

There has been a widespread call for a ban on these cages but alternative forms of managing large flocks of birds have not yet been fully developed. The Edinburgh modified cage is an attempt to improve the hens' welfare by enabling them to live in larger cages, fitted with perches, nest boxes and dust baths. Production is above average in these cages, and all facilities are heavily used. Feather, foot and claw damage is also reduced. It is felt that further development of such modified cages would lead to vast improvements in hen welfare.

In conclusion, environmental design is a broad subject encompassing the physical, social as well as developmental needs of the animal. Designing animal environments to take these needs into consideration, as well as the needs of the humans operating the system, is a difficult task, and in order to do it effectively we must have an understanding of the impact the environment can have on the well-being of the animals. A logical sequence of events leading to a new system would, therefore, be: (i) define the behavioural requirements; (ii) determine if existing systems contravene these require-

ments and, if so, determine the consequences for the animal; and (iii) if there is a need following (ii), then a new system(s) requires to be designed taking into account behavioural requirements and other management and economic considerations.

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Stereotypies in the stabled horse: Causes, treatments and prevention

L. Winskill, N. K. Waran, C. Channing and R. Young

IERM, University of Edinburgh, Kings Buildings, West Mains Road, Edinburgh, EH9 3JG, UK

The environment for most stabled horses is far removed from that of its wild ancestors. The horse is a social animal, and in natural groups in the wild it lives in harems, usually consisting of one stallion, a few mares and all their offspring up to two-years old¹. They restrict their movements to a specific home range within which the major requirements are food, water and shelter. Home ranges of free-ranging horses vary greatly in size and are correlated with resource availability². In contrast, the stabled animal is removed from this normal open range and often deprived of social contact. Many performance horses (e.g. racehorses, show jumpers, etc.) in Europe and also in India are confined for up to 24 h a day with the exception of short periods of time reserved for exercise, and others are turned out to pasture for merely a few hours a day.

This restricted environment often has a significant effect on the normal time budget of the horse as it can no longer spend the majority of the day foraging and expending energy looking for suitable resources². Feeding with concentrated food also has consequences for the

horse, since it eliminates the additional time that confined animals can occupy themselves with ingestion and manipulation of food². Free-ranging horses spend a high proportion of their time grazing. A study by Boy and Duncan³ on free-ranging feral Camargue ponies during spring and summer revealed that 57.5% of their time was spent grazing. This proportion of time is likely to be greater in the winter months, when grass is scarcer. In the stabled environment, however, if fed on hay, horses will spend 40% of their day eating, which is reduced by one tenth if fed chiefly on concentrates⁴.

As already highlighted, the stabled horse is often deprived of social contact, both visual and physical. The design of the majority of housing for horses does not take into consideration their behavioural needs, often enclosing the animal in small individual loose boxes or stalls, where it is deprived of social contact and exercise. Rees in her book *The Horse's Mind*¹ describes the confined horse as being like 'a fish out of water'. She notes that many learn to accept confinement, but others kept in these unnatural conditions, deprived of freedom,

exercise and companions, become excitable and irritable. It is in such conditions that behavioural problems may arise.

This article discusses the incidence of behavioural problems of the stabled horse giving examples of those most commonly found and how they might be treated and prevented from occurring. More general factors relating to the occurrence of these problems are also mentioned.

Behavioural problems and their incidence

Stabled horses can be seen to exhibit a variety of behavioural problems or 'stereotypies' such as crib-biting, weaving, wind-sucking and wood-chewing. Such behavioural anomalies are often wrongly referred to as 'vices', a term which implies that the blame should be attributed to the horse itself and not to the management procedures adopted or the housing imposed by humans^{3,6}. An example of such misuse of terminology is highlighted in the paper by Krzak *et al.*⁷ regarding wood-chewing of stabled horses, in which they state that: 'The owner of a wood-chewing animal must absorb the costs of replacing damaged fences and stalls and of preventative measures such as covering wood surfaces with metal, wire or taste repellents. For these reasons, horses that exhibit this 'vice' are of reduced value and may not be saleable'. The welfare of the animal is not mentioned; merely the cost and inconvenience brought upon the owner are highlighted. Fraser and Broom⁵ believe that such attitudes have been an important factor in the perpetuation of many systems which result in poor welfare, while Luescher *et al.*⁸ suggest that the term 'vice' should be reserved for nuisance behaviours related to temperament such as biting, kicking and rearing.

Some behavioural problems of the stabled horse are more accurately referred to as stereotypies, e.g. 'repetitive, invariant behaviour with no obvious goal or function'⁹, and are indicative of a situation in which the animal lacks a certain degree of control over its environment⁵. Stall-walking, crib-biting, wind-sucking, weaving, swaying, pawing, stall-kicking, head-shaking, head-nodding, crib-whetting and tongue-dragging are behaviours that have received detailed description, and are examples of movement sequences which horses repeat with very little variation in form⁶. Stereotypies have been recognized and much researched in many confined animal species, for example, zoo animals¹⁰, pigs¹¹, sheep¹² and domestic fowl¹³, but as emphasized by Rees¹, such behaviours in stabled horses seldom receive the same attention.

The proportion of horses exhibiting stereotypies varies among studies, which makes it difficult to assess the extent of the problem. A study by Kennedy *et al.*¹⁴ revealed that 18.4% of the 49 horses observed at two

riding schools and four private livery yards showed clearly recognizable stereotypies. This figure was even thought to be an underestimate, as the staff at the stables described more horses as stereotypy performers than those identified during observation. Kiley-Worthington and Wood-Gush¹⁵ stated that in some of the racehorse stables which they visited, all the horses were exhibiting stereotypies, and in another stable 26% of the horses were seen to perform a stereotypy within only half an hour of observation. A recent article⁸ quoted that over 15% of domesticated horses exhibit stereotypies.

These figures, however, should all be questioned due to the small sample sizes involved in the studies. In an investigation involving 1035 thoroughbred horses aged 3–8 years in Italy, Vecchiotti and Galanti¹⁶ report the incidence of cribbing, weaving and stall-walking as 2.4%, 2.5% and 2.5%, respectively, of all behaviours. Similarly, a recent study carried out on 21 thoroughbred horses in the north and centre of Italy showed that 67 out of 1180 (5.7%) horses showed a behavioural problem¹⁷. These lower percentages are perhaps a better representation, as a larger number of horses were analysed. However, until a study is undertaken comparing the incidence of stereotypies between differing breeds, ages and sexes of horses with varying types of yard (e.g. breeding, racing, livery or riding school), it will remain difficult to quote an accurate figure representing the extent of occurrence of stereotypies in the stabled horse. Another factor which will have an effect on studies involving survey questionnaires distributed to horse owners is a reluctance on the part of some owners to admit that their horse is a stereotypic performer (as this often decreases the value of the animal), leading to underestimation of the affected numbers.

Stereotypies: examples, causes and treatments

Quantitative evidence relating to the causal factors of stereotypies in stabled horses is very scarce in the scientific literature, the majority being purely anecdotal in nature. With the exception of more recent studies^{17,18}, research in this area has involved either small sample sizes¹⁹ or has consisted of a collection of individual case studies¹⁴. This lack of evidence implies that the causes of abnormal behaviour are still unclear, and more research is still required.

Wood-chewing

Wood-chewing is a normal component of a free-ranging horse's feeding behaviour, especially when preferred grasses are less abundant during late autumn and winter²⁰. Wood-chewing is, however, a common problem in the stabled environment, where a horse may chew 0.5 kg of wood a day⁵. Coupled with the financial burden on

the owner to replace fences and stable boards, wood-chewing can also cause damage to the animal itself, largely by causing excessive wearing of teeth²¹. It can pose more serious consequences such as gastrointestinal disease²², and small splinters of wood or nails may puncture the oesophagus or mouth^{5,21}, and may also lead to the formation of phytobezoars or enteroliths²¹.

The association of wood-chewing with pelleted feeds has been well documented²². The exact cause of wood-chewing associated with these feeds is unknown although reduced cecal pH and relative lack of fibre or 'chewing time' or both have been suggested^{5,22}. The horses' natural diet consists of an almost continuous consumption of roughage, a large amount of which is required by the system for proper digestive fermentation. Willard *et al.*¹⁹ undertook an experiment to determine the effect of diet on cecal pH and feeding behaviour of horses. For the study, three fistulated horses were used, and their dietary treatments were hay, concentrate and concentrate plus cecal infusions of Na₂CO₃. Horses fed on hay were found to spend significantly more time eating feed and significantly less time chewing wood, in coprophagy, in searching for feed and in standing than those receiving the concentrate diet. The amount of wood chewed per day was significantly greater for horses fed on concentrate diet and the Na₂CO₃ infusions appeared to reduce the amount of time spent chewing wood by the concentrate-fed horses, but the difference was not significant. They state that their results may indicate that increased cecal acidity and a narrowed acetate-propionate ratio, as was noted with the all-concentrate diet, influences the horse's desire to chew wood and practice coprophagy.

Doubts, however, have to be raised about the significance of these results, firstly due to the small sample size used (three horses), and secondly as only two feeding regimes were used: 8 kg of mixed grass legume hay and 6 kg of a sweet feed mixture fed at 12 h intervals. A combination of hay and concentrate may have been more appropriate to normal feeding practices. Another factor is that the authors do not mention whether these quantities of hay and concentrate represent the same percentage of body weight, which will have an effect on the results.

The results of this experiment contrast with those of a study carried out by Jackson *et al.*²³, where horses were subjected to one of the three treatments. In the first, the animals were fed long-stemmed alfalfa hay twice a day; in the second they were fed alfalfa cubes twice a day, and in the third they were fed alfalfa cubes three times a day. Both the cubes and hay were fed at 2.5% of body weight per horse per day. It was shown that there was no difference in the amount of wood chewed, despite the fact that animals in treatment 2 spent less time eating than those in treatments 1 and 3, and the cubed alfalfa would have contained less roughage than the long-

stemmed hay (C. Morgan, personal communication). The difference between the two studies could possibly be explained by the fact that horses in the latter experiment were able to socialize, whereas those in the former were maintained in metal stalls, where boredom could also be a factor predisposing the horses to chew wood. Furthermore, reduced cecal pH and lack of fibre or chewing time^{19,22} suggest that the degree of intestinal fill provided by the diet should also be investigated.

Exercise of the stabled horses is also believed to reduce wood-chewing by reducing boredom⁷. A study undertaken by Krzak *et al.*⁷ demonstrated that horses chewed more wood when they did not receive exercise than when they received 45 min of exercise on a mechanical treadmill followed by a further 45 min in a paddock with bare soil in either the morning or the afternoon. The greatest amount of wood-chewing occurred during the late night and the early morning when distractions were minimal. The authors believe that this provides some support for the boredom theory, and also suggest that hunger may have been associated with wood-chewing in this particular study, as its incidence was seen to increase several hours after the afternoon feed. Feed restriction has already been found to be related to the performance of oral chain manipulation in tethered gilts¹¹, stereotyped pecking at nonfood objects in broiler breeders²⁴ and abnormal behaviours, including chewing wood in individually penned sheep¹². Frustration of feeding motivation has been suggested as an underlying cause of oral stereotypies in pigs²⁵; however, in this particular study⁷, wood-chewing did not appear to be related to the time of feeding, as oral contact was not associated with the afternoon feeding and did not increase immediately before or after the morning feeding.

Finally, weather has been associated with the amount of wood-chewing. In the study by Jackson *et al.*²³, the incidence of wood-chewing was seen to increase, in both wet and cold weather.

The most common method employed to prevent wood-chewing is to cover all wood surfaces with a noxious substance such as creosote⁵, carbolium or lemon-flavoured oils²². Such practices, however, only prevent the performance of the behaviour and fail to identify the underlying cause. It is obviously important that the animal receives a correct diet in terms of protein and energy, and should contain more than 50% roughage, or there will be a risk of failing to satisfy its needs for fibre fill and chew time³. If it is essential that the horse be confined, adequate exercise should be given, and attempts made to relieve boredom; for example, by providing a companion animal such as a goat²⁶. Providing a sheep as a social companion proved successful in an experiment looking at social facilitation in pigs, in which one of the treatments involved housing the animals in isolation²⁷. The inclusion of toys has also been suggested²⁶. Since wood is a natural component of a

horse's diet, the problem cannot be entirely eliminated²⁶.

Crib-biting and wind-sucking

Crib-biting and wind-sucking are probably the most easily recognizable stereotypies in the stabled horse¹⁴. Wind-sucking involves opening the mouth, contracting the pharyngeal muscles, flexing the neck muscles and swallowing air, usually making a characteristic grunting noise. Crib-biting (or cribbing) is characterized by the horse resting its upper incisors on a solid object such as a door or a manger. It then leans back, arches its neck and engulfs a bolus of air (aerophagia)^{28,29}. In rare cases, the mouth may be placed against the knees or cannons⁵. Cribbing is usually associated with stabled horses; however, some will crib when turned out to pasture²⁸. Both crib-biting and wind-sucking can be detrimental to the health of the animal. Crib-biting can cause excessive wear of the incisor teeth, in some instances they may be worn down to the gum line^{26,27}, and both crib-biting and wind-sucking can cause the musculature of the throat to increase in size, and make the animal more susceptible to flatulent colic^{5,29}. Horses which practise aerophagia intensely may reduce their intake of feed, which will ultimately lead to a deterioration of their physical condition⁵.

Heredity has been thought to play a role in the frequency of stereotypies. A survey was undertaken by Vecchiotti and Galanti¹⁶ in which 80 trainers were interviewed on the occurrence of anomalous behaviours, involving a total of 1035 thoroughbred horses. The incidence of crib-biting (also weaving and stall-walking) in related horses was found to be higher than that in the surveyed population. The authors suggested that this was due to the involvement of inheritance in each of the three behaviours. However, as discussed by Broom and Kennedy⁶ this could simply be due to the fact that many related horses, particularly thoroughbreds, are kept in similar housing conditions which may give rise to the performance of stereotypies.

In other species, it has been shown that stereotypies are associated with opioid activity, which may have the effect of quietening the performer³⁰. When naloxone is administered to stereotyping sows, the behaviour is stopped⁵; narcotic antagonists were also found to prevent crib-biting in horses²⁹. Baseline β -endorphin levels in cribbing horses were found to be half of those in non-cribbing controls. This was thought to be due to cribbing horses having an impaired release of β -endorphin, which in turn increases the sensitivity of opioid receptors (Gillam *et al.*, 1994, unpublished).

In a study investigating the effects of different diets on the frequency of cribbing behaviour, feeding grain or sweetened grain rations was seen to cause a significant

increase in cribbing frequency (Gillam *et al.*, 1994, unpublished). This is thought to be due to the palatability of these particular rations, since palatable food has been shown to release β -endorphins and enhance stereotypic behaviour patterns in the horse²⁹. Kennedy *et al.*¹⁴ undertook a study in an attempt to discover factors relating to both management, and horses' characters which may be linked to the development of stereotypies. Many of the individual animals involved who performed crib-biting were seen to exhibit this behaviour around the time of feeding. A proportion was seen to exhibit crib-biting post-feeding, which could possibly be related to the palatability of the food²⁹. Heifers tied up in stalls have also been found to spend most of their time performing stereotypies 2–4 h after feeding³¹. Other bouts of crib-biting in this study, however, were linked to the anticipation of food prior to feeding¹⁴. Pigs exposed to an intermittent delivery of food with a chain in front of them were seen to develop stereotypic chain manipulation in the interval between food deliveries, and displayed a lower plasma cortisol level than in the absence of the chain, suggesting a stress-reducing role of chain manipulation when the pigs were anticipating the delivery of food³², which could possibly be an explanation for the increase in the frequency of crib-biting seen in horses prior to feeding time.

Feeding has been associated with the performance of oral stereotypies in a number of other species; for example, wire-chewing in commercially housed rabbits and bar-biting in heifers³¹, sheep³³ and pigs¹¹. When on high feed intakes, tethered gilts performed a lower incidence of repetitive behaviours such as bar-biting and chain-chewing, which increased when fed a small ration¹¹. Bar-biting, crib-biting and other stereotypies are more frequent in the absence of straw or other manipulable material³⁴, so it appears that the type and bulk of forage offered as well as the ability to manipulate are important⁵.

Traditionally, the control of crib-biting and wind-sucking has been directed towards preventing the behaviour by mechanical or surgical techniques²⁶. The cribbing strap is the most commonly used mechanical control device. This consists of a 4 cm leather strap fastened around the throat, tightly enough to make arching of the neck uncomfortable, but not so tight as to interfere with respiration^{5,28}. In some designs, there is a metal 'gullet-piece' which has a recess into which the windpipe fits, or a pressure plate containing one to three sharp spikes^{5,28}. These straps can be buckled so tightly that they interfere with normal eating, and in one noted case a tightly applied strap was associated with acute chondritis of the larynx²⁸. Another preventive measure consists of a hollow cylindrical perforated bit, which prevents the animal from making its mouth airtight⁵.

Surgery has been performed in both wind-sucking and crib-biting horses^{5,28,35,36}. It is, however, a very drastic

measure to undertake in order to prevent behaviours caused largely by management practices imposed by man. The success rate of operations is also fairly low, and the majority of animals responding to these methods of prevention are those which have not practised the anomaly for long periods⁵.

Attempts such as surgery or the use of a cribbing strap when used to prevent the performance of a behaviour prevent only its manifestation without eliminating the causal factors involved. Such measures may cause additional frustration for the animal, which may perform another stereotypic behaviour that it is not restricted from expressing, further compromising its welfare. As recommended for animals performing wood-chewing, the housing and management of the horse needs to be improved. A simple task such as feeding at random times throughout the day may help in reducing the expression of crib-biting and wind-sucking which occur prior to feeding. However, in their most severe forms, wind-sucking and crib-biting may continue to be performed when turned out to pasture (personal observation), emphasizing the persistence of stereotypies once developed⁹. In such circumstances where the behaviour continues despite recommended changes in feeding and other management practices, such as the provision of social companionship and increased exercise regimes, the use of narcotic antagonist drugs such as naloxone and naltrexone, may play a role²⁹, although this could be argued by some to be no better than surgery or physical restriction.

Weaving and stall-walking

Weaving and stall-walking have been described as locomotor activities which have become fixations²⁶. The main feature of weaving is that the horse swings the head and neck from side to side, whilst shifting its weight from one foreleg to the other^{5,22}. This is similar to the rocking behaviour shown by monkeys in captivity⁵ and in institutionalised humans⁹. Head-swaying has also been observed in singly caged rabbits, where its function has been suggested as a mechanism to relieve boredom³⁷. Stall-walking describes a form of stereotypic pacing, in which the horse constantly walks around the perimeter of the stable. It is thought to resemble weaving as both behaviours involve accurate precision and repetition⁵. Both activities can lead to weight loss, but particularly 'stall-walking', where vast quantities of energy can be depleted^{5,26}. Stall-walking can also cause flexion of the spine, especially if the area available to the animal is particularly small⁵. Apart from its aesthetic appearance, the performance of weaving is disliked by horse owners as it can cause uneven musculature development in the neck, which can have an effect upon performance.

There is little information available regarding the causal factors of these behaviours, although frustration, boredom due to lack of variety in the environment and lack of exercise have been suggested^{5,26}. Lack of variety in the environment has been found to be a contributing factor in the occurrence of stereotypic pacing in captive felids, as the frequency of this behaviour in captive leopards was found to decrease significantly after enrichment of the environment¹⁰. In many captive carnivore species, stereotypic pacing is thought to be caused by the build-up of frustration due to being unable to perform predatory behaviour¹⁰. Stereotypic pacing in captive American black bears was seen to reduce dramatically when food was hidden in manipulative objects³⁸, and in captive polar bears expectation of food was found to influence the frequency of pacing behaviour³⁹. Feeding could also be one of the contributing factors influencing the onset of stall-walking in the stabled horse, but there is no evidence to suggest this, more research obviously being required in this area.

There are not many measures undertaken to prevent these behaviours. A metal grate is often attached to the stable door to prevent horses from weaving, but the most obvious method of preventing an animal from developing these stereotypies would be to turn them out to pasture, as they appear to be linked to the need to exhibit locomotory behaviour.

General factors relating to the occurrence of stereotypic behaviours

As previously mentioned in relation to crib-biting and wind-sucking, inheritance is thought to play a role in the performance of stereotypies in horses. There is, however, little evidence to accompany this hypothesis with the exception of the survey of thoroughbred horses in Italy by Vecchiotti and Galanti¹⁶, in which they revealed a genetic component in the causation of crib-biting, weaving and stall-walking. A study in Japan⁶ came to a similar conclusion. This is certainly apparent in dogs, in which particular breeds seem to be predisposed to abnormal behaviours (e.g. whirling in Bull Terriers)⁸. Kiley-Worthington⁴⁰ also notes that stereotypies seem to be more prevalent in thoroughbred and Arab-type horses, which suggests a genetic factor, although she suggests that this could be due to the restricted environments that these 'warm-blooded' breeds are kept in.

It has been proposed by a number of authors that stereotypies can be learnt by imitating neighbouring stereotypic performing animals, particularly between mothers and their offspring^{5,8,40}. Stereotypic behaviour in bank voles was more rapidly developed in those individuals which were visually exposed to a demonstrator already performing stereotypies⁴¹; similarly, neighbour-

ing stereotyping sows were seen to influence the amount of stereotypic behaviour performed by tethered gilts⁴². However, in an experiment designed to determine whether a horse could learn the position of grain in one or two buckets by watching another horse, Baker and Crawford⁴³ showed that no observational learning was demonstrated by the animals. The reason why neighbouring horses develop stereotypies is, therefore, more likely to be as a result of them being kept in the same inadequate environment rather than due to their ability to copy.

Abrupt weaning has also been suggested as a possible factor relating to the onset of the performance of stereotypies, as a survey of thoroughbred breeding farms in Italy showed that 23.8% of horses less than two years old showed abnormal behaviour¹⁷. These behaviours were seen to commence immediately after the post-weaning period, and as the animals were turned out until the training period, the authors believe that the abrupt weaning could be a stressor for the foals, which could in turn lead to behavioural problems.

The management of young horses in training was the major factor linked to an increase in the prevalence of abnormal behaviour in a survey sampling the largest uniform population of thoroughbred horses yet to be studied, in relation to the performance of weaving, box-walking, wind-sucking and crib-biting¹⁸. The same study found that the risk of horses performing abnormal behaviour increased when the total number of horses on the yard was less than 75, in box designs which minimized social contact between horses, when bedding types other than straw were used, and when the amount of feed was less than 8.8 kg per day.

Conclusion

In order to prevent the development of stereotypies in the stabled horse, an appreciation of the type of social and physical environment the horse has evolved to live in is obviously required⁴⁰. This knowledge should also be taken into consideration in future housing design; for example, by providing more space and social companions in the form of group housing. It will, however, probably prove difficult to persuade owners to take into consideration their animal's behavioural requirements as horses are very valuable animals and are too often 'wrapped in cotton wool'. This is highlighted in a survey of thoroughbred breeding farms in the north and centre of Italy, where stallions were found to perform a higher frequency of abnormal behaviours than mares¹⁷. The authors suggest that the reason for this is the different management of the two sexes. This is probably true, since stallions are worth vast sums of money and are nearly always kept in single stables, with no access to pasture for fear of theft or injury. Horse owners, there-

fore, need to be educated about the psychological causes of stereotypies, as most are treated only because they are not aesthetically pleasing and may decrease the value of the animal.

If horses are to be confined, then every effort must be made to prevent the occurrence of these abnormal behaviours using suggestions outlined in the article; for example, by providing hay *ad libitum*, providing a social companion and adequate exercise. There is also scope for the provision of enrichment devices such as the 'Edinburgh football', which has already proved to be a successful foraging device for pigs⁴⁴.

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