biting (Blackshaw, 1981);
2. Cannibalism;
3. Reproductive behaviour problems such as abnormal mating behaviour and abnormal maternal behaviour;
4. Eating too much or too little; dominance relationships that prevent some animals from having access to food and water;
5. Abnormal dunging habits;
6. Persistent inguinal nose thrusting (PINT) (Blackshaw, 1981). PINT is defined as occurring when a pig repeatedly thrusts its nose into the inguinal area of a resting pig with the top of its snout, until the recipient pig moves. It is a behaviour pattern of high-ranking pigs, although other pigs do it;
7. Various stereotypies, which are repeated actions with no goal direction, have been described (Fraser, 1975) in tethered sows when not provided with straw;
8. Snout rubbing, when pigs rub their snouts on the flanks of other pigs causing necrosed areas (Allison, 1976).

These behavioural problems are easy to see and tell us something about the mental well-being of the animals. However, we do not know if animals experience emotional feelings in the same way as humans. Perhaps, the important thing to recognize is that these abnormal behaviours tell us that all is not well in the husbandry system.

A deficiency in iron may contribute to the incidence of tail biting (Fraser, 1987), but other factors have since been ranked as being of greater importance.

The incidence of cannibalism such as tail and ear biting has exceeded 10% of pigs in some studies (Arey, 1991).

Stereotypies may increase in prevalence through a piggery via social facilitation (Appleby, Lawrence and Illius, 1989). Some stereotypies, such as ear sucking and biting, may be associated with low levels of fibre in the diet (Meunier-Salaün, Edwards and Robert, 2001). Belly nosing/snout rubbing by piglets does not appear to be related to stress, diet quality or the presence of milk in the diet but is somehow related to the age at weaning (Gardner, Duncan and Widowski, 2001).

Abnormal behaviours, such as tail and ear biting, stereotypies and belly nosing, may be redirected rooting or nosing behaviour caused by barren commercial environments (Beattie, Walker and Sneddon, 1996).

POULTRY - CHICKENS

VISION AND OTHER SPECIAL SENSES

Chickens have panoramic vision of about 300°, and possible binocular vision of 26°. Sight is an acute sense and colour vision is important. Preference is probably for colours that are easiest to see against a green background, and this ability to discriminate colour is unlearned.

One-day-old chicks prefer to peck at round rather than angular objects (Goodwin and Hess, 1969). They also prefer to peck small (0.3 cm), solid objects, but would rather approach fairly large ones, especially if moving or making a rhythmical noise.

Selection of food is based on visual cues and immediate taste cues. This is important to know when managing poultry and their food. If the composition of the food changes due to availability of grains, the hens may not change easily to eating seeds of a different shape or colour.

Hearing is an acute sense in chickens, and communication within and among flocks of birds takes place mainly via signals provided by postures, displays and vocalizations (Mench and Keeling, 2001).

Postures and displays are used to signal threat and submission (Kruijt, 1964).

The varieties of vocalizations are in the categories of warning and predator alarm calls; contact calls; territorial calls; laying and nesting calls; mating calls; threat calls; submissive calls; distress, alarm or fear calls; contentment calls; and food calls (Mench and Keeling, 2001).

Morphological features associated with the head and neck are important for both communication and social recognition (Mench and Keeling, 2001). Comb size and colour in males and females are influenced by the levels of sex hormone and are indicators of social status (Guhl and Ortman, 1953).

Little is known about the sense of smell.

SOCIAL ORGANISATION, DOMINANCE HIERARCHIES AND LEADERSHIP

There are three common types of husbandry systems used for intensively housed chickens:

Cages. Chickens are kept in groups of 3–10 birds in cages with space allowances of 350-600 sq cm per bird (Mench and Keeling, 2001). Stocking densities vary around the world, 350 sq cm on average in the United States, to as high as 700-800 sq cm in Norway and Switzerland (Savage, 2000).

Meat chicken sheds. These hold from 10,000–70,000 meat birds, housed on litter in either semi-enclosed or environmentally closed houses. Stocking densities vary from 30–50 kg live weight per square metre (Mench and Keeling, 2001).

Breeder sheds. These house flocks of several thousands in semi-enclosed or enclosed housing on litter or wire. The male to female ratio is about 1 to 8–15, with the space allowance of 0.2–0.3 square metre per bird (Mench and Keeling, 2001).

The social organization differs in these systems but peck orders emerge in cages and breeder sheds. This has not been shown in meat chickens. In cages, there is a definite hierarchy established by pecking and threatening when the hens are placed in the cage, usually a few weeks before laying commences at six months.

The social order in broiler flocks is relatively unimportant as they are generally processed at an age when the establishment of social stratification is just beginning (Siegel, 1984).

Laying hens have complex interrelationships involving social rank, aggression, feeding behaviour and egg production (Mench and Keeling, 2001).

In large groups kept together for some months, subgroups form and become restricted to an area. This means that birds can recognize their own group members and those of an overlapping territory. It was suggested that this territorial behaviour is important in large flocks as it reduces the numbers of conflicts when strangers meet (McBride and Foenander, 1962). It has also been shown that individuals are more dominant in the area where they spend most time. Thus in larger flocks, hens tend to live in neighbourhoods where they are well-acquainted (Craig and Guhl, 1969).

Laying hens choose to feed close to each other when given a choice of feeding locations, which demonstrates the importance of social attraction (Meunier- Salaun and Faure, 1984).

Hens that are in the same cage and in neighbouring cages synchronize their feeding. Chickens show socially facilitated feeding, in particular, they peck more at feed when they have company than when alone (Keeling and Hurink, 1996).

It has also been shown (McBride *et al*., 1963) that hens do not move randomly in normal intensive housing conditions—they maintain their heads at regular patterns of spacing and orientate them to avoid the frontal aspects of other birds. However, they turn, probably in defence, to face approaching birds.

In cages that are too low for the chickens to raise their heads in a threat, aggression is provoked by an approaching bird rather than by a bird that is in continuous close proximity (Hughes and Wood-Gush, 1977).

Recognition of each other is based on features of the head, the comb being the most important cue (Guhl, 1953). Hens can distinguish between breeds that are dissimilar but are unable to distinguish between individuals of such breeds.

The ability of flock mates to recognize and remember one another becomes very difficult under commercial poultry husbandry conditions where group sizes are very large (Mauldin, 1992). Dim or coloured lighting can affect a chicken’s ability to discriminate between other birds (Mench and Keeling, 2001).

Mortality, production and behavioural problems are all worse in large groups of hens, which implies the formation of unstable social groups (Mench and Keeling, 2001), so this is particularly a problem in barn/aviary egg-production systems.

Peck orders are regarded as highly stable once established, and in mixed groups, males and females have their own peck order (Guhl, 1958). Agonistic pecking begins to occur within a few weeks after hatching, stable dominance and subordinate relationships usually do not become established until 6–8 weeks of age in cockerels and 8–10 weeks in pullets (Guhl, 1958).

A potential problem in the industry, depending on spacing and the strain of poultry, is the frequency and severity of agonistic acts. Al-Rawi and Craig (1975) did an interesting experiment, beginning with relatively generous space allowances per hen and then decreasing the space. They found that social interaction rate increased as space decreased then suddenly fell off as space decreased further. It has been shown that individuals behave less aggressively towards subordinates in the near presence of dominant flock-mates. This 'third-party-effect' (Ylander and Craig, 1980) is associated with a reduction in agonistic behaviour or it may be due to the lack of space for threat displays.

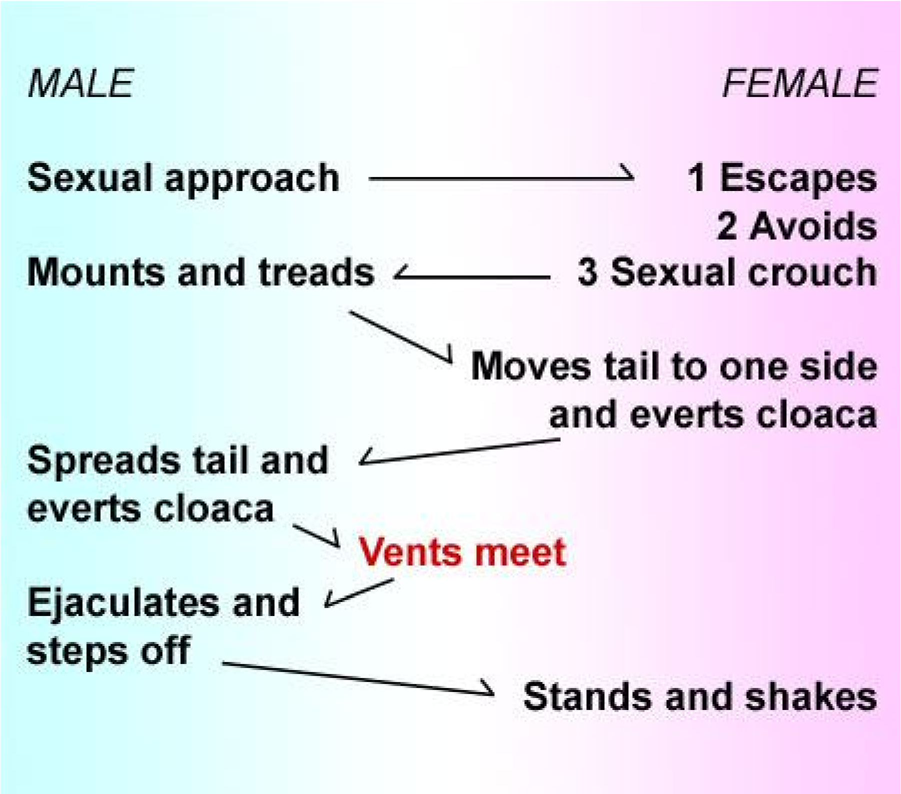
The results of this experiment on spacing indicate that interpretation of the results is important. Another point to be aware of is that selection for productivity traits may cause behavioural changes. Increased aggressiveness and social dominance, prior to full maturity (Bhagwat and Craig, 1977) has accompanied the selection for early onset of egg production in several genetic stocks studied.

Higher-ranking hens may have better egg production than the lowest ranked bird in a cage, possibly because the higher ranked birds have greater access to feed (Cunningham and van Tienhoven, 1983).

Most aggression is seen at the feed trough, where there is some competition among the chickens (Mench and Keeling, 2001). Aggression in cages is relatively low, as the small group size in the cages allows the hens to establish a stable dominance hierarchy (Mench and Keeling, 2001). Once a social group becomes organised, the incidence of agonistic interactions decreases (Mauldin, 1992).

SEXUAL BEHAVIOUR

A series of displays occurs before mating, based on a stimulus-response sequence (Fischer, 1975) initiated by the male (see diagram).



(Modified from Fischer, 1975).

Male courtship displays are generally elaborate, involving vocalizations and noises, postures, spreading of the feathers to increase apparent size and emphasize plumage characteristics (Kovach, 1975).

Sexual behaviour and dominance relationships are important in the management of mating. Because the female must crouch to elicit courting behaviour in the male and this is also a submissive behaviour, high-status females are often difficult to mate. Although it is never done commercially, research suggests that to overcome this, chickens may be sub-flocked and this reduces the number of individuals each may dominate or be submissive towards. When high-ranking hens are isolated from hens lower in the peck order, they crouch more often than when in the larger flock, and hens in the middle and lower thirds of the peck order crouched less often (Guhl, 1950).

MATERNAL–OFFSPRING BEHAVIOUR

Maternal behaviour or broodiness has been selected out of commercial laying strains so it is not important in intensive poultry husbandry systems.

In a broody hen with chicks, a bond is formed and the chicks learn to respond to the maternal feeding call, distress call and to the hen’s ‘purring’ sound as she settles down. Repeated exposure to her, accompanied by food, guidance and protection, strengthen the filial bond. Exposure to maternal calls during embryonic development may be important for the development of post-hatch species-specific maternal call recognition (Gottleib, 1976).

Being precocial, birds are self-sufficient after hatching, but parents serve an important protective function while also teaching the chicks about edible and inedible foods (Nicol and Pope, 1996).

Precocial chicks imprint on their parents in the first few days of life (Rodgers, 1995). Imprinted chicks remain close to the imprinted object, which is normally a parent, but under laboratory conditions may be a variety of different objects (Mench and Keeling, 2001).

ABNORMAL BEHAVIOUR

1. Sometimes males will hound other males, which can be a problem.
2. Caged birds may exhibit some abnormal behaviour such as head flicks and feather pecking, i.e., pecking and pulling the feathers of other birds (Mench and Keeling, 2001). Feather-pecking may be a form of redirected ground pecking (Blokhuis, 1989). Experience in early life with ground pecking may influence pecking behaviour in later life (Blokhuis, 1991). The motivation for the redirection of ground-pecking happens when the incentive value of the ground is low, compared with the incentive value of pecking substrates (Bindara, 1969). In high-density situations, the birds and feathers make up a higher proportion of stimuli relative to the litter area. It is possible that the birds may perceive the feathers as dust and that may cause a redirection of ground-pecking to feather-pecking (Hansen and Braastad, 1994).

3. In some housing systems, cannibalism can be a problem.
4. Pseudo-mating occurs most frequently between high-ranking males and low-ranking males, who are pursued and trodden (Guhl, 1949) and indicates that dominance relationships are important. The same situation may occur in flocks of hens.

ALTERNATIVE HUSBANDRY SYSTEMS

There is ongoing research into alternative husbandry systems, which may in the future replace the cage. Commercial egg layers are housed mostly in cages in groups of 3–10, with much restriction on the bird’s movement. Meat chickens are housed on litter in either semi-enclosed or environmentally closed houses, often in groups up to 70,000 birds.

Very few birds are maintained in free-range conditions as it is uneconomical in terms of labour, food requirements and wastage in egg handling, problems of predators and disease control, and lack of egg hygiene (Sainsbury, 1980). Free-range eggs have a 15–20% rate of dirty eggs that are classed as second-rate eggs, whereas the rate in conventional caging is 2% (Slack- Smith, 2000).

The problem of deciding what is best for a hen is difficult and some researchers have devised experiments in which they provided birds with a choice of flooring (Hughes and Black, 1973; Hughes, 1976) and a choice of environments (Dawkins, 1980; Wegner, 1980).

The hens chose fine hexagonal mesh over coarse rectangular mesh and over perforated steel sheet. It seemed that the hexagonal mesh supported the bird’s foot at more points than the other two floors. In comparing wire and litter floors, it was found that previous experience with either wire or litter floors affected the choice: birds reared on litter spent more time on litter than those raised on wire.

In the environmental preference studies (Dawkins, 1980), hens were given a choice of cage or an outside run. Hens used to living outside in the garden all chose the run. Hens previously used to living in cages tended to choose the cage on first trial, although subsequently they came to choose the run. So choice is strongly influenced by previous experience. The fact that the hens prefer an outside run to a cage is not indicative of suffering in a cage. Preference in itself is no indication of suffering.

Before egg laying, hens will work to gain access to nest sites. The demand for this resource is inelastic. Hens in cages without nests often show abnormal activities during pre-laying, such as increased pacing, reduced sitting and displacement behaviours (Sherwin and Nicol, 1993). So, if cages contain a nesting box, there is an opportunity for more normal behaviour. Different systems have been tested for performance and behaviour traits of laying hens since 1977 in Celle, Germany (Wegner, 1980).

Comparison of different maintenance systems. Free-range system with deep litter, deep litter without range and battery cages. Egg production has been found to be more economical in cages (i.e., less feed per egg).

Comparison of different cage types with different numbers of hens per cage. There is reason to suppose that some differences exist in behaviour between battery and deep-litter systems, so cage types other than the conventional battery cages are being compared.
There are two types of 'get-away' cages developed in England and The Netherlands:

(i) 80 cm x 100 cm x 65 cm (l x w x d) cage with three perches and two feed troughs at equal levels on both sides of the cage, with 16 and 20 hens, respectively, with four nests per cage. The cages are either filled with wood shavings or the sloping floor that forms the roof of the cage below allows the eggs roll into a collecting tray. Fibre mats are put into the nests to make them more attractive. It is a two-tiered system. This design had problems as the hens used the nests to scratch, sand bath and rest in, so 25–30 per cent of eggs were dirty, destroyed or eaten. Too much labour was required to supply litter daily and collect the eggs.

(ii) 1 m x 1 m x 55–80 cm (w x d x h) Celle cage with four nests, each with a sloping fibre floor, two feed troughs on both sides and one sand bath. The whole cage floor has a 5° slope from the side of the sand bath to the side of the nests. It is also a two-tiered system.

Egg production in these get-away cages with 15–30 hens per cage of 1 sq m floor area is similar to that in a conventional cage with three or four hens per cage. Some disadvantages of this system were cracked eggs at the floor, which was not elastic enough; and the sand bath, which was opened eight weeks after the start of laying, was immediately used for laying and was forced to be shut. Monitoring of hens was also difficult in this system.

Enriched cages (e.g., the Edinburgh modified cage). These cages are similar to battery cages but provide more features for the chickens, which allows a wider variety of behavioural characteristics. The cage houses four hens and provides them with a perch, a nesting box and a dust bath (Wathes and Charles, 1994).

The aviary and perchery systems. The main idea is to make better use of the space between floor and ceiling in the poultry house by installing several horizontal levels and so increase the number of hens per square metre of floor area. The aviary system used was made of plastic foil and measured 8.50 m wide x 12 m long (10 hens per square metre of floor area).

Better use of height is achieved by having two rows of perches along the house. One feed trough is on the floor and the other is on the perches. There is a 'farmer automatic nest' in two parallel rows and in two tiers, which can be moved out of the aviary into a special room where the eggs are automatically removed from the litter. Nipple drinkers provide water. Good results for laying performance and number of losses compared with hens in cages have been achieved.

The final analysis of results was completed in April 1981, and a report referred to the West German government. Murphy (1982) gives an outline of the final conclusions in her comprehensive report. She states that if all aspects studied are considered, then none of the systems may be described as totally adequate for the overall welfare of the birds.

Cages showed overall advantages in economy and hygiene; there was significantly less social conflict among the birds with a lesser number and intensity of threats, agonistic pecks and associated vocalizations, and fewer deaths from cannibalism than in the floor systems. However, when compared to floor-housed birds, those in cages showed more behaviour indicative of conflict and frustration during nest selection and egg-laying behaviour. It has been recommended that further research into completely new husbandry systems or modifications of existing systems be carried out to provide optimal conditions in all aspects of egg production.

ANIMAL TRAINING

Training involves the development of desirable responses and the effective deletion of unwanted responses. It reflects the principles of learning theory which describe the way associations develop between events and the way to influence relationships between stimuli and responses.

The ways animals learn to behave to remain comfortable and supplied with resources that meet their behavioural needs have been systematically evaluated in experimental studies. Admittedly, the rat is the only species that has been studied comprehensively but it provides a very useful model for learning in other species. Whether or not they appreciate it, the best trainers apply critical elements of learning theory and are also full-time students of animal behaviour. By studying their animals' responses they can predict responses before they occur. This allows them to improve the timing of cues and rewards.

Top trainers know when to reward their subjects. This may sound simple but it is a critical skill since giving rewards too frequently stops animals from developing improved responses whereas being too stingy causes them to lose interest and motivation. Similarly, removing rewards is pivotal in any extinction programme designed to eliminate unwanted responses. We can all see how to stop giving titbits that are linked to unwelcome behaviour (such as begging) but the best trainers can work out how to remove rewards that are being delivered unintentionally for responses that were never specifically trained (such as attention-seeking behaviours).

Trainers must also know *how* to reward their subjects. To do so they need to be aware of the current priorities of their animals and possibly how to increase their drive for a given resource. For example, sniffer dogs trained to find explosive for food rewards are fed their rewards close to the spot where they smelt the explosives. This maintains a strong link between the learned stimulus (odour of explosive) and reinforcement (food). Additionally they are given no food unless they find explosive. So, hunger maintains the motivation to find the odour of explosive.

The label used to describe all the resources for which an animal has evolved to work is primary reinforcers. So, a tasty fish given to a dolphin that has offered a desirable response is an example of a primary reinforcer. Training or circumstance can link such innately rewarding resources with novel stimuli that become what we call secondary reinforcers. An example of a secondary reinforcer is the clicker used in dolphin training to tell the animal to expect a fish for the desirable response it just made. So, the presentation of the secondary reinforcer is a way of rewarding the animal before a true reward can be delivered to it. This system allows animals to be trained at a distance and in the absence of apparent primary reinforcers which sometimes have a distracting effect on their eventual recipients.

Even if you are only training a dog to shake hands, we recommend that you become familiar with basic learning theory. In the meantime, here is a list of some of the characteristics that distinguish top trainers:

- Train one response at a time.
- Train one response for one stimulus.

- Consistency means using uniform cues for responses and not blurring one's signals.

- Timing is the critical factor when developing associations between responses and rewards and responses and their intended cues. So, poor timing can make reward-based training ineffective. In contrast, poor timing in traditional negative reinforcement training can amount to abuse.

- Shaping relies on the reserving of reinforcement until an improved response appears.

- Secondary reinforcers are most effectively established when presented before or up until the presentation of a primary reinforcer.

- Classical and instrumental conditioning sometimes conflict but good trainers often combine them with excellent results.

- Punishment can be effective when the punishing agent is only mildly aversive. Having said that, aversive stimuli should be used in training only with great care since they can rapidly cause a decrease in motivation and creativity while effectively undermining the human-animal bond.

- Once an animal has learned to fear a particular stimulus, it will also show fear of other similar stimuli.

- Fear often disrupts conditioned responses.

Learning Theory

Imprinting - Non-associative learning - Classical conditioning - Operant conditioning
Extinction - Positive reinforcement - Negative reinforcement - Punishment - Shaping

Imprinting

First described by Konrad Lorenz, imprinting is said to occur when innate behaviours are released in response to a learnt stimulus. Most imprinting promotes survival of newborn animals and shapes their future breeding activities. Imprinting has a number of characteristics.

Characteristics of imprinting

1. Critical sensitive period

Imprinting occurs at a particular time (termed the sensitive period) during early postnatal life. For example, in anserine birds such as ducks and geese, the time for imprinting is 24-48 hours after hatching when the 'following response' is learnt. At this time a gosling learns to follow his mother who is normally the first large moving creature in his world. In fact, of course, the visual stimulus that he imprints on does not necessarily have to be Mother Goose. In these species imprinting can occur on any object within a certain size range regardless of its colour or shape. Movement helps to attract attention but is by no means essential.

Although the dominant sense involved in imprinting is sight, sound and olfaction are also involved. In a variety of experiments, young chicks and ducklings were imprinted on humans, wooden blocks and classically even old gum boots. They bonded with a single item and would follow it wherever it went. Rather like Mary and her little lamb, Konrad and his little gosling were to go on to form a life long association. Although Lorenz was the first to record his observations in a scientific manner, the essence of imprinting had long been recognised. Indeed, Chinese peasants have for centuries capitalised on the tendency to imprint in making ducks more effective in the control of snails that otherwise damage rice crops. By imprinting ducklings onto a special stick, the peasants can not only take their brood out to the paddy fields as required but, by planting the stick sequentially in different parts of the plantation, they can ensure that molluscs in all areas can be subjected to predation.

Imprinting seems more important in precocial species, in which the offspring are less dependent on their mothers for food and warmth, than in altricial species which often confine their more vulnerable, and often hairless, young to nests. This is why many horse breeders are recognising the life-long benefits of thorough handling of their foals during the first 24 hours of life. Altricial neonates, on the other hand, are unlikely or unable to stray from their home base in the first few days of life and therefore do not need the same response. They learn similar lessons rather later in life during what are called "socialisation periods". These apply when the animal's sensory, motor and thermoregulatory systems are fully functional and they learn to move away from their mother and to interact with others of the same and other species. The window of opportunity for learning varies according on the species. In dogs it is from 3-10 weeks and in cats 2-7 weeks, while in primates it is usually 6-12 months. Stimuli that the youngsters of each species are exposed to during these window periods will be accepted as being “normal”. We do well to exploit this limited learning opportunity in our companion animals.

2. Imprinting is irreversible:

The imprinted knowledge is retained for life. Of all forms of learning, imprinting is the least likely to be forgotten or unlearned.

3. Imprinting establishes an individual animal's preference for a certain species

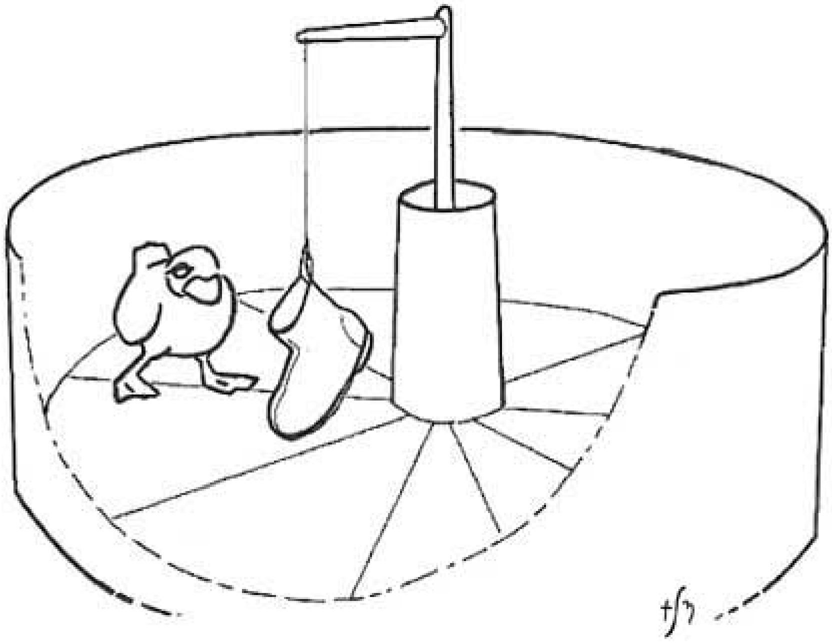
Contrary to what one might predict to be their genetic tendency, once they have imprinted, animals will always prefer to follow the learned stimulus rather than a member of their own species. The following response in ducks that have imprinted on humans means that the ducks will preferentially follow any human rather any duck.

4. Some behaviours are affected by imprinting more than others

Not all behaviours are affected by imprinting. Lorenz noted with some amusement that jackdaws that had imprinted on him would court his favour by presenting him with juicy fresh earthworms and would even attempt to introduce these into his ear-holes. However, when not sexually aroused, these birds would happily join other jackdaws in flight. In sexually dimorphic species (in which the external appearance of males and females differ), sexual imprinting varies depending on whether the youngster is male or female. So, while a male mallard duckling will identify his future mate by relating it to the appearance of his mother (or attachment figure), the same does not apply for a female. While falcons imprinted on humans require a combination of human and avian stimuli to elicit sexual responses.

5. Stressful stimuli fortify imprinting

If there is an increased level of stress at the time of the original imprinting, the learning is more robust that normal. So if, in the laboratory set up illustrated in the figure below, obstacles are placed in the runway between the duckling and the followed object then the following response the duckling subsequently exhibits is more determined and energetic. It may be that this enhances an individual duck family's level of imprinting at times of greatest need, for instance when the threat of predators or the distraction of other broods is a particular problem.



After imprinting there are two major categories of learning, *associative* and *non-associative*. In non-associative learning the animal is exposed to a single stimulus to which it can become habituated or sensitised, while in associative learning a relationship between at least two stimuli becomes established. There are two sub-divisions under the umbrella of associative learning. These are called *classical conditioning* and *operant conditioning*. The latter, as we will see, is important for animals to be able to solve novel problems in their environment.

Non-associative learning

Habituation

Habituation is said to have occurred when repeated presentations of the stimulus by itself cause a decrease in the response. It is really the simplest form of learning. For example, a wild goose's flight response to humans decreases after it turns up from a remote winter feeding ground to spend the summer on a lake in a popular park. Compared to its behaviour when it first flew in, it soon tolerates people approaching it and eventually almost ignores them. It habituates to the stimuli. Consider a police horse, that is gradually exposed to more and more of the potentially frightening stimuli that he will later encounter when out on patrol. The people delivering these stimuli in training are familiar to him and start their disturbances at a considerable distance from him. Only when he is ignoring the rumpus at a certain noise level and a certain distance will these variables be made more threatening.

The likelihood of habituation and its rate are dependent on the nature of the stimulus, the rate of stimulus presentation, and the regularity with which it is presented. Habituated responses show spontaneous recovery when stimulation is withheld. This means that exposure to the relevant stimuli must continue at intervals to prevent the original response (eg a flight response) recurring.

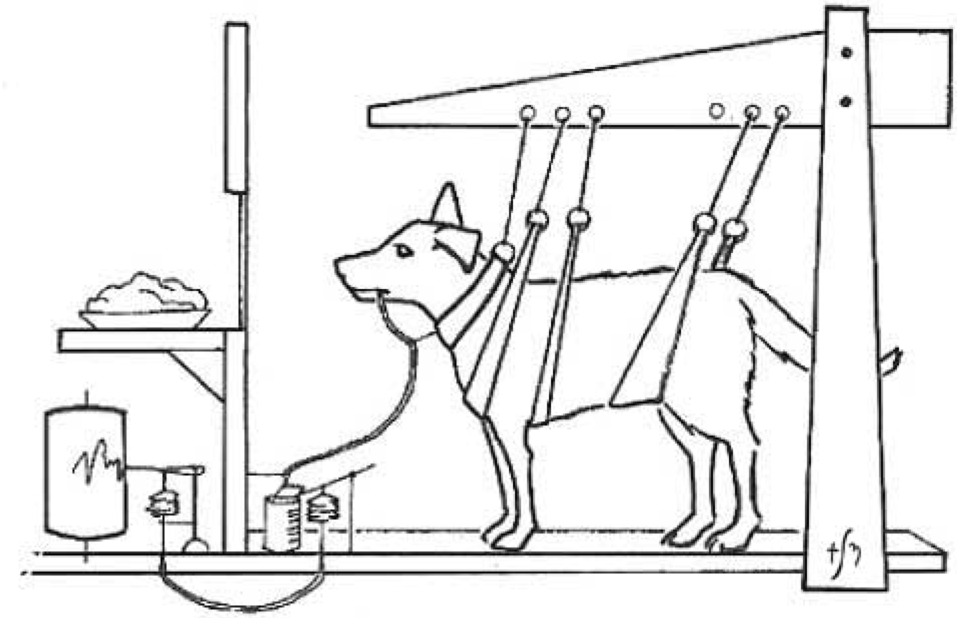
Sensitisation

Sensitisation is the opposite of habituation in that there is an increase in a response after repeated presentations of the stimulus by itself. The stimulus has to be intrinsically unpleasant or aversive. If one recalls the magnified unpleasantness of a dripping tap when searching for sleep, the effect of sensitisation becomes clear. Sensitisation can over-ride habituation. For example, if the police horse had been involved in a road traffic accident every day for a month, he would reliably become sensitised to motor vehicles and perhaps even become phobic so that just the sound or sight of them might be sufficient to send him into a flight response.

Classical Conditioning

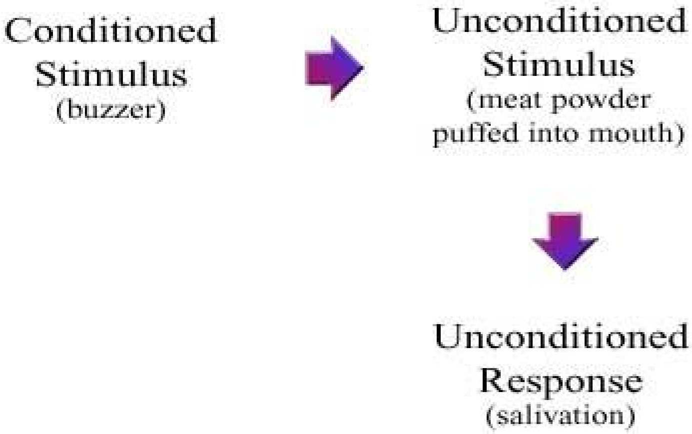
Classical conditioning is the acquisition of a response to a new stimulus by association with an old stimulus. It involves coupling a stimulus with an innate behaviour or physiological response. Most laboratory based classical conditioning studies focus on physiological responses. The most famous, of course, involved Pavlov and his dogs. Ivan Pavlov was a Russian physiologist who trained dogs to salivate at the sound of a bell ringing. Indeed he went on to win the Nobel prize in 1904 for research in which he measured the saliva production of dogs in response to a variety of stimuli and many workers in this field still refer to this sort of learning as Pavlovian conditioning.

Pavlov had spotted his experimental dogs salivating when they heard his technician tinkling a bell as he approached the kennels to feed them. To determine how accurately a dog could build such associations, he decided to replace the sound of the bell with more easily varied sounds made by a buzzer and then a metronome. He surgically implanted a tube to collect saliva and measure its rate of production using the apparatus shown. A second hole in the dog's cheek was used blast meat powder into its mouth.

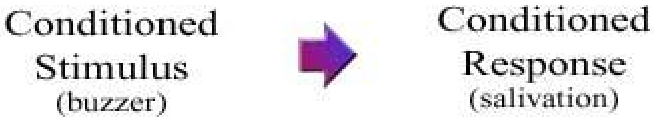


Pavlov coupled a novel external stimulus to a physiological stimulus and response. The dog learned to respond to a new stimulus, the buzzer, which had previously been irrelevant or neutral. Because its effect was the product of learning, Pavlov called the buzzer a *conditioned stimulus.* The salivation response to the *conditioned stimulus* is called the *conditioned response*. Before the learning experience, only meat powder, the *unconditioned stimulus*, produced salivation as an *unconditioned response*. Crucially, in classical conditioning, the sound of a buzzer was followed by the delivery of food to the mouth, regardless of what the dog might have done when it heard the buzzer. Classical conditioning enables the animal to associate events over which it has no control. This increases the predictability of an environment.

The classical conditioning procedure is as follows:



So that



Learning about sex seems especially likely as a consequence of classical conditioning. Stallions get aroused when they hear the sound of the bridle used to control them in the service pen. Dog breeders capitalise on a similar effect to ensure reliable performance of stud dogs. If they observe the same routine before taking the dog to the same room prior to every mating, these stimuli condition a response that supersedes the attractiveness of a particular bitch.

Another useful example of this sort of learning is seen in cows that let release milk when they hear calves calling because they have formed an association between this sound and subsequent suckling of teats. On dairy farms an analogous phenomenon arises when the unconditioned stimulus of being milked by a human, linked to a milk-let down response, is replaced by simply being in the milking parlour or sometimes even the collecting yard. The involuntary milk let down shown by dairy cows when they hear the milking apparatus becomes a conditioned physiological response.

The interesting footnote to Pavlov's study was that he recorded that his dogs would race ahead of their handlers to get to the experimental area. They wouldn't just hang around waiting for a stimulus that made their mouths water, they would try actively to put themselves into situations and perform activities that led to rewards. This was a result of trial and error learning and brings us neatly to the other important category: operant conditioning.

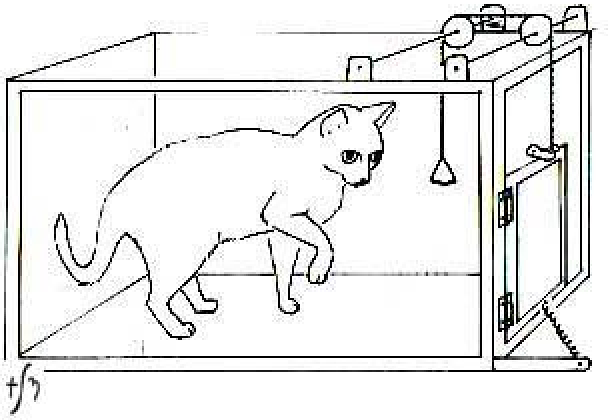
Context specificity

Pavlov's dogs knew that the lab was where they received meat powder. The ropes that held them in place may well have caused great resentment in a different context such as a park. Their effect was context specific in the same way that some cats seem to know that white coats represent danger, but only at the veterinary clinic. Household visitors can wear white coats without provoking a panic response. Because these animals learn to expect individual cues with specific outcomes in certain places, their learning is said to be context specific. Learning to behave in different ways that are entirely dependent on the context is what accounts for a puppy giving appropriate responses to cues in a training school and yet apparently forgetting everything when out on a walk. Good trainers do their best to break down context specificity. This is why, for instance, one of the most time consuming elements of guide dog training, after a dog has been taken through basic training with artificial obstacles, is the process of repetition in other contexts to eliminate any dependence on the training ground's environmental cues.

Operant conditioning

An operant response is a voluntary activity that brings about a reward. In operant conditioning, the buzzer used by Pavlov might still be presented but the dog must make a particular response before food is consumed. In other words, there is a special link (what learning theorists call a contingency) between a particular behavioural response and a food reward.

While Pavlov was concentrating on the physiological responses of dogs in harnesses, Thorndike (1911) was studying the behavioural responses of cats in puzzle boxes. Instead of delivering food independently of behaviour whenever a signal had been presented, Thorndike delivered it once his animals had responded. In a body of work intended to discredit the notion that animals are capable of reason, Thorndike described the behaviour of a naïve cat in a specially designed box.



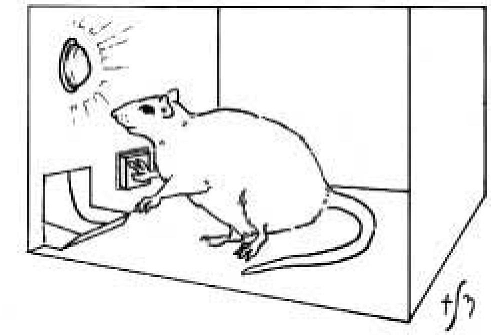
Of course without any food or other home comforts, life was rather dull and unsustainable in the puzzle box but the cat could get out - but only by pulling a trigger. Motivated to access food outside the box, Thorndike's cats would eventually learn to escape by operating the trigger that released the door latch. Once out of the box, the cat would get his food. Thorndike called this “trial and error learning". This label has largely been replaced by the terms *instrumental learning* and *operant conditioning*. The animal sees a cue (the trigger), performs a response (pulling) and gets a reward (liberty and food). The effect of the reward is to strengthen the correct response. This is known as ***reinforcement*****.** The term reinforcement refers to the process in which a *reinforcer* follows a particular behaviour so that the frequency (or probability) of that behaviour increases.

Reinforcers and punishments

Operant conditioning enables an animal to associate events over which it has control. This increases the controllability of the environment and represents the crucial difference between classical (Pavlovian) and operant conditioning. In classical conditioning, rewards become associated with stimuli while in operant conditioning they become associated with responses. The majority of exercises in animal training rely on operant conditioning. Rewarding the desired behaviour relates to the Law of Effect which states that whatever behaviour immediately precedes reinforcement will be strengthened. Several studies suggest that lack of control over aversive events can bring about major behavioural and physiological changes. For example, after being exposed to uncontrollable electric shocks, rats have increased gastric ulceration, increased defaecation rates and are more susceptible to certain cancers when compared to individuals that do have control over comparable shocks.

The distinction between classical and instrumental conditioning seems clear when we are considering the temporal relationship between the response and the reinforcement but the mechanisms involved are likely to be the same. Indeed, they are both often found in what appears to be a single response. The likelihood of an association arising depends on the relationship between the first event and the second via stimulus-response-reinforcement chains. Consider a cat that has learned to run towards the kitchen when she hears the sound of the tin opener. The sound of the tin opener comes before food and therefore becomes classically associated with food, making the appearance of her supper more predictable. Running in response to the auditory cue is a product of operant conditioning that is reinforced every time she is fed. Her life is more controllable as a result of this learning because she can choose the speed with which she runs or even whether to bother running at all.

This field of study was developed further by B.F. Skinner who created the Skinner box, a device that is basically a problem box in which the subject learns by trial and error that pressing a bar yields a small reward. The bar-pressing behaviour is then reinforced. Skinner reported his findings in a seminal paper called the Behaviour of Organisms. He argued that, with the selection of appropriate rewards, this system could be used to teach anything.



Food is not the only reward that can be used. The other obvious one is water that can be given to subjects that have been kept thirsty. This is interesting because close observation of the heads of experimental pigeons in Skinner boxes shows that they adopt different approaches to the key (an operant device that must be pecked) depending on whether they are expecting to receive a food or water reward. If the reward is water then the bird will use the device with closed eyes, an open mouth and a peck of longer duration and less force than the peck for food.

Some argue that reinforcement is necessary for learning to take place. However, rats that receive a shock to their hind-paws while in transit, when being trained to run from A to B down an alleyway will reach A faster than those given only food as an incentive. A reinforcer is anything that increases the frequency of the particular behaviour that it follows. Operant conditioning allows us to use reinforcers and punishers that positively and negatively influence the likelihood of a behaviour being repeated or not. A response will increase in strength when followed by a reward. In his free operant experiments, Skinner measured the strength of a response by recording the response rate, i.e. number of responses per unit of time. Skinner used this outcome to develop the principle of reinforcement.

If a blue tit pecks for long enough at the foil on a milk bottle he will encounter the cream below and be more likely to repeat the pecking behaviour. Reinforcement has occurred. The blue tit has an innate drive to continue foraging in this way if the costs can be offset by the benefits. In other words, if evolution has equipped him to be an efficient food gatherer, the bird can judge, at a subconscious level, whether the time and energy spent pecking at the foil and the risks of predation by the nearest cat are outweighed by the (taste and) nutritional value of the cream. This exemplifies what ethologists refer to as *optimal foraging*, the non-human equivalent of a time and motion study. The pleasure and nourishment brought by the activity justify its pursuit.

The merit of a reinforcer can only be measured in terms of the degree to which it makes the behaviour more likely in future. If a trainer's saying "good dog" in response to a dog’s heel-work has no effect on the dog’s future behaviour then, according to this definition, reinforcement has not occurred. The trainer's words have had a neutral or even confusing effect. The definition does not describe how or why some events act as reinforcers. Whether some event is called a reinforcer is purely a matter of the effect it had. This is why, instead of encouraging owners to give their dogs praise, which can so often be understated and, as a result, ineffective, many of the more enlightened dog schools tell their humans to 'make those tails wag'.

Animals can be trained to do quite remarkable things if they are reinforced at the right time. For example, in one study, Skinner delivered food to eight pigeons every 15 seconds regardless of what they were doing at the time. After a number of rewards, six of them were performing behaviours (such as circling in a single direction) repeatedly throughout the interval between reinforcers. Even though there was no causal relationship between the behaviour and the reinforcer, the birds happened to be doing something at the time of reinforcement. By waiting for an incidental movement of the eyelids, scientists were able to teach pigeons to blink to receive a food reward. Cats that learn to rub their owner's legs just prior to the delivery of food have learned in the same way. The activity generally does little to get the food to them quicker, i.e. is not causal, but because of its contiguity to reinforcement it is slavishly included in pre-prandial rituals. Those of us who repeatedly press the on-button at a pedestrian crossing are probably subject to the same phenomenon. Because we perceive a link between serial button pressing and the appearance of the signal to cross, we think it is the best way of getting the desired outcome quicker. Strangely, this was called superstitious learning for some time. This was surely a misnomer since the pigeon was behaving predictably and rationally rather than misguidedly.

Reinforcers can be either primary or secondary. Primary reinforcers are any resources that animals have evolved to seek. If the animal's motivation is correctly predicted food, water, sex, play, liberty, sanctuary and companionship can all be used as primary reinforcers. *Secondary reinforcers* are stimuli that are not intrinsically rewarding but that have become associated with the kind of primary resources listed above. These associations make great sense in evolutionary terms since an auditory, olfactory or visual cue that has become reliably linked with a primary reinforcer will hold an animal’s interest much longer than a neutral stimulus. For example, a fox can learn to make associations between the smell of hens and the meal they represent. If the smell did nothing to help the fox feed then it would hold no value and remain neutral. Instead, it encourages the fox to persist in its foraging activities.

The houselight in a Skinner’s box can be used to indicate a correct response if the reward and the light have been delivered simultaneously on a number of occasions. The light becomes reinforcing. The rat appears to look forward to illumination of the light. Consider for a moment the way in which horses are often praised with tactile stimuli, they can be either scratched at the withers or patted on the neck. Horses have evolved to find grooming one another rewarding. Indeed horses indulging in the familiar 'I'll scratch your back if you scratch mine' occupation have reduced heart rates that suggest they may be getting pleasure or stress reduction from the stimulation. So, a scratch in the correct part of the withers can represent a primary reinforcer. By comparison, the far more common practice of patting horses on the neck is reinforcing only if the owner has coupled the pat with something pleasant. Because horses have not evolved to be motivated to behave in a certain way for pats on the neck, the stimulation has to be conditioned as a secondary reinforcer.

Perhaps the best example of a secondary reinforcer is the sound made by a so-called 'clicker', the handy device used by thousands of trainers world-wide. Pioneered by students of Skinner, this association allows the trainer to bridge the gap between the time at which an animal performs a response correctly and the arrival of a primary reinforcer. The Brelands developed feeding devices that made a characteristic sound as a prelude to food. Psychology labs that use rats for learning studies do the same thing and call it hopper or magazine training. Essentially the clicker comes to mean 'Yes, That's good - expect a reward any second now'. When a clicker is first used the correct association is established by making the sound just before giving a delicious reward and doing this many times to convince the animal of the signal's reliability. Clicker training proves particularly helpful when training behaviours in a free operant situation. Any secondary reinforcer can be instituted in this way. The only significant feature of a commercial clicker device is the sound it makes which is crisp and distinctive. The crispness facilitates precise reinforcement of sophisticated and brief behaviours such as the blinking of an eye. Being pocket-sized or attachable to key-rings, clickers are convenient but by no means unique. Indeed, as long as they cannot be confused with words that appear in common parlance, human vocalisations (so-called clicker words) are even more readily available.

Secondary reinforcers are most effectively established when presented before or up until the presentation of a primary reinforcer. Simultaneous presentation of a reward and a novel secondary stimulus is less likely to work because the primary reinforcer will block or overshadow the new stimulus. Similarly, presentation of the secondary stimulus after the primary reinforcer is unproductive, because although an association will exist between the two, it does not help the animal predict the arrival of a reward. Perhaps this is why hunting species respond more to the smell of blood as reliable precursor of food than intestinal contents, which appears only after a kill.

Dogs have evolved to appease the leader of their pack and this may be why they respond so readily to social rewards such as petting and praise from humans. Some dogs can be reinforced by the slightest social contact and this is why pushing such a pet to the floor after it has broken a house rule by jumping up at a visitor is highly unlikely to eliminate the unwanted behaviour. Given that appeasement and affirmation of a social bond is the reason for contact being so reinforcing, it is important to remind ourselves that the human offering such a reward can only really make it worthwhile for the dog if the dog has an understanding of that human’s perceived greater social rank. This is probably why a vet saying “Good Boy” as she deals with a strange dog in the clinic is far less effective than when she uses the same words with her own pet. Equally this explains why guide dog trainers emphasise the importance of developing a bond between dogs and their trainers and subsequent owners, before asking them to work.

For dogs with an innate play drive that makes their ancestors, the wolves, look like proper party poopers, many toys have value and therefore can have reinforcing properties. As well as being rewarding in their own right, toys can be used as conditioned or secondary reinforcers in behaviour therapy. If a dog behaves fearfully when exposed to certain stimuli, it can be taught to look forward to exposure to a special toy as a prelude to the arrival of all pleasant experiences. Once established as a secondary reinforcer the toy can be used to build pleasant associations with the aversive stimuli.

The speed or strength of learning increases with the size and attractiveness of the reinforcer. This is why rats will learn to run faster in a maze if the food reward at the end is especially valuable. Recently, John Rogerson has described the use of toys in a thoughtfully constructed reward gradient. With a reward gradient, reinforcers are graded in terms of their increasing value to the animal. Food can be used in this way by being presented in increasingly tasty, favoured and plentiful forms. Similarly, the relative value of toys can be determined and phobic dogs can be exposed to toys of increasing value as they are exposed to closer approximations of the real source of the phobic response.

There is an important note to bear in mind when we consider the size of rewards. They can be too great. The effect of increasing the size or attractiveness of the reinforcer has certain limits in that too high a level of arousal can have a disruptive effect on learning. The optimum level of arousal decreases as the complexity of the learned task increases.

Contiguity is the principle stating that events that occur together will become associated. Giving a sugar lump to a horse two minutes after a pat on the neck will not develop a useful association. The lump and the pat have to arrive together if the pat is to become reinforcing. The same principle applies in recall training in dogs. The ignorant owner who sees his dog scavenging, calls him back and then hits him is hitting him for coming when he was called, not for chewing chicken bones.

For the best results in a training or learning context, it is not sufficient for a reinforcer to be contiguous. There is excellent scientific evidence that it also has to be surprising. The importance of surprise seems to be that it represents an avenue through which the animal can know that it has made a discovery.

Extinction

Extinction results when the learnt response occurs but is no longer followed by reinforcement or when one always presents a conditioned stimulus without the unconditioned stimulus. The effect of these procedures is an eventual reduction in response strength, as measured for example, in rate of response. Humans rarely work with reliable enthusiasm if they are not paid. The same can be seen in non-human animals. If they don't get their expected rewards they are less likely to behave in ways that have previously paid off. The behaviours drop out or become extinct. Extinction occurs when an animal no longer receives a reward for a correct response and eventually stops responding. Dogs that beg at dinner tables stop begging if they are never rewarded. Often extinction is accompanied by reversion to innate behaviours instead of simply an absence of the learned responses. Occasionally animals may experiment at this point by adopting sequences of other learned behaviours in an attempt to acquire rewards. If, during the extinction process, a novel stimulus is presented just before the conditioned stimulus, unlearning is accelerated. This technique is called *disinhibition***.**

There are some intriguing outcomes associated with extinction. Early in extinction it is usual for a "frustration effect" to occur, so called because one theory proposes the subject responds faster because it is "frustrated". To avoid misinterpreting an extinction-based behaviour modification program as a failure, it is important for therapists to be aware that the frustration effect occurs. Things will usually get transiently worse before they get better. For example, rather like a human repeatedly pressing the on switch of a faulty television set, a horse that has learned to break the rope that tethers it by being been reinforced with liberty will pull much harder when first it is tethered by a chain.

Because extinction does not occur in a vacuum, stimuli present during extinction can exert considerable control over behaviour. Therefore a dog that begs at the dinner table and scavenges food from semi-feral toddlers will extinguish this response if it receives no further rewards. If the presence of a grandmother at the family table, laying down the rules about table manners and less than messy eating, is associated with the absence of reinforcement then the extinction will occur most quickly when Granny is at home.

Extinction can apply to any behaviour that occurs and is no longer reinforced. Both welcome and unwelcome behavioural responses will weaken in the absence of reinforcement. If after a long rest interval between trials, further conditional stimuli (cues) are presented, they elicit a conditional response that is much higher than in the previous of the extinction trials. This rebound in response strength after a 'rest', following extinction, is called spontaneous recovery. It is often overlooked in behaviour therapy designed to eliminate unwelcome behaviours by extinction. If an undesirable behaviour makes a return, trainers often forget the original response strength when they compare current behaviour with previous behaviour. So, when the response recurs after a long absence, the trainer's conclusion is slightly damning with remarks like "the removal of rewards hasn’t helped" or "the animal has regressed". In fact, like the hearty glow of a candle flame before it dies out, this is the typical pattern found in extinction. This is particularly important with habituated responses that can show spontaneous recovery if reinforcement is withheld. To prevent the original fearful response reoccurring, the trainer must continue to expose the animal to the relevant stimuli from time to time.

Positive reinforcement

Reinforcement can be positive or negative. Both types of reinforcement make a response more likely in the future. Reinforcement schedules can be constant or intermittent and intermittent reinforcement can be delivered at either invariable or variable rates.

Continuous reinforcement

A reward is delivered after each response. Animals learn fastest when they are reinforced after every correct response. This is known as a continuous reinforcement schedule.

Fixed Ratio (represented by the initials FR)

Associations can still be established with less regular rewards or higher schedules of reinforcement. This is hardly surprising since wild animals may need to perform a given behaviour several times to acquire food. It is this persistence that trainers rely upon when they have established an association and wean their animals off continuous reinforcement. A reward is delivered after a fixed number of responses. A common code used in learning protocols is FR5, which means the reward is delivered immediately after the fifth response. On a fixed reinforcement schedule the animal often learns to predict the pattern of food delivery and therefore appears to lose interest by slowing down its response to stimuli after each reward while beginning to pay keen attention only as it gets near to the end of the fixed ratio (in this case, the fifth iteration of the response). To avoid these peaks and troughs in responsiveness, variable ratio schedules can be used.

Variable Ratio (represented by the initials VR)

A reward can be delivered after a random, variable number of responses. For example VR5 means although the rewards are sometimes delivered after ten, sometimes after twenty and sometimes after one response and so on, the average number of responses required for a reward is five. After a response has been established (this being achieved quickest on a continuous reinforcement schedule) many trainers adopt a variable ratio schedule in the knowledge that it is often very difficult to reward responses every time they occur especially if they form part of public displays, competitions or if they have to occur at some distance from the trainer. Trained behaviours learned on a variable reinforcement schedule are the most persistent and they are slower to extinguish than those resulting from fixed and continuous schedules. This is because during training on a variable ratio, many responses may have had no consequences and persistence is more likely to be rewarded. Dogs that *sometimes* get titbits for begging at tables take longer to give up when owners learnt to never reward the behaviour than those that have had constant reinforcement.

Fixed Interval (FI)

A reward is delivered for the first response that occurs after a fixed interval of time has passed since the last reward. For example FI5 means the reward is delivered for the first response after five seconds has passed since the last reward.

Variable Interval (VI)

A reward is delivered for the first response after a time interval since the last reward. The interval varies on a random basis but averages out to a particular value. VI5 means that these time intervals average out at five seconds and would range between zero and ten seconds.

There is one other schedule worthy of mention, the *differential reinforcement* of other behaviours. This is a schedule in which a trainer chooses one behaviour that will not be reinforced. Instead the trainer reinforces a variety of other behaviours. Predictably, this approach causes the non-reinforced behaviour to drop out and is often used to change problem behaviours. While this schedule withholds reinforcement of the problem behaviour it still allows reinforcement to be delivered. Withdrawing reinforcement completely may not always be advisable, as there is a danger of removing all incentives to respond in any way. Just as it is important to avoid confusion and promote creativity when training a new behaviour, it is imperative that when training an animal to stop performing a problem behaviour, it is simultaneously given the opportunity to perform a more acceptable behaviour with a similar motivation. A dog that chases joggers can most easily be trained to stop and look at the handler if it associates the sight of a jogger with an owner-centred ball game into which it can channel its motivation to chase.

Partial reinforcement effect

The term partial reinforcement effect refers to both the increase in performance under partial reinforcement schedules and the increased resistance to extinction of responses that these produce when compared with continuous reinforcement. Responses can be made highly resistant to extinction by training up to very high partial reinforcement schedules. Conversely, if trainers want to extinguish a response, they do well to start by determining the schedule of reinforcement used to establish the response.

Negative reinforcement

Negative reinforcement, which is all too often confused with punishment, occurs when an animal learns to behave in a certain way to avoid a negative stimulus or reduce its unpleasantness. This is central to the traditional training of horses since the application of the conditioning stimulus precedes both the desired behaviour and the potentially unpleasant reinforcer. In order to be effective, removal of the unpleasant sensation must immediately follow the correct behaviour. For example, tapping the flank with a whip to prompt sidewards movement is effective if the tapping ceases when the horse moves laterally. Similarly, in dog training, choke chains that are intended to act as a portent of pain can only be effective if their characteristic sound acts as a warning to the dog. Sadly very few people can use these dangerous devices properly by releasing the tension on the leads when their dogs stop pulling. Instead they tend to hang on and launch into the first bouts of a tug-of-war tournament that is endless for both parties, frustrating for the humans and painful for the dogs. Meanwhile many more owners fit choke chains incorrectly, forming a uni-directional ratchet device, eliminating the possibility of reinforcement by relief from neck pain. Giving a verbal warning is the only means of overcoming this problem; hence the 'Heel'-choke approach popularised by Barbara Woodhouse.

Let's suppose that after our begging dog has been taken away from the table, he is taken to the park and trained to walk to heel using a choke chain. Now we have an opportunity to consider, in the table below, how both reinforcement (a titbit of food) and punishment (a yank on the choke chain) can be positive and negative. Be it positive or negative, reinforcement will always make a response more likely in future. Conversely, positive or negative punishment will always make a response less likely in future.

Effect of the treatment

Response becomes more likely in future	Response becomes less likely in future
Positive reinforcement (titbit reinforces begging)	**Positive punishment** (applying tension on the lead increases choking action and neck pain)
Negative reinforcement (easing tension on the lead reduces choking action and neck pain)	**Negative punishment** (complete removal of food extinguishes begging)

Punishment versus negative reinforcement (and examples using food and choke chains).

Both punishment and negative reinforcement are consequences of behaviour and so are central to operant conditioning. Many trainers claim not to use negative reinforcement but are instead simply confused by the term that may have unpleasant connotations. It is almost somehow politically incorrect. Unfortunately, it seems the fear of prejudice has only served to muddy the waters of animal training. In this context, negative refers to the removal of something from the animal's world while positive refers to an addition. So, when trainers reinforce a behaviour with the removal of something unpleasant, they make the behaviour more likely in the future. The response has been negatively reinforced. Punishment and negative reinforcement are interrelated. By definition an animal must know that a stimulus is aversive in order for its removal to be reinforcing. So, in order to use negative reinforcement a trainer has to have used positive punishment as well.

Negative punishment or omission forms an important part of our attempts to improve or modify responses. Most readers will agree that a dog being encouraged to perform a new behaviour will first attempt to use an established response. The absence of reinforcement at that point makes repetition of the unwanted established response less likely. Reinforcement has been omitted and therefore the dog has been negatively punished. This moves the animal on to try new solutions to its problem. The trial and error process continues. The use in dogs of training discs, as developed by the late John Fisher, relies on omission or non-reward. The discs make a characteristic sound when rattled or thrown to the ground, and are introduced to the dog in association with the removal of a food reward that the dog is expecting to consume. The frustration that may be experienced is compounded by the same consequence on three or four occasions, after which the dog seems to stop expecting to be rewarded. The discs can next be presented at the time of unwelcome behaviour. Perhaps by associating the sound with learned frustration, the dog stops the response for a brief period. This allows the trainer to reward him for stopping.

In the interests of clarity all trainers and animal educators should consider carefully their use of these terms. Punishment is not in itself a dirty word. Nor is negative. Both negative punishment and positive punishment can be extremely mild. The degree to which one relies on either reinforcers or punishers and the consistency and tact with which one applies them are what matters to the animal.

Punishment

There are some problems with the use of punishers. Perhaps this is why they are unpopular. Whereas negative reinforcement involves the conditioning of preceding signals that predict the potentially aversive stimulus, punishment is a form of backward conditioning because any signalling of the aversive stimulus is either absent or follows the undesirable behaviour. Trainers who use punishment to eliminate undesirable behaviour have to be careful that the wrong association is not created. Rather than correctly associating the undesirable behaviour with a painful consequence, many animals learn to fear the trainer or the training area.

The punishment procedure makes the onset of an aversive stimulus contingent on a particular response. The punishment procedure may or may not lead to a reduction in the response. The situation is complicated because the punishing stimulus also elicits other responses, which may actually increase the performance of the "punished response". Whipping a horse for bolting will usually serve to rocket it forth once more.

Presentation of aversive stimuli will usually produce an overall suppression of behaviour. However, with the passage of time, the behaviour recovers. In other words, a reduction in performance of the punished response may have nothing to do with the specific link between the response and the "punishing" stimulus. So, even if the thrashing produced a reduction in the bolting response it is not clear why.

The effectiveness of punishments is limited by a number of factors including punishment intensity. The more motivated an animal is to perform an action, the greater the intensity of the punishment required to stop it. When punishing unwanted behaviours linked to anxiety, such as a dog barking when left alone, the result may be an unwelcome and possibly inhumane escalation in distress. If there are no alternative treatments, there may be ways of maximising the effectiveness of punishment. For instance, by using an aversive sound such as a high-pitched alarm it may be possible to distract as well as punish the perpetrator. This is likely to be particularly effective if the stimulus is presented at the beginning of the unwelcome behaviour sequence because at this stage that motivation is lowest and distraction is possible.

Shaping

Although Skinner's findings with his lever-pressing rats may seem to represent common sense, his school of thought has produced some intriguing principles. Perhaps one of the simplest yet most powerful of these is shaping. This is the concept of reinforcing successive approximations to the final response. The technique allows a trainer to move from a situation where it is impossible to reinforce a desired response (because that response never occurs) to one where the response is occurring, being reinforced, and increasing in reliability. If trainers wish to reinforce particular responses they can either wait for the behaviour to occur spontaneously, which can be readily reinforced if the behaviour occurs frequently, or shape the behaviour pattern. In seeking to train complex behaviours or those that occur uncommonly in an animal, the trainer will usually opt to reinforce successive approximations of the final behaviour. A good example of shaping comes from the send-away exercise in dog training. Contrary to the dog's innate tendency to remain with the pack, this persuades it to leave the owner. It is achieved by rewarding the dog for small movements away and then, on the next occasion, an all-important demand for more of the same response before reward delivery. Crucially, shaping relies on sparing and grading the reinforcement so that animal does not stagnate. A common characteristic among good trainers is their ability to recognise an opportunity to reinforce improved "approximations". While poorer trainers complain that their animals fail to understand what is being asked of them and feel that the animals have peaked in their training, their superiors have the sense and patience to monopolise each tiny improvement as the only way of moving towards the final response.

In shaping, it is important to reward a behaviour as soon as it happens. This is avoids a phenomenon called the *delay of reinforcement effect*. Any delay in rewarding the improvement will lessen the effect of that reward. This may be because it allows the subject to perform another response during the delay interval, which is reinforced. An example might be rewarding a horse for jumping a fence very cleanly by a giving him a sugar cube. To administer the sugar while riding, you would have to bend forward and place it in front of the horse’s mouth. Since this could not be achieved safely you would probably slow down and even halt. Instead of learning to jump ever more cleanly, the horse would predictably learn to slow down and halt, these being the behaviours closest to the reward.

Generalisation and discrimination

Pavlov found that almost any stimulus could act as a conditioned stimulus provided it did not produce too strong a response of its own. In very hungry dogs, even painful stimuli like electric shocks delivered to the paws, which initially caused flinching and distress quite soon evoked salivation if paired with food. Pavlov carried out exhaustive tests using this apparatus and a variety of tactile, visual or auditory stimuli (the board in front of Pavlov's dog could be used to present visual images with an infinite variety of colours and shapes). He found that if a dog was conditioned to salivate when a pure tone of perhaps 800Hz was sounded, it would also salivate when other tones were given but to a lesser extent. This is now known as *generalisation*. The dog generalised its responses to include stimuli similar to the conditioned one and the more similar they were the more the dog salivated.

The opposite process to generalisation is *discrimination*. Dogs naturally discriminate to some extent otherwise they would salivate equally to all sounds and tones. Discrimination can be accelerated if, as well as rewarding the right tone, the dog is slightly punished when it salivates to the others. This is called conditioned discrimination and has been of enormous benefit in working out the sensory capabilities of animals. For example by refining the stimuli to which dogs are required to respond in order to get a reward, we can ask question about what they can actually see. So, for instance, by training a dog to respond consistently to a colour in a certain wave-length, we can ask the question “can dogs see the colour blue”? The ability to discern between panels of the same reflectance but different colour tells us that the answer is yes, along with green (we know this because they are more sensitive to light in these wave bands than to red).

Commands used to cue a behaviour can be the product of discrimination. Police attack dogs exemplify the way in which certain words can be kept in reserve for special purposes. When he is excited at the prospect of a bite, he has to discriminate between words to discern the release command. Equally, after he has bitten, when he hears 'leave' he has to discriminate between this command from his handler and all the other shouting, screaming and blasphemy that accompanies a dog assisted arrest.

By rewarding animals for responding appropriately to stimuli that are less and less obvious, we can foster the power to discriminate between the stimulus that is rewarded and all other background information that would otherwise prevail. Discrimination is what allows us to train dogs to detect drugs, pigs to locate truffles, and chickens to identify images of familiar feathered friends. A similar process is at play when we train animals to respond to smaller and smaller cues in training.

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