THE ROLE OF THE HORSE IN EUROPE
Equine vet. J., Suppl. **28** (1999) 20-25

Understanding equine stereotypies

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Keywords: horse; stereotypy; behaviour; welfare; diet

Summary

It is frequently asserted that equine stereotypies, such as crib-biting, wind-sucking and weaving, are caused by boredom. However, this explanation is too general to be of practical use in discerning the causes of each stereotypy or in devising management practices to prevent their occurrence. The majority of equine stereotypies start within one month of weaning when both the nutritional and social environment of the foal are substantially altered. Epidemiological research has revealed that the provision of low quantities of forage and minimal opportunities for social contact are associated with a higher reported prevalence of stereotypic behaviour. Experimental data also suggest that oral stereotypies develop in response to a low forage diet but this may be partially adapative. Oral stereotypies may increase salivary flow therefore reducing the acidity of gastric tract and speeding the transit of ingested feed. Stereotypic horses may be less reactive to short-term aversive stimulation. Neither direct nor circumstantial evidence confirms anecdotal reports that horses copy stereotypies from each other. Surgical and pharmacological methods of prevention should not be attempted unless the underlying causes are removed.

Introduction

Equine stereotypies such as weaving, crib-biting and box-walking are frequently described as 'stable vices' or problem behaviours, reflecting the fact that they have long been a source of confusion, concern and annoyance to horse owners (Cooper and Mason 1998). Equine stereotypies share, by definition, the unifying characteristics of being repetitive, invariant in form, and appearing to have no obvious function (Mason 1991). The majority of texts produced for the horse owner promote the message that these behaviours also share a common cause, which is most frequently described as 'boredom' (e.g. McBane 1986). Preventing boredom is therefore suggested as a remedy for crib-biting, wind-sucking and weaving (e.g. Rose 1977).

However, appealing to boredom as a cause of equine stereotypies is fraught with difficulties. First it is not clear that horses have the capacity to feel bored, at least not in a way that we would recognise. The human capacity to experience boredom may be a legacy of our evolutionary history as innovative and opportunistic feeders. It has been argued that the aversiveness associated with boredom acts as a stimulus for inquisitive exploration, prompting the animal to seek out novel experiences (e.g. Stolba *et al.* 1983) but constructing an *a priori* argument about which species possess the capacity to feel bored is difficult. Boredom may be a superfluous subjective state for an animal that spends 16 h a day eating grass or hay, or it may be an important state mediating, for example, the switch from eating one type of grass to another. Such speculations are not likely to be particularly fruitful. An alternative approach is to try to obtain evidence that individuals of a given species show inquisitive exploration, initiating a search for novelty in the absence of any cues. This has been attempted in pigs (Wood-Gush and Vestergaard 1991) although it is extremely difficult to design experiments that do not provide some form of cue (Rushen 1993). There have been no experiments to determine whether horses exhibit inquisitive exploration.

A second problem is that the term boredom is so all-encompassing that it may suggest to the horse owner that any attempt to increase stimulation is beneficial. Therefore, it has been proposed that boredom in the horse can be reduced by dividing the exercise period into 2 separate periods or by playing the radio. Mail order catalogues for horse owners market a variety of stable toys, including giant scented plastic apples to hang in the stable, or apple-flavoured rollers for horses to mouth in the stable. There is no evidence that these toys reduce boredom and very little evidence that they reduce the stereotypic behaviour that supposedly results from it. A more appropriate form of environmental enrichment might be to try to stimulate natural patterns of behaviour within the stable. In one experiment, the behaviour of 5 stabled, nonstereotypic horses was examined when they were given a foraging device for 5 days. The horses spent time manoeuvring and eating from the device at the expense of time spent in other movement in the stable, and the authors speculated that such a device could have a role in the treatment or prevention of stereotypies (Winskill *et al.* 1996). This requires systematic investigation.

Third, a focus on boredom shifts attention from the initial stages of stereotypy development, where there is now considerable evidence that intense stimulation rather than understimulation plays a major role, to the later stages, where animals of many different species begin to withdraw from their environment (Cooper and Nicol 1991). Indeed, Wemelsfelder (1993) reserves the term boredom to describe the state that, she postulates, accompanies an animal's declining responsiveness to the environment.

It is therefore not sufficient to appeal to a general concept, such as boredom in attempting to understand how different equine stereotypies develop, what their effects are on the

horse, and what, if anything, should be done to prevent and treat them. Instead, we need to identify the specific management practices that are associated with a high risk of stereotypy development and, in order to understand more about the origin of these behaviours, we need to determine what, if any, function they serve initially and as they become established parts of the horses' behaviour. These tasks can best be achieved by taking a multidisciplinary approach.

Epidemiology

Ethologists have long recognised that the most probable general cause of stereotypies in horses and other species is frustrated motivation, which may be associated with a high level of arousal (Dantzer 1986; Odberg 1987). In equine husbandry many different motivations are potentially frustrated by different management practices and Kiley-Worthington (1987) wrote that the remarkable thing about equine stereotypies is how so many environmental factors can add up to cause the behaviour. If causes can be multifactorial then identifying the role of any particular management practice in the development of equine stereotypy will not be easy if a conventional experimental approach is adopted. Epidemiology which, until recently, was a rather under-utilised branch of equine veterinary research (Reeves 1997), provides an alternative approach. Modern epidemiology with its emphasis on the quantification of risk is a particularly appropriate technique to use for problems that are complex and multifactorial and there has been a recent surge of interest in the application of epidemiology to a range of problems in the horse, including studies of the the risk factors associated with the onset of colic (Reeves *et al.* 1996) and racing injuries (Wilson *et al.* 1996). Epidemiology also avoids some of the ethical issues associated with experimental work on horses. Nowhere could there be a greater need for clear epidemiological research than in this thorny area of horse behaviour and welfare.

The usual first step in this type of research is to survey the prevalence of the problem in question. In Thoroughbreds an overall prevalence of stereotypies of between 7 and 15% has been reported (Vecchiotti and Galanti 1986; Prince 1987; Luescher *et al.* 1991). In a study of 1750 horses used in different equestrian disciplines, the prevalence of both weaving and crib-biting was higher in dressage and event horses than in horses used for endurance riding (McGreevy *et al.* 1995a). There was also a positive association between the performance of stereotypy and the amount of time horses spent in the stable, both within and between disciplines. Once prevalence has been established, information about the association between stereotypic behaviour and various management factors can be obtained. The first detailed cross-sectional survey of this kind was undertaken by McGreevy *et al.* (1995b). A postal questionnaire was issued to 159 racehorse trainers in England and Wales which, with a 62.3% response rate, provided information on 2946 horses. The data were analysed first to establish any associations between the management factors under consideration. It was found, for example, that larger yards were less likely offer forage frequently but more likely to offer more than 6.8 kg of forage/day. Next, simple associations between these management factors and the reported prevalence of stereotypies and wood-chewing were analysed. Finally, in order to adjust for the potential confounding effects of other variables, the data were subjected to logistic regression analysis and odds ratios were calculated to quantify the extent to which a given management factor was associated with an increased or decreased risk of stereotypic behaviour. The odds of an event occurring are defined as the ratio of the probability that it will occur to the probability that it will not. The odds ratio is the ratio of the odds of abnormal behaviour in one group to the odds of abnormal behaviour in a a baseline group. An odds ratio less than 1.0 indicates a decrease in risk. McGreevy *et al.* (1995b) found that a number of aspects of the management of the horses in their stables were significantly associated with the reported prevalence of stereotypic behaviour. The most significant finding was that the risk of stereotypic behaviour decreased when horses were fed more than 6.8 kg of forage/day. Box designs that allowed visual contact between horses, and the provision of straw bedding were also associated with a reduced risk of abnormal behaviour in general. In contrast, the management of the horses when outside their stables e.g. in terms of exercise regime, was not significantly associated with the performance of stereotypic behaviour.

Despite their value in quantifying risk and in examining the relationships between environmental variables, cross-sectional surveys of this kind have a number of drawbacks. One is that they rely on information supplied by owners rather than observed by experimenters. A second is that they present a static snapshot in time. Although McGreevy *et al.* (1995b) argued that it was probable that the horses in their survey had generally been housed in the reporting yard for some time, they were not able to prove that the stereotypic horses had actually been exposed to the management factors that were revealed as important by the statistical analysis. The management factors of a given yard may have caused the abnormal behaviours reported by that yard but it is also possible that yards responded to the appearance of abnormal behaviours by altering their management practices, or even that yards with certain management practices were more likely to 'buy-in' horses already exhibiting, or with a greater potential to develop, stereotypies. Therefore, although cross-sectional surveys are a useful source of material with which to generate hypotheses, they are not very effective in establishing cause and effect relationships.

These difficulties in interpretation can largely be overcome by conducting longitudinal or prospective epidemiological surveys, where individual horses are followed over time so that the exposure of each horse to different events can be recorded in sequence and cause-effect relationships more clearly inferred. In 1995, we began a 4-year prospective study of the development of competition horses with the aim of identifying initiating factors in the development of abnormal behaviour patterns in young horses (A.J. Waters, unpublished data). As in previous work, careful records have been taken of the management factors to which each horse is exposed. However, a unique feature of this study is that every foal included is observed directly and repeatedly during the pre-weaning period to establish the nature of the mare-foal bond, the duration and frequency of sucking bouts, and the influence of the mare's temperament on the foal. Foals are observed again at weaning to assess the extent of distress shown. Behavioural observations are continued after weaning and supplemented by information acquired from owners. Direct behavioural observations therefore form the core elements of the database.

To date over 180 foals have been included in the study and the oldest cohort is now age 3 years. By June 1997, 16 horses had developed wood-chewing, and 14 had developed some form of stereotypic behaviour. As yet, the numbers are too small to analyse the different forms of stereotypic behaviour separately. However, a most dramatic finding is that two-thirds of the horses that have developed any form of stereotypy have done so within one month of weaning. As the horses were weaned at different ages it seems that some factor associated with the weaning process is responsible for this surge in cases, rather than a simple increase in risk with age. This is interesting and appears to confirm Kiley-Worthington's (1987) view that 'weaning may be the single most important factor governing the development of stereotypies'. But it is worth reflecting that many circumstances change at weaning. Most obviously, the mare-foal bond is broken, but housing and feeding practices are frequently changed at the same time and it is not clear which, or what combination, of these factors is primarily responsible. Once general risk factors have been identified by an epidemiological approach it may be more fruitful to proceed to a different level of analysis.

Behavioural experiments

Despite similarities in the general causal situations that give rise to stereotypies it has been argued that the underlying heterogeneity of stereotypies should not be overlooked (Mason 1991). The physical appearance of the different equine stereotypies suggests, in itself, that they may arise from different source behaviour patterns, perhaps reflecting the frustration of different motivational systems. Therefore, it has been suggested that the oral stereotypies, crib-biting and wind-sucking, might be related to feeding behaviour, while locomotor stereotypies, weaving and box-walking, may derive from some frustrated attempt to move or escape from the stable (Houpt and McDonnell 1993; Cooper and Mason 1998). However, the evidence for this view is not compelling. First, despite a plethora of reviews, anecdote and opinion, there have been very few scientific studies of stereotypic behaviour in the horse. Most arguments that have been made depend on extrapolation from results obtained from species with very different ecologies. Second, the horses used as subjects in behavioural experiments have often been stereotypic for many months or years. Stereotypies tend to become increasingly self-organised and less dependent on the original causal situation with time (Cooper *et al.* 1996). Third, most experimenters have considered one type of stereotypy rather than attempting a comparative study or have placed behaviours under a general umbrella of 'abnormal behaviour'. For example, Marsden (1993) reported that feeding practices had a greater effect than housing practices on the performance of abnormal behaviour in horses. Marsden found that the physical restriction of a tie-stall had no significant effect on the amount of abnormal behaviour performed by 6 Thoroughbred geldings but that feeding a high concentrate, low forage ration resulted in a significant increase in abnormal behaviour. However, no information was provided on what type of abnormal behaviour was performed by the horses during the experiment, or whether they had shown signs of abnormal behaviour before the experiment began. The experimental data that are available are reviewed below.

Studies on oral grasping and wood-chewing

Wood-chewing and biting the stable, as relatively variable behaviours, are not usually classified as stereotypies. However, wood-chewing may precede the development of oral stereotypies such as crib-biting in some individuals. In the longitudinal survey described above (A.J. Waters, unpublished data) all the horses that have so far developed crib-biting were first recorded as wood-chewing.

Krzak *et al.* (1991) found that wood-chewing occurred primarily at night and wrote that 'the stomachs of the horses in this trial would likely have been empty when oral contact began to increase'. Haenlein *et al.* (1966) reported that wood-chewing was the 'only undesirable side effect' when horses were fed pelleted compared with loose hay. Willard *et al.* (1977) reported that horses fed an all-concentrate diet spent significantly more time chewing wood than horses fed hay. The concentrate diet altered caecal fermentation and increased caecal acidity, and the authors argued that this may have influenced the horses' desire to chew wood. More recently, Johnson *et al.* (1998) found that abnormal biting of the stable and wood-chewing were both increased in horses that were fed a predominantly concentrate diet in comparison with horses fed 8 kg of hay/day. These behavioural effects were significantly reduced in horses that were fed a predominantly concentrate diet that was supplemented with virginiamycin, a substance that suppressed lactic acid production in the hindgut and increased hindgut pH. However, as Johnson *et al.* (1998) noted, it is not clear how changes in gut acidity might come to affect behaviour.

Crib-biting and digestive function

Dietary factors that influence wood-chewing are also pertinent to understanding crib-biting. If these behaviours are performed to regulate some aspect of digestive function then adaptive responses by the horse would be expected. In one study, horses prevented from crib-biting for 24 h by the fitting of cribbing collars, resumed the behaviour at a higher rate than before when the restrictive collars were removed (McGreevy and Nicol 1998a). Behaviours that exhibit this rebound pattern of motivation generally have some role in maintaining homeostasis (Wurbel *et al.* 1998). When the short-term prevention of crib-biting was compared with the effects of short-term prevention of a normal behaviour, eating hay, McGreevy and Nicol (1998b) found that the 2 behaviours were partial substitutes for each other. When horses were prevented from performing both crib-biting and eating hay, crib-biting horses showed a highly significant increase in gut transit time which was not observed in noncribbing horses. The authors suggested that normal gut motility and transit times in crib-biting horses may depend on physical flushing by saliva associated with their crib-biting behaviour. The mechanism by which crib-biting affects digestive function has yet to be elucidated but these results do suggest that the origin of crib-biting is associated with specific dietary problems.

Crib-biting and stress coping

An influential hypothesis has proposed that stereotypies may assist animals to cope with stressful conditions (for review see Mason 1991). The evidence that this is the case for crib-biting is, however, weak and contradictory. A key prediction of the

stress-coping hypothesis is that stereotypic animals should have lower baseline concentrations of various physiological parameters associated with stress, although it is not clear whether this should be the case all the time or only during bouts of stereotypic behaviour. In horses, the physiological parameters that have received most attention are heart rate, plasma cortisol and plasma beta-endorphin. Some studies have found no difference between cribbing and normal horses in baseline plasma cortisol (McBride 1996) or endorphin levels (McBride 1996; McGreevy and Nicol 1998b). Others have reported higher baseline cortisol (McGreevy and Nicol 1998b) or endorphin levels (Lebelt *et al.* 1996) in cribbing horses. In contrast, Gillham *et al.* (1994) reported that baseline levels of beta-endorphin were significantly lower in crib-biting horses than nonstereotypic controls. One difficulty in interpreting these conflicting results is that horses that develop stereotypies may be more reactive than other horses from the start. The performance of stereotypy may decrease concentrations of these physiological parameters to varying degrees in different individuals, perhaps to levels that do not differ significantly from those of nonstereotypic horses. Longitudinal studies of individual horses initiated prior to the onset of stereotypy would aid interpretation. However, if crib-biting functions to reduce stress, preventing its performance should result in an increase in physiological stress parameters. McGreevy and Nicol (1998b) found a slight increase in cortisol when cribbing horses were prevented from both crib-biting and eating hay but, rather inconclusively, this effect was mirrored in the nonstereotypic control horses.

A further difficulty is that opioids, such as beta-endorphin, have a plethora of physiological roles and have been implicated, for example, in reward processes. It has been proposed that the performance of stereotypy becomes self-reinforcing via the facilitation of central opioid release (see Mason 1991, for a discussion of this hypothesis) but the relevance of measuring peripheral plasma levels of beta-endorphin to investigate this hypothesis remains controversial (Ladewig *et al.* 1993). The inhibitory effect of opioid antagonists on crib-biting behaviour found by Dodman *et al.* (1987) lends some support to this idea, although the results were not replicated by McBride (1996) and the effects of naloxone are not specific to stereotypic behaviour. An alternative to using opioid antagonists is to look for evidence of opioid-based reductions in reactivity or sensitivity to painful stimuli during bouts of stereotypy. Lebelt *et al.* (1996) found that established crib-biters had a reduced heart rate and were less responsive to an applied thermal stimulus during bouts of crib-biting behaviour than during interbout intervals. But stereotypic individuals may also show a general reduction in reactivity during periods when they are not performing the stereotypy. Minero *et al.* (1997), for example, found that the heart rate and behavioural response of cribbing horses was lower than that of nonstereotypic horses when a lip twitch was applied as a method of restraint.

Studies of weaving

There have been very few experimental studies of weaving in horses. McBride (1996) included 3 weaving horses and could not reduce the occurrence of the behaviour by the use of anti-weaving bars or the use of naloxone. Two unpublished undergraduate research projects conducted at the University of Bristol in 1994 and 1995 examined the effects of placing a mirror on one wall of a stable. Nonstereotypic horses stood close to the mirror and spent substantially less time looking over the stable door while, for 2 weaving horses, the frequency and duration of time spent weaving were reduced. A double-blind trial currently in progress at the University of Bristol is examining the effects of feeding a valerian-based herbal supplement, claimed to have a general calming effect, to weaving horses.

Social learning

A number of authors state most confidently that horses imitate stereotypies from each other (e.g. Kiley-Worthington 1987). However, as Houpt and McDonnell (1993) note, there is no good evidence that this is the case and clusters of horses with stereotypies may occur on or between yards because of shared exposure to the same management factors. If stereotypies have a function, even partially, in meeting frustrated dietary needs or in reducing arousal then it might be beneficial for a young animal to learn how to perform the stereotypy by watching a more experienced individual. There is some evidence that the development of locomotor stereotypies in bank voles is facilitated in young animals that are housed in visual contact with stereotypic adults (Cooper and Nicol 1994) but designing a similar experiment for horses would be prohibitively expensive. The tendency to copy stereotypic behaviour could be related to the ability to acquire other information or behaviour via the visual observation of companions. However, the studies of equine social learning to date have all produced largely negative results. There is no evidence that horses learn where to find food, or how to obtain it by watching more experienced individuals (Baer *et al.* 1983; Baker and Crawford 1986; Clarke *et al.* 1996; Lindberg *et al.* 1999) although individuals of many other species perform well in such experiments (reviewed by Nicol 1995). However, experiments on equine social learning have tended to use mature subjects and further work with young, potentially more susceptible horses would be useful.

Conclusions

Review articles on equine stereotypic behaviour are relatively common but experimental papers, particularly in peer-reviewed journals and on locomotor stereotypies, are conspicuous by their absence. There is a great need for more information at a time when evidence suggests that we are getting closer to establishing the important causal factors in the development of oral stereotypies. It is clear that, in horses, as in many other species, diet and feeding regime play a critical role in the development and maintenance of abnormal oral behaviour. The mechanism by which high forage diet reduces the risk of abnormal oral behaviour is not yet known and, clearly, many different levels of explanation are possible. It has been suggested that a high forage ration may reduce the time available to perform stereotypy or that the motivation to forage is reduced through increased gut-fill or other feedback mechanisms (McGreevy *et al.* 1995c; Cooper and Mason 1998). The work of Johnson *et al.* (1998) suggests that there may be feedback from changes in gastric acidity. A number of factors, most importantly the feeding of concentrate diets (Rowe *et al.* 1994) and periods of food deprivation (Murray and Eichorn 1996), increase gastric acidity to harmful levels that can result in rapid ulceration (Murray and Eichorn 1996).

Increased wood-chewing may represent the horses' attempt to take in some form of food to raise gastric pH. The performance of crib-biting may result in increased salivary flow providing a direct and adaptive method of reducing gastric acidity. In horses where crib-biting is an established stereotypy, the onset of the behaviour within minutes (Gillham *et al.* 1994) or, even, seconds (McGreevy *et al.* 1995c) when horses are fed highly palatable concentrates may indicate that horses have learnt that a short-term protective response is required. It is probable that these attempts are not wholly successful, therefore providing the element of frustration hypothesised to underlie the continued development of stereotypies and their eventual emancipation from the original causal situation.

In contrast, weaving appears to be a response to the confinement of the stable. The motivation of horses to reinstate social contact cannot be underestimated and weaving is particularly likely to develop when horses are first separated from their dams at weaning. In horses that already weave, the behaviour can most easily be triggered by removing a horse from a neighbouring stable. It appears (tentatively) that the provision of a mirror may help to reduce the social isolation in the stable, although providing increased opportunities for real social contact is likely to be more effective.

This view of equine stereotypies as adaptive attempts by the horse to cope with an inadequate diet or environment suggests that veterinary intervention to prevent them by using surgical or pharmacological methods may be counterproductive.

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