Chapter 5

STEREOTYPIC BEHAVIOUR IN THE STABLED HORSE: CAUSES, EFFECTS AND PREVENTION WITHOUT COMPROMISING HORSE WELFARE

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Abstract. Apparently functionless, repetitive behaviour in horses, such as weaving or crib-biting has been difficult to explain for behavioural scientists, horse owners and veterinarians alike. Traditionally activities such as these have been classed amongst the broad descriptor of undesirable stable vices and treatment has centred on prevention of the behaviours per se rather than addressing their underlying causes. In contrast, welfare scientists have described such activities as apparently abnormal stereotypies, claiming they are indicative of poor welfare, citing negative emotions such as boredom, frustration or aversion in the stable environment and even suggesting prevention of the activities alone can lead to increased distress. Our understanding of equine stereotypies has advanced significantly in recent years with epidemiological, developmental and experimental studies identifying those factors closely associated with the performance of stereotypies in stabled horses. These have allowed the development of new treatments based on removing the causal factors, improving the horses' social and nutritional environment, re-training of horses and their owners and redirection of the activities to less harmful forms. Repetitive activities conventionally seen as undesirable responses to the stable environment, their causal basis and the effectiveness of different approaches to treatment are discussed, both in terms of reducing the behaviour and improving the horse's quality of life.

1. Introduction: Investigating Stereotypy in the Horse

In the stable, there is considerable deviation from the behavioural patterns of the wild or free-ranging horse. Stereotypic patterns of behaviour, such as weaving, crib-biting and box-walking, are particularly associated with stabling, affecting between 10 and 40% of stabled horses (Nicol 1999a). These are often described as 'abnormal' as they are; rarely observed in free-ranging horses, difficult to explain in functional terms, undesirable to horses owners, and because they can lead to or are caused by, welfare problems for the stabled horse (Cooper & Mason 1998). In stable management, stereotypies are traditionally classed with a wider category of 'vices' that are considered undesirable to people (*e.g.* Houpt 1982; Luescher *et al.*, 1998). These terms are, however, unhelpful when considering the welfare of the horse, as they emphasise the inconvenience of the behaviours to humans, rather

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than simply describing the observable events or seeking to understand their root causes and functional significance through objective investigation.

The understanding of causes and effects of equine stereotypies are investigated in epidemiological studies by McGreevy *et al.* (1995a, b), Luescher *et al.* (1998) and Redbo *et al.* (1998), which have been reviewed by Nicol (1999a). These consistently relate the incidence of stereotypies to a number of management factors including the feeding of concentrates with little access to fibre and social isolation. On their own, surveys can however only show a correlation between behaviour and management practises, so empirical studies are required to investigate the causal relationship between these environmental factors and the development and perseverance of stereotypy.

Empirical studies aim to investigate the effects of varying specific factors on the incidence of stereotypy under controlled conditions. Equine ethologists have investigated the effectiveness of traditional preventative measures such as weaving grills (McBride & Cuddeford 2001), anti-cribbing devices (McGreevy & Nicol 1998a) and the effects of pharmacological intervention (Dodman et al., 1987). Recent studies have also measured the horses' physiological distress responses such as heart rate or adreno-cortical activity (Broom & Johnson 1993) to test if there are any underlying effects of treatment on horse welfare (Lebelt *et al.*, 1998; McGreevy & Nicol 1998b, c; McBride & Cuddeford 2001). Generally these studies have found that preventative measures alone increase distress, suggesting a compromise of horse welfare. A number of alternative approaches have also been investigated, including foraging devices (Winskill *et al.*, 1996), feed additives such as fibre and anti-acids (Johnson *et al.*, 1998; Nicol *et al.*, 2001), increasing social contact (Cooper *et al.*, 2000) and even mirrors (Mills & Davenport, in press; McAfee *et al.*, in press). Initial results from such studies are encouraging with significant reductions in stereotypic behaviour with no apparent compromise of horse welfare.

The final pieces in the jigsaw are developmental studies of stereotypy. It is well known that many stereotypic activities change as they develop, becoming more repetitive, more divergent from their original root behavioural patterns and often harder to disrupt both behaviourally (Cooper *et al.*, 1996) and pharmacologically (see Mason 1991, for review). Empirical studies alone, as they are only a snapshot of the occurrence of the behaviour, may lead to mis-interpretation if the horse has been performing the activity for long periods of time. Developmental studies, in contrast, track changes in behaviour through time, and are particularly useful in investigating the relationship between stereotypy and their effects. Horses are, however, expensive to maintain and equine stereotypies may arise gradually so developmental studies are practically and financially difficult to perform. Nevertheless, the results of such long-term studies are now becoming available (Nicol 1999a; Waters *et al.,* in press) and show, for example relationships between weaning practice and both incidence and type of stereotypy.

2. Activities Described as Equine Stereotypies

Two locomotor activities are classically described as stereotypic; weaving and box-walking. Weaving has been defined as the lateral swaying of the head over the stable door or some other barrier (Mills & Nankervis 1999) (see Figure 1). The activity may also involve the swaying of the rest of the body, including the shoulders, and picking up the front legs. In stables with weaving grills a similar activity called treading (Kiley-Worthington 1987) may be observed, involving swaying of the body or alternative lifting of the forelegs, but without the swaying of the head and neck. Box-walking has been defined as the pacing of a fixed route around the stable (Kiley-Worthington 1983). Typically, a circular route is traced but in larger stables or in the field, horses may trace a 'figure of eight' shaped route.

In addition, several other repetitive body or limb movements such as nodding, door-kicking and pawing can also be described as stereotypic. Nodding involves the vertical movement of the head and neck typically whilst held above the stable door or other barriers (Cooper *et al.*, 2000) which is morphologically distinct from weaving. Nodding can also be readily distinguished from head-shaking and aggressive head movements as it involves the repetition of the head movement, though

Figure 1. A horse weaving over a stable door [Courtesy of Natalie Waran].

it may have developed from such activities as a conditioned response to stable management practices. Door kicking involves kicking the stable door, walls or other stable furnishings with the fore-legs. These and similar activities such as pawing the ground are commonly seen in stabled horses prior to feeding or other potentially stimulating periods of the day (Kiley-Worthington 1983; Mills & Nankervis 1999).

Several oral activities have classically been described as stereotypic, including crib-biting, wind-sucking, grasping and wood-chewing (Owen 1982). Crib-biting involves the grasping of a surface (usually horizontal) in the teeth (McGreevy & Nicol 1998a) and the apparent engulfing of air (see Figure 2). Typical cribbing surfaces include the top of the stable door, shelves or horizontal lips on the stable wall or the edges of feed or water buckets. Wind-sucking involves the same contraction of neck muscles and apparent engulfing of air, but without grasping. Both cribbing and wind-sucking can be characterised in behavioural observations as 'an apparent sharp intake of breath' and are often accompanied by an audible 'grunt'. Wind-sucking is often also called aerophagia (air swallowing) in scientific literature (*e.g.* Karlander *et al.*, 1965; Baker & Kear-Colwell 1974; Kuusaari 1983). This is, however, a misnomer as tracing of the air movements in the respiratory tracts of wind sucking horses reveal that little or no air is swallowed (McGreevy *et al.*, 1995c).

Grasping where the horse holds or bites stable fittings without the apparent air-engulfing can also be described as stereotypic (Owen 1982) when the horse

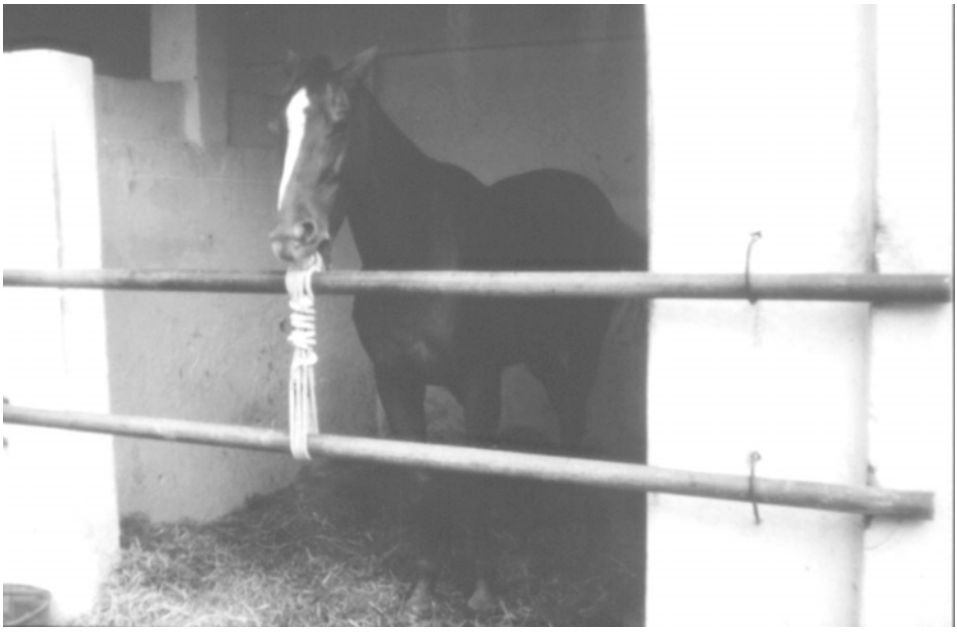

Figure 2. A horse performing crib-biting in a racing stables in India (Courtesy of Natalie Waran).

repeatedly grasps the same location. Finally, wood-chewing involves the grasping, stripping and apparent ingestion of wooden surfaces in the stable, such as the top of the door or edges to stable walls (Krzak *et al.*, 1991), though it can also be seen in free-ranging horses on fence posts and trees. Wood-chewing and grasping can be confused if the cribbed surface is wooden, and careful attention needs to be made to establish if the horse is ingesting wood (lignophagia) when discriminating between the two. Wood-chewing is considered a behavioural problem as it leads to damage to stable fittings and there is concern that ingestion of wooden splinters may harm the horse (Green & Tong 1988).

Several other activities that are considered undesirable by stable managers may be better described as redirected behaviour or even considered the normal learnt response to stable management. An example is bed-eating, which involves the chewing and ingestion of bedding substrates such as straw, paper or shavings (Mills *et al.*, 2000). It is often accompanied by nosing and sifting for hard feed or forage that has fallen to the floor and closely resembles the natural foraging patterns of feeding horses. It commonly follows the feeding of concentrates and may represent attempts to find spilt food or perseverance of feeding behaviour following a small meal or even attempts to balance the low fibre concentrated meal with more fibrous material. Bed-eating is more common in horses that do not have access to high fibre forages such as hay and it is more common in horses on straw bedding than in horses housed on rubber, paper or shavings (Mills *et al.*, 2000). Horses on straw also show few oral stereotypies such as crib-biting (McGreevy *et al.*, 1995a; Mills *et al.*, 2000). Bed-eating is not considered a stereotypy in this chapter as it appears to be part of the horses' repertoire of feeding behaviour and diet selection in the stable.

A number of other mouth movements that are not conventionally described as 'vices' may, however, be described as stereotypic. These include repetitive licking of non-food items such as the stable wall, floor, the sides of food buckets or other stable furniture. Normally licking would have a function such as picking up spilt feed, water or attempts to intake trace nutrients, but where the behaviour is repetitive and focussed on a single location, then it may conform to the definition of stereotypy. Other repetitive activities seen in horses include sham-chewing or tooth-grinding where the horse performs repetitive tongue, mouth or jaw movements without any obvious food substrate in the mouth. These activities are frequently observed around the time of feeding concentrates (Willard *et al.*, 1977) and may represent the expression of feeding motivation, either in anticipation of feed delivery or following the consumption of a concentrate meal. These mouth movements resemble activities that are conventionally described as stereotypic in other species, such as vacuum chewing in pigs or tongue-rolling in calves. Such activities in horses have rarely been considered a problem either by horse owners or horse observers so few studies have investigated their incidence, causation or treatment, though it is probable that they ontogeny is related to that of other oral stereotypies.

Another activity commonly seen in stabled horses that can be described as stereotypic is the repetitive adoption of facial expressions ('face pulling') in response to specific cues. These expressions can involve lip-curling, teeth baring or apparently

agonistic responses such as attempts to bite and actual bites. They often arise in stabled horses at feeding time or accompany interactions with humans or other horses. The handler's interpretation of these social signals (sometimes labelled as 'nippy', 'stroppy' or 'pulling faces') may help to identify individuals and their characteristics on the stable yard, but also represent misleading anthropomorphism of horses' behaviour (Mills 1998). Whilst they share a degree of morphological similarity as they involve changes in facial characteristics in response to environmental challenges, it is difficult to classify these activities as a cohesive category of behaviour, as they are can be unique to individuals and probably develop from a variety of root behaviours. Again little research has been carried out into this diverse group of responses, though it is likely that they originated as part of the horse's complex communication and social signalling behaviour and may have been reinforced by feeding or the social responses of people or other horses.

2.1. THE CAUSES OF EQUINE STEREOTYPY

Stables differ from the free-ranging environment in a number of factors including space, nutritional environment, social environment, types of environmental substrates and the ability to make controlled environmental choices. These factors may individually or in combination contribute to the development of stereotypies. There may, for example, be an overall deficit in environmental stimulation, which might lead to emotional states such as boredom, deprivation or frustration. Specific factors that differ include the changes in the nutritional environment and choice of feeds. Horses are naturally foragers who consume large quantities of fibrous feed (Waring 1983; Harris 1999), whereas many stabled horses, particularly performance horses have carefully controlled diets, with a high reliance on concentrated feeds. Furthermore, the stabled horse has little opportunity to control the timing of feeding and other procedures such as turning out and exercise. This routine may not only contribute to the amount of stereotypy but also to their timing. The social environment also conventionally differs between the stable and the field, where horses may have more choice over social spacing and companions. Finally, the rearing environment of the animals is also likely to influence the development of stereotypy, either by directly preventing specific activities that are re-directed into stereotypy or more generally affecting the development of the horse's behaviour and its ability to learn new adoptive strategies to challenges faced in later life.

3. General Factors Associated with Housing: Boredom and Frustration

It is often claimed that stereotypic behaviour is a response to boredom in captive animals such as stabled horses (Kiley-Worthington 1987), and it occupies the time that would otherwise be engaged in other functionally significant activities such as grazing, social interactions, or predator avoidance. This argument is tempting, as many of the environmental challenges faced by free-ranging horses are no longer an issue in the stable as they are provided by the management regime. In the absence

of other environmental challenges stereotypy may either have a time filling function (McFarland 1989) or may compensate for low environmental stimulation by providing sensory substitutes (Wiepkema 1985).

However, in the majority of stereotypic activities observed in captive animals, including stabled horses, there is little evidence to support this hypothesis. During quiet times of the day, the majority of horses spend their time either dozing or foraging and stereotypy is rare. Bouts of stereotypy tend to be focussed on periods of high environmental stimulation such as feeding time and prior to turning out (Johnson *et al.*, 1998; Cooper *et al.*, 2000; Henderson & Waran 2001) rather than periods of low environmental activity. This occurs on quiet yards where episodes of environmental stimulation are confined to feeding times and turning out and on busy yards where there is a high level of human disturbance as well as the stimulation of exercise and feeding times (McAfee *et al.*, 2002).

Low environmental stimulation may be indirectly related to stereotypy, not as a means of increasing environmental stimulation, but as a consequence of low behavioural competition. Contemporary models of animal motivation (*e.g.* Toates 1981; McFarland 1989) state that an animal's decision making process is based on a number of competing behavioural systems, such as feeding or predator avoidance. The importance of the activities associated with these systems (and consequently the likelihood of performance) will depend on the animal's internal state (*e.g.* hunger) and external cues (*e.g.* presence of food, absence of predators). As these behavioural systems compete for expression, high priority activities will exclude or even suppress the expression of low priority activities. In this control system, the removal of competing cues, for example predatory stimuli, not only reduces the motivation to perform related anti-predatory activities, but also removes the inhibition of other responses that would occur with performance of these anti-predatory responses. Consequently stereotypies are more common in environments with low environmental complexity; firstly because there is the absence of appropriate substrates for expression, secondly because the range of alternative substrates is limited and thirdly because there is little behavioural competition to inhibit their performance (Cooper *et al.*, 1996).

Another common general explanation of stereotypy is 'behavioural frustration' where repeated activities are derived from the perseverance of highly motivated activities that can not be adequately expressed in the captive environment (Hughes & Duncan 1988). This explanation is supported by the form and timing of the majority of stereotypies in domestic animals. For example, pre- and post-feeding stereotypies are common in a number of animals (Mason & Mendl 1997), including dry sows who perform sham rooting, bar-biting and sham chewing at feeding time and mink which somersault and pace prior to feeding. In these cases the stereotypy may either represent the perseverance of the activity in the absence of a satisfactory end point or the redirection of the activity to an apparently functionally irrelevant alternative. In horses a number of highly motivated activities that cannot be adequately expressed in conventional stables may lead to stereotypy. These include the prevention of locomotor activity and exercise, restrictions on diet selection and foraging, and imitations on both the social environment and predator

avoidance activities (Houpt & McDonnell 1993; Cooper & Mason 1998; Nicol 1999b).

3.1. CONCENTRATED FEEDING

A number of authors have implicated the feeding of concentrates as a significant factor in the development of stereotypies (Kiley-Worthington 1987; Houpt & McDonnell 1993; Marsden 1993) and these suggestions are supported by empirical studies (Willard *et al.*, 1977; Johnson *et al.*, 1998). The underlying rationale is that horses are naturally free ranging grazing herbivores that spend much of their time feeding to maintain balanced energy and nutrient intake. In the stable, the requirement to forage has been removed as horses are provided with a balanced diet. Although such diets are theoretically formulated to meet all the horse's dietary needs, they may not meet the horse's behavioural needs. Conventional stable rations come in a concentrated form which take little time to eat and contain considerably less bulk or dietary fibre than the diet the horse has evolved to consume. Under these circumstances, horses may still be motivated to forage after the concentrate has been eaten. If, for example feeding time is controlled by gut fill or chewing time (Cooper & Mason 1998), then the horse may only be able to express the motivation to feed as an analogue such as crib-biting, sham-chewing or wood-chewing. In addition concentrated feeding may lead to digestive problems as dietary fibre is involved not only in gut-fill but also in gut transport and buffering of digestive systems (Harris 1999; Nicol 1999b). In particular, grain-based concentrate feeds may lead to harmful levels of gut acidity (Rowe *et al.*, 1994; Murray and Eichorn 1996) and the high levels of repetitive oral activity (included grasping, crib-biting, licking and sham-chewing) associated with concentrated feeding may be a response to gut conditions (Nicol *et al.*, 2001).

Providing less concentrated feed or more fibrous forages (*e.g.* hay or haylage) may reduce the intensity or frequency of oral stereotypy by allowing foraging of more appropriate substrates. This prediction is supported by both epidemiological and empirical evidence. McGreevy *et al.* (1995a) found that low forage was a major risk factor in the incidence of stereotypies, whilst Marsden (1993) has reported that providing forage (soaked hay) significantly reduces oral stereotypies post feeding. Furthermore, the incidence of post feeding oral stereotypies is significantly higher in horses that do not have access to hay at feeding time, compared with horses that receive hay at the same time as their concentrate feed (unpublished, Cooper *et al.*). The relationship between oral stereotypies and forage is probably best illustrated by the studies of McGreevy and Nicol (1998c) on the prevention of cribbing and grasping. They found that removing a favoured cribbing surface from a horse's stable significantly increased plasma cortisol (suggesting a physiological response to frustration) unless the horses had access to fresh hay. This not only illustrates the dangers of preventing stereotypy, but also that oral stereotypies and foraging may act as partial substitutes for each other if they share the same motivational root.

Another means of addressing the horse's motivation to forage without providing

Figure 3. A horse feeding using an EquiballTM (Courtesy of Natalie Waran).

high fibre feeds, is to use foraging devices such as the EquiballTM (see Figure 3). The rationale behind such devices is that not only does the horse take longer to eat its ration as the feed trickles from the device, but also it allows a mode of expression for the horse's foraging behaviour. Empirical studies indicate that such devices increase time spent 'foraging' in stabled horses (Winskill *et al.*, 1996), but they may not reduce oral stereotypies, as these activities are spread over a longer period of time. Foraging devices appear to be more effective at reducing locomotor stereotypies such as box-walking or pre-feeding stereotypies such as weaving (Henderson & Waran 2001). Whether such devices are effective by removing the underlying causes of the stereotypy, providing a more acceptable substitute or whether they simply represent the extinction of a learnt response will be explored later in this chapter.

3.2. TURNING OUT AND EXERCISE

Another factor that may be associated with the performance of stereotypic behaviour, is the amount of exercise or 'turn-out time' that horses receive. It has been suggested that unless stabled horses have the opportunity to perform kinetic activity outside the stable, they may respond by performing undesirable locomotor activities in the stable such as weaving or box-walking (McGreevy 1996). There is however little evidence that exercise routine has a consistent effect on incidence of stereotypy in the stable (Marsden 1993) and exercise routine was not identified

as a risk factor in an epidemiological study (McGreevy *et al.*, 1995a). The evidence for a relationship between exercise routine and stereotypy is therefore equivocal. Evidence does however exist to suggest that turning out or exercise acts as a focus for the expression of stereotypic behaviour, with Cooper *et al.* (2001) finding a high incidence of weaving immediately prior to turning out and Waran and Campbell (unpublished data) finding that the period post-exercise is associated with the performance of cribbing in thoroughbred horses undergoing training.

Stereotypic behaviour itself is rarely observed in the field either because the horses are not exposed to the cues that stimulate stereotypies or if they are, the underlying motivation can be more appropriately satisfied. Some horses will nevertheless perform stereotypic behaviour in a relatively 'free-living' environment (for example weaving over a field gate or cribbing on fence posts). This is seen both in older horses with prior experience of stables who may persevere with the behaviour in other environments and in young foals. McGreevy (1996) identified a small number of foals that performed crib-biting on fence posts and rails prior to weaning. These activities did not appear to be related to any deficiencies in maternal care as the dams were described as good mothers with good milk supply. In a more detailed study by Waters (2002) concentrating on the development of stereotypic activities, these pre-weaning stereotypies were only found in foals that received grain-based dietary supplements prior to weaning, which supports the relationship between diet and oral stereotypy found in older stabled horses (Johnstone *et al.*, 1998; Nicol *et al.*, 2001).

In the cases of older horses with experience of stabling, the stereotypy may become emancipated from its original causes, either because of the endogenous reinforcement of the activity or failure to extinguish the response in the field. Emancipation is the process by which behaviours become independent of their original causal factors (Cooper *et al.*, 1996) and has been widely accepted to occur with stereotypic patterns of behaviour. Instead of reflecting current problems, an established stereotypy may be likened to a neurological 'scar' that marks a legacy from past conditions (Mason 1991). Empirical evidence for emancipation is, however, rare and confined to studies of laboratory animals (*e.g.* Cooper *et al.*, 1996; Powell *et al.*, 2000). In horses the emergence of stereotypic behaviour seems to be reduced in foals that are given an enriched environment, but the same effect has not been observed in older animals (Nicol 1999a). This suggests that foals are particularly reactive to stimuli that elicit stereotypies. It is generally thought that, with age, equine stereotypies are elicited by a wider set of stimuli than in early development and, further, that they become relatively resistant to normal control mechanisms. This is why older horses are commonly seen stereotyping in environments that appear to support high welfare and may explain some of the variation in effectiveness of treatments or preventative measures. In these animals, the stereotypic activities may also have become part of their repertoire of learned behaviour, activated as a conditioned response in anticipation of a particular eliciting event (*e.g.* a concentrate meal, removal of a companion).

3.3. ROUTINE AND CONDITIONING

Many stable yards follow relatively set routines. Horses may, for example be fed, exercised and returned to the stable at roughly the same time each day. Within these routines, there is potential for horses not only to learn when key events occur during the day (*e.g.* feeding time), but also what events precede and reliably predict these events (*e.g.* certain people on the yard, activity in the feed room). Under these conditions there is considerable potential for horses to learn to associate their actions, for example, kicking the door, with particular rewarding events that follow them. For example, a horse that kicks the door may be rewarded by receiving additional attention or by being fed earlier within a yard, or it may associate its door-kicking actions with feeding time. Horses may naturally perform a number of appetitive or anticipatory activities prior to feeding, such as approaching the feed or pawing the ground. In free-ranging conditions these may lead to acquisition of the feed, whereas in the stable, the actual feeding is dependent on the carer and consequently beyond the horses' behavioural control. If, however, these incomplete anticipatory actions are reliably followed by rewarding events such as feeding or turning out, then the horses will nevertheless learn to associate performance of the anticipatory action with its apparent rewarding consequences.

There is good evidence that stereotypy has become a conditioned response to events on the equine yard. Activities such as weaving, nodding and box-walking are most prevalent before feeding time (Winskill *et al.*, 1996; Cooper *et al.*, 2000). The event of turning out can also be a cue that initiates the performance of nodding and weaving (Cooper *et al.*, 2000). This may either be a conditioned response to a desirable outcome such as leaving the stable, or the expression of species typical anticipatory activities in an unusual form such as attempts to socially interact with other horses being led to the field (Nicol 1999b; Cooper *et al.*, 2000).

Changing the horses' routine also suggests that certain horses have learnt to stereotype prior to feeding. For example, changing the feeding time or changing the cues that pre-cede feeding dramatically reduces pre-feeding stereotypy (unpublished, Cooper *et al.*), but not post-feeding stereotypy. This may explain the effect of trickle feeding devices such as the Equiball™ (Winskill *et al.*, 1996; Henderson & Waran 2001) *i.e.* they reduce pre-feeding stereotypy by removing pre-feeding cues rather than acting as an alternative means of expression for pre-feeding motivation. If this is true, then changing husbandry routine may be an effective treatment of stereotypy. However, there are difficulties with these approaches. Firstly, there is the danger of an initial increase in stereotypy following the dis-association of environmental cues and reward. This is typical of extinction of conditioned response, prior to the actual loss of association and presents a problem in convincing horse managers about the effectiveness of a change in husbandry. Secondly, any decrease in stereotypy following change in routine may be short lived as the horses learn new associations that predict feeding in the new routine. Consequently in the longer term stereotypy may return to its former levels and the husbandry routine may need to be continually changed to maintain the effect.

3.4. SOCIAL ENVIRONMENT AND OBSERVATIONAL LEARNING

Horses are social animals and the horses' social environment is often overlooked in stable management. Conventionally horses are singly housed in stables for ease of management. Whilst this may have benefits in limiting opportunities for negative social interactions such as biting or kicking, these may well be outweighed by prevention of positive social interactions. It is also believed that social housing can lead to the social facilitation, copying or mimicry of stereotypy. This could occur where introducing a horse that reliably performed a stereotypy, such as weaving or wind-sucking, caused other previously non-stereotypic horses in the yard to take up the activity, rather like an infectious disease. For this reason many horse owners avoid mixing stereotypic with non-stereotypic horses (McBride & Long 2001) and even visually isolate stereotypic horses. Whilst there is some empirical evidence of social facilitation of stereotypy in other species such as voles (Cooper & Nicol 1994), there is no such evidence from horses where accounts of copying are largely anecdotal and subject to scepticism (Cooper & Mason 1998; Nicol 1999b).

In contrast both epidemiological and empirical studies of stereotypy have suggested that enhancing the horses' social environment actually reduced the incidence of stereotypy. For example, McGreevy *et al.* (1995a) found that stereotypy was less common on large yards where horses had visual contact with a large number of other horses. The low incidence of stereotypy in these yards may be related to a number of factors (*e.g.* increased yard activity compared with smaller yards) but within these yards increased visual contact with other horses was also a factor in lowering risk of stereotypy. In empirical studies, allowing close visual and tactile contact with the neighbouring horse (directly through a grill between stables, as opposed to when the horses happened to have their heads out of the stable door) significantly reduced weaving and nodding relative to the conventional stable (Cooper *et al.*, 2000).

This increased close social contact may help explain the low incidence of stereotypy in stall-tied horses such as those of the household cavalry who have restricted locomotion but greater opportunity for social interaction than conventionally stabled horses (Marsden 1993). It may, however, be inconvenient or impractical to socially house all horses, due to risk of infection, undesirable social interactions, or just the cost of maintaining an additional horse. A simple alternative may be the use of stable mirrors, which appear to have a similar effect to social contact in both short (Davenport *et al.*, 2001) and long term (McAfee *et al.*, 2002) studies. Whether horses with mirrors 'see' another horse or are merely distracted by the movement is not clear, but whatever the horses see, appears to reduce weaving.

3.5. WEANING AND REARING ENVIRONMENT

Researchers at the University of Bristol recently completed a four-year study of 225 thoroughbred and part-thoroughbred horses weaned between 3 and 9 months of age (Nicol 1999a; Waters *et al.*, in press). The study focussed on weaning practice of warm-blooded horses, selecting foals that were exposed to one of three common

weaning strategies, stable weaning, barn weaning and paddock weaning and following the development of stereotypies in later life. Stable weaning involved removal of the foal from the mother and housing it in isolation in a stable or box. Barn weaning involved a number of foals being weaned and group housed without the mothers in a large arena. Paddock weaning involved housing mothers and foals in a large enclosure (*e.g.* a field) then removal of one mare at a time until only foals remained in the field. The study consisted of direct observations of foals in the months around weaning, and tracking the incidence of stereotypy in subsequent years.

The study found the incidence of oral stereotypies to be much higher than expected from other epidemiological studies (Nicol 1999a), with 10.5% of foals developing crib-biting and 30.3% of foals developing wood-chewing. This could be because direct observation was used to record stereotypy, whilst most epidemiological studies rely on owner based surveys alone. Alternatively, horses with high incidence of oral stereotypies may be culled from the adult population or oral stereotypies may simply be less common in older horses. The incidence of weaving (4.6% of horses) and box-walking (2.3% of horses) were consistent with other epidemiological studies of adult horses. These locomotor activities tended to arise later than oral stereotypies in the study population at a median age of 60 weeks for weaving and 64 weeks for box-walking compared with 30 weeks for wood-chewing and 20 weeks for crib-biting.

Weaning practice was a major factor in both the incidence and the type of stereotypy. Stereotypic behaviour was least common in paddock weaned foals, with little overt disturbance in behaviour beyond the initial response to removal of the mare. This supports the studies of Houpt *et al.* (1984) and McCall *et al.* (1985), both of which found group weaning to cause less stereotypy in horses than weaning in isolation. Box-walking was most commonly observed in stable-weaned foals following separation from the mare, whereas barn-weaned foals commonly nosed and mouthed con-specifics, an activity that may represent redirection of suckling (Nicol 1999a). Both stable- and barn-weaned horses performed more wood-chewing in later years than paddock weaned horses and the development of crib biting appeared to be associated with the feeding of concentrates following weaning (Waters *et al.*, in press). In contrast, weaving did not appear to be related to weaning practice and many horses start to weave when they are about one year old, after they have been sold from the stud to new homes.

These epidemiological, experimental and developmental studies, therefore, give an insight into the causal factors underlying the development of stereotypy and their continued performance in later life. Having described the activities commonly labelled stereotypic in horses and their causes, the remainder of the chapter will deal with the consequences of different approaches to preventing stereotypy and good preventative management practises without compromising the horse's quality of life.

4. Consequences of stereotypies and problems with traditional and current remedies

4.1. WHY TREAT EQUINE STEREOTYPIES?

The reasons for seeking to reduce the incidence of stereotypic behaviour in horses can broadly be divided into two areas. These are, firstly the undesirable physical or behavioural consequences of the activities for the horse and secondly the attitudes of horse owners. Reasons that fall within the former area offer good grounds for seeking to reduce stereotypy so long as the preventative measures are effective and so long as the costs of the treatment to the horse do not outweigh the benefits of prevention. Owner attitudes may seem to be not a good reason for treatment, however, they are a major factor in horse husbandry and ethologists and veterinarians need to be sympathetic to the culture of horse owners when delivering practical advice on managing stereotypy (McBride & Long 2001).

Performing stereotypies incurs costs on the horse in terms of time and energy. If stereotypies are merely a time-filling activity, then there should be little concern about an increase in time spent on their performance. If, however, performing stereotypy impinges on other activities (such as eating or resting) then it may interfere with the horse's ability to respond to its environment. All non-feeding stereotypic behaviours waste energy, so there is usually a reduced ability to sustain bodyweight in any horse that spends a significant amount of time in such activities rather than feeding and resting (McGreevy *et al.*, 2001). Weaving is also thought to cause excessive wear and tear on the hooves and the musculo-skeletal system. Box-walking in a single direction can cause lateralised atrophy and hypertrophy of the lumbar musculature. Self-mutilation can lead to bite wounds and secondary infections.

Crib-biting has been associated with digestive disorders, tooth erosion and failure to thrive. Owen (1982) notes that crib-biting leads to flatulence and chronic colic. Unless specially modified sites are provided, tooth wear is an inevitable consequence of crib-biting. While such tooth wear is unlikely to be associated with pain since nerves are not exposed, it can result in difficulty in grasping and chewing forage, and this may ultimately result in loss of body condition. Weight loss may also occur in crib-biters if planes of nutrition are critical, because these horses spend more time and energy performing the behaviour and less time resting and nourishing themselves (McGreevy 1995).

Although the link between wind-sucking and/or crib-biting and digestive disorders such as colic has yet to be proved, it is commonly assumed by both horse owners and veterinarians (Ritzberger-Matter & Kaegi 1998). This may be because the incidence of colic is low in both stereotypic and non-stereotypic populations of horses, but that the risk of colic is cited when justifying surgical or physical prevention of crib-biting and 'wind-sucking'. One potential explanation linking colic to the ingestion of air has been challenged by radiographic evidence that indicates the ingestion of minimal volumes of gas during crib-biting (McGreevy *et al.*, 1995c). Even if a relationship between digestive disorders and stereotypy were

to be found, this would not mean stereotypies cause these problems as they may be correlational, with both symptoms sharing another root cause or it may even be that the gut disorder leads to stereotypy. For example, if low fibre diets cause high gut acidity, then increased oral activity may be a means of lowering acidity by saliva production (Nicol 1999b). This is supported by the finding that crib-biting horses experience more gut erosion and mucosal erosion in comparison to non-cribbers (Nicol *et al.*, 2001).

If the benefits to the horse of allowing the crib-biting outweigh the concerns felt by owners then it could be argued that allowing continued performance is desirable to outright prevention (McGreevy & Nicol 1998a). This could be achieved by allowing affected horses to crib-bite, but to provide with adequate foraging opportunities. The damage done to incisors during a lifetime performing this behaviour could also be minimised by the provision of cushioned cribbing-bars throughout the horse's environment. However, this would meet with opposition from those who feel that crib-biting is directly linked to an increased risk of flatulent colic. This supports the need for good education programmes for horse owners when introducing new practises.

In some countries, stereotypic activities such as crib-biting and weaving are considered an 'unsoundness' when vetting horses (Hayes 1968), consequently must be declared at auction and tend to lower the value of affected animals (Mills pers comm). The reason for this is the popularly held view that other horses may mimic these and other stereotypies, creating additional problems for the owner. Because of the perceived risk of copying and because stereotypies are thought to be associated with health and performance problems, horses exhibiting them are often further isolated from other horses, for example stabled out of sight of conspecifics. This may exacerbate the behaviour if social isolation is a factor that increases stereotypy. Furthermore, isolating horses complicates management and contributes further to the unpopularity of stereotypic individuals and is a significant reason for their reduced market value.

In spite of the desire to prevent stereotypies for aesthetic and occasional health reasons, no traditional remedy that is effective for every crib-biter has yet been found. In the search for a permanent cure for stereotypic behaviour, all kinds of prevention are regularly tried. When the behaviour is established, the motivation to stereotype is so strong that the resourceful horse seems able to get around all devices aimed at thwarting it.

4.2. PREVENTION ATTEMPTS, INCLUDING SURGERY AND HARDWARE

4.2.1. *Surgery*

Attempts at long-term prevention of crib-biting by surgical intervention involve the excision of many combinations of different muscles and/or nerves of the ventral neck (Forsell 1929; Hamm 1977; Hakansson *et al.*, 1992) but most have considerable drawbacks. With surgical approaches to crib-biting, especially myectomies, there is likely to be some disfigurement, which is particularly unwelcome in the case of show horses. Buccostomy wounds, on the other hand, regularly heal over

well. Palatoschisis has also been described as a surgical approach to crib-biting (Smith 1924), but has fallen out of favour.

Differing success rates for myectomy are claimed by various authors, with Forsell (1929) quoting between 100 and 60 per cent success, while a more recent report (Hermans 1973) claims a 53 per cent 'cure' rate. Similar discrepancies appear in success rates cited for neurectomy, with Monin (1982) and Fraufelder (1981) claiming 60 per cent with successful outcomes and others reporting complete failure (Firth 1980). It seems likely that confusion in terminology, differing criteria of success, varying follow-up periods and post-operative management may all have contributed to this divergence in reports of success rates (Owen 1982; Schofield & Mulville 1998). Of the surgical cases that show partial improvement rather than complete resolution, grasping is reported to be more persistent than grunting. This supports the findings of McGreevy *et al.* (1995c), which revealed the involvement of the musculature of the ventral neck in the air-engulfing process that accompanies the characteristic grunt.

4.2.2. *Preventing the grasping of objects*

Short-term prevention of crib-biting can be accomplished by using bucket muzzles to eliminate the grasping component of the behaviour or by housing horses in boxes with no projections or modifying any ledges in a loose-box with rolling bars and plastic guttering (Kennedy *et al.*, 1993). Anecdotal reports of cribbing horses in such projectionless boxes for three years (Hayes 1968) suggest that once acquired, the behaviour is extremely persistent. This reminds us that horses have good memories and their stereotypies are readily emancipated. The disadvantage of using a muzzle is that it may impair the ability of the horse to prehend food and interfere with diurnal ingestive rhythms. Similarly, devices that deliver dental and palatal pain may interfere with the horse's ingestive behaviour and result in a failure to thrive. While horses rapidly learn to eat with bits in their mouths, the presence of a permanent fistula is sometimes associated with transient drinking difficulties and the more persistent effusion of ingesta (Owen 1982).

4.2.3. *Interfering with air-engulfing*

Claims have been made that permanent fistulation of the buccal cavity (Karlander *et al.*, 1965) or the use of a fluted bit will control the air-engulfing phase of both crib-biting and wind-sucking. These measures make it difficult for the horse to keep its mouth airtight. But since the mouth remains open during crib-biting, it would appear that consummation of the behaviour does not rely on a sealed buccal cavity. The reports claimed for the success of the buccostomy and fluted bit are therefore controversial. Furthermore, it has been suggested that oral structures are not critical to the air-engulfing phase of the behaviour.

4.2.4. *Punishing neck-flexion*

The most common means of short-term prevention of both crib-biting and wind-sucking is the application of a cribbing-collar (Hayes 1968). This simple device discourages the characteristic flexion of the horse's neck that accompanies the

behaviour. It consists of a leather strap incorporating a galvanised, hinged arc that accommodates the trachea and allows normal breathing despite the collar being tightened to the point where neck-flexing and/or the engulfing of air are not performed. Since the terminal grunting in this oral-based stereotypy is known to involve distension of the cranial oesophagus (McGreevy *et al.*, 1995c), it is possible that this type of constriction not only makes crib-biting uncomfortable but also makes it less easy to consummate. Modifications of the collar include the use of leather spurs and metal spikes to increase the discomfort applied when the horse flexes its neck (Owen 1982). Often horses may adapt to the constriction of the collars, which are subsequently tightened, occasionally to the extent that skin trauma is apparent (Hachten 1995). Combinations of straps that can be tightened around different parts of the cranial neck have been advocated to reduce tissue damage at the poll (Hachten 1995).

4.2.5. *Punishing grasping*

Proprietary electric fencing is commonly used inside the stable as a deterrent to crib-biting. It is arranged on all ledges in the same way that taste deterrents are applied (Houpt & McDonnell 1993). There is an exhaustive list of taste deterrents for horses, ranging from sheepskin to creosote (Magner 1903; Miller & Robertson 1959). Meanwhile, filing of the incisor teeth, metal inserts between the teeth (Magner 1903) or others that impinge on the palate (Owen 1982) have been described as ways of making the grasping of fixed objects unpleasant.

Commercially available electronic dog-training collars have been adapted to fit the equine neck. These can be remotely controlled so that the horse does not associate punishment with the presence of a human (Houpt & McDonnell 1993). The principles of learning theory suggest that it would probably be advantageous to use dummy collars before and after aversion training of this sort in order to prevent the association of punishment with the collar itself. However, despite promising early reports, follow-up studies in 60 cases of aversion therapy using such electric shock collars indicated that only nine ‘cures’ were effected and of these three required reinforcement therapy after nine months (Owen 1982). One obstacle with the technique may be that the horse may not crib-bite for a long time after the first shock. Considerable patience and constant observation may be required for the trainer to maintain the contingency between crib-biting and punishment. It is reported that by applying an electric shock after the horse has grasped but before it has engulfed air, punishment and therefore extinction of grasping, rather than simple avoidance, may be achieved (Baker & Kear-Colwell 1974). The dose of shock is important, since learning may not occur above an optimal level of arousal (Lieberman 1993).

4.2.6. *Acupuncture*

While data for the success of acupuncture in the treatment of crib-biting are extremely limited, some success has been claimed for it in the treatment of crib-biters (Kuusaari 1983). Investigations into the use of ear staples to stimulate acupuncture points are proceeding (McDonnell, pers. comm.). It is important to

acquire long term data to verify that short-term effects were not simply a result of the animal being distracted by the intervention.

4.2.7. *Pharmaceuticals*

Dopamine pathways are intimately related to the appearance of stereotypic behaviour, and opiate transmission regulates dopamine release (Cabib *et al.*, 1984). This has prompted research into the use of opioid antagonists as therapies for equine stereotypy, and sustainable pharmacological approaches to equine stereotypies are under investigation, for example, opioid antagonists (Dodman *et al.*, 1987). It has yet to be established, however, whether these remedies work by making the behaviours less rewarding or by reducing the frustrating effects of the environment. Transient elimination of crib-biting was reported in 100 per cent of subjects treated with naloxone, nalmefene or diprenorphine (Dodman *et al.*, 1987). Crib-biting was prevented for up to a week by continuous infusion of 5 to 10 mg of nalmefene per hour (Dodman *et al.*, 1987). But these pharmaceutical agents have many additional effects, for example, naloxone is a cataleptic that suppresses appetite, so they may also reduce the performance of other functional behavioural pathways.

The effects of such drugs on the horse's ability to perceive its environment are unclear. If they are used as a palliative to the effects of poor management, psychoactive pharmaceuticals may be contraindicated on welfare grounds (Houpt 1995, McGreevy & Nicol 1998a). The greatest impediment to the development of commercial forms of pharmaceutical cures appears to be the short half-life of their active ingredients (Dodman *et al.*, 1987). Some of the opioid antagonists would have to be injected daily, which would make them unacceptable to many owners. Subcutaneous depot preparations, still being developed, may be another option.

4.2.8. *Operant feeding*

Operant demand systems, using oral movements, for food rewards, have been investigated as an approach to the prevention of crib-biting (Houpt 1982; Winskill *et al.*, 1996; Henderson & Waran 2001). The premise is that this behaviour has its origin in frustration arising from low-arousal environments, so these devices can be used to deliver small aliquots of the horse's daily ration only when the horse has activated a trigger or moved a food-cube several times. Thus, the horse's time-budget can be replenished with behaviours that are neither stereotypic nor deleterious to its health. Data on the efficacy of operant feeding devices are limited but the approach has sufficient merit to be investigated further. One abiding problem may be that because operant demand devices rely on pelleted forms of food, they may fail to provide the level of oral stimulation that horses have evolved to require (Toates 1981; McGreevy *et al.*, 1995b).

4.2.9. *Turn-out to pasture*

It is widely acknowledged that the most successful means of reducing the frequency of all common stereotypies is to give the horse greater time in paddocks with *ad libitum* forage and social contact with conspecifics (Pell & McGreevy 1999). This option may, however, not be practical where there is limited access to grazing and

may not completely erradicate the behaviour in all horses, as cribbing and weaving are also often seen in the field. Nevertheless, where possible this option would be the preferred means of treating stereotypies as it is effective at either eliminating or reducing stereotypy in virtually all cases by allowing horses to perform a wide variety of activities that may have been frustrated in the stable.

4.3. BEHAVIOURAL AND PHYSIOLOGICAL CONSEQUENCES OF PREVENTION

If stereotypies are a response to specific challenges faced in the stable environment then simply preventing the behavioural symptoms of the problem is no cure and this can result in a number of undesirable side effects, including perseverance despite the obstacles to performance, expression in a modified form and behavioural or physiological indicators of distress. For example, within an environment that severely limits normal forage intake (for example, an intensive training programme characterised by the provision of a high-concentrate : minimal-roughage diet), an oral stereotypy such as crib-biting may provide a route to normal feeding and digestive activity. Clearly, prevention of the symptom does nothing to ameliorate the cause. Horses prevented from crib-biting by the use of a traditional cribbing collar showed significantly more crib-biting on the first day after prevention than did control horses (McGreevy & Nicol 1998b). There was also a highly significant increase in the crib-biting rate of the test horses on the first day after prevention in comparison with their baseline rate. This defines the increase as a post-inhibitory rebound and it is argued that it reflects a rise in internal motivation to crib-bite during the period of prevention. Behaviours that exhibit this pattern of motivation are generally considered functional, and their prevention may compromise welfare.

It is possible that if a specific stereotypy is prevented, it may precipitate the appearance of unwelcome behavioural side-effects. Horses in electrified stables may, for example, exhibit greater reactivity, whilst horses in projectionless stables may be unable to adequately scratch or groom themselves and therefore their welfare may be further compromised. In addition, individual horses may perform more than one stereotypy and elimination of one stereotypy may precipitate the emergence of a modified or alternative stereotypy. For instance, horses without physical substrates for crib-biting occasionally develop the ability to crib-bite on their own limbs or the bodies of conspecifics (Hayes 1968; Boyd 1986). Alternatively, crib-biters prevented from grasping may begin to wind-suck (Sambraus & Rappold 1991). If crib-biting functions to reduce acidity of the digestive tract by the buffering action of equine saliva, as has been suggested by Nicol (1999b), then prevention of the opportunity to crib-bite may have harmful effects on the gut.

Finally, prevention of stereotypy per se may lead to distress, either because the activity is a general coping response to the captive environment or because prevention frustrates a highly motivated response to specific challenges encountered in the stable. Although evidence for the coping hypothesis in horses has been described as weak (Nicol 1999b), there is good evidence that preventing specific

stereotypies causes physiological responses consistent with increased stress such as raised heart-rate and adreno-corticol activity. These elevated responses have been found both for physical prevention, for example weaving bars (McBride & Cuddeford 2001), and anti-cribbing collars (Lebelt *et al.*, 1998; McBride & Cuddeford 2001) and even the removal of favoured cribbing surfaces (McGreevy & Nicol 1998c). These responses, elevated heart-rate and corticosteroids and perseverance of the activity in forms that can further damage the horse, raise obvious concerns about the indiscriminate use of preventative measures. If stereotypies need to be reduced, then prevention alone is no solution, and treatment is more likely to be effective by focussing on the requirements of the stabled horse to resolve the underlying motivational problem or if this is not possible, to redirect the behaviour to less harmful forms.

5. Preventative Management

5.1. SYMPATHETIC WEANING

Weaning can expose the young horse to a number of novel environmental challenges, including removal from its dam, a change in nutritional environment, a change in its housing and changes in social environment. Horse breeders should do their utmost to reduce distress in foals at the time of weaning to avoid short or long term coping responses that may include overt redirected and stereotypic behaviours. Several studies have shown that group weaning has definite benefits in terms of incidence of stereotypy for the foals when compared with complete isolation (Houpt *et al.*, 1984; McCall *et al.*, 1985; Waters *et al.*, in press). The latter study in particular shows that both crib-biting and wood-chewing develop at an early age in foals, and that foals weaned individually are at a greater risk of developing stereotypies than group-weaned foals. In terms of reducing the risks of stereotypy, paddock weaning is therefore recommended and stable weaning in isolation should be avoided. Even in group weaned foals, careful attention should be paid to post weaning feed. Foals receiving a grain-based hard-feed following weaning were four times as likely to develop cribbing as foals who did not receive a hard feed (Waters *et al.*, in press). Finally, even the type of forage can be a risk factor, as those receiving hay as post-weaning forage, were less likely to develop wood-chewing than those on a hay replacer such as haylage (Waters *et al.*, in press).

5.2. ENVIRONMENTAL ENRICHMENT

While the concept of emancipation explains why it may not be possible to reverse the process of stereotypy development in mature horses, the proportion of time they spend performing the stereotypy can be reduced by increasing opportunities for foraging behaviour (Houpt & McDonnell 1993) and social contact (Cooper *et al.*, 2000). Remedial steps to improve the environment in which an animal performing stereotypic behaviour is in, should be encouraged, simply because this has the potential for improving its welfare.

Given the social structure and time budgeting of feral horses, the importance of the roles played by social contacts and foraging could have been predicted. Stereotypy prevalence were lower in Australian Thoroughbred horses kept at pasture compared with stabled horses (Pell & McGreevy 1999). This statistical information is important because it suggests that some stereotypic behaviours may be caused by management practices. Management factors provide useful indices of what may be sub-optimal in the environment of intensively housed performance horses. These revolve around the stable management of young animals and how much of their day is spent experiencing this environment. Stable designs that enhance the degree of social contact between horses, the use of straw bedding, and a generous daily forage ration that is preferably placed in a haynet with fine mesh are all considered likely to reduce the incidence of new stereotypies and to lessen the degree to which established stereotypies are performed.

Horses choose to perform much of their weaving over the stable door, especially when companions from neighbouring stables are removed. This suggests that horses may start to weave when their motivation to leave the enclosure with other members of the herd is thwarted. Stable designs that reduce social isolation are associated with a risk of stereotypic behaviour (including weaving), so there is support for the view that weaving develops as a form of frustrated escape response (Kiley-Worthington 1987). Furthermore, weaving was significantly reduced when weaving horses were housed in stables that provided increased visual contact with neighbouring horses. The incidence of weaving dropped to zero when the horses had opportunities for social interaction with their neighbours on all four sides of their enclosure (Cooper *et al.*, 2000).

5.3. DIETARY MANAGEMENT, INCLUDING ADDITIVES

It has been known for some time that the feeding of concentrate diets (Rowe *et al.*, 1994) and periods of food deprivation increase gastric acidity to harmful levels that can result in rapid ulceration (Murray & Eichorn 1996). High-concentrate diets also alter caecal fermentation and increase caecal acidity (Willard *et al.*, 1977). Early signs of abnormal wood-chewing and stable biting were higher in horses fed a predominantly concentrate diet than horses fed 8 kg of hay per day. However, this did not remain true if the horses fed concentrates were given an additional supplement, virginiamycin, which suppresses lactic acid production in the hindgut and increases hindgut pH (Johnson *et al.*, 1998). This suggests that crib-biting may function to reduce acidity of the digestive tract. The exact mechanism by which crib-biting could reduce the acidity of the digestive tract is not known but it has been suggested that this activity may result in increased salivary flow (Nicol 1999b).

5.4. BREEDING STRATEGIES AND DATABASES

Since we know that some unwelcome behaviours follow a familial pattern of inheritance (Vecchiotti & Galanti 1986) it may be that there will emerge a drive to breed from animals that can cope with the stressors of intensive management. While there

may be initiatives to identify the genes of horses that cope best with intensive management and are thus less likely to display stereotypies, it is hoped that the technology can be harnessed to improve horse welfare rather than simply to select for tolerance.

The prevalence of stereotypies puts them on a par with other disease processes, for example, lameness, which in 1982 was found to end 10.6 per cent of racing careers (Jeffcott *et al.*, 1982). However, because they are not a direct cause of wastage and perhaps because they do not alter the appearance of the animal, they prompt few attempts at preventive medicine. The increasingly prevalent practice of identifying and recording the performance of non-racing sport horses, for example, the British Horse Database, will enhance the quality and, hopefully, the depth of the gene pool. The results of the surveys may provide methods for change, while the incentives for change may remain more obscure. The economics of performance animal welfare may be more difficult to calculate than those of farm animals (Bennett 1995; McInerney 1995).

6. Conclusion

Epidemiological and empirical studies consistently indicate an association between equine stereotypies and two management factors in particular, the feeding of low fibre/high grain content feeds and restrictions on social behaviour. In conventional equine husbandry, both differ markedly from the ecological niche for which the horse has evolved and both suggest that stereotypy is a response to behavioural restriction in the stable. There is also evidence that stereotypic activities can be conditioned responses to rewarding situations in the stable and that early experience can have a significant effect on both the form and likelihood of stereotypy.

To prevent the performance of equine stereotypies, humans have used physically restricting devices, electric shock and surgery. In many cases these methods are distressing, harmful and ineffective, especially where they address the symptoms rather than the underlying cause. Reduction of stereotypic behaviour by allowing appropriate expression of the underlying motivations is a better strategy than control. By feeding high forage rations, providing the minimum amount of concentrate feed to sustain health, and maximising opportunities for social contact, especially around the time of weaning, the emergence of new stereotypies and expression of established ones should be reduced.

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