Chapter 10

Equine Behavior Problems

Problem behaviors are often called "vices" by horsemen and women, and the synonym "misconduct" accurately describes several behaviors already covered. In theory, all behavior problems have a neurologic basis either through learning, instinct, or physiology. In a few cases, there is an associated neurological abnormality. The incidence of undesired behavior varies, depending on which behaviors are included. Although higher incidences have been reported, a more likely estimate suggests somewhere between 9% and 20% of horses have a behavior problem, with approximately half being incidental or nuisance problems and half being medically based or stereotypic/obsessive-compulsive in nature.[1–3]

Management practices have a significant impact on problem development. In the early 20th century, most horses worked on farms. Today, the number of farms in the United States has dropped by two-thirds and mechanization has become the norm. As a result, only 1.5% of households in the United States have horses. Instead of being used for work, horses are now thought of as family members by approximately 35% of the owners or as pets or companions by about 60%.[4] Modern owners are inclined to think of the horse as a big dog, not understanding horse behavior or learning. This explains why there are so many nuisance problems. In today's increasingly urban society, horses spend less time in pastures and more time in stalls, resulting in significantly higher rates of serious problems.[5,6] Stall-bound horses can "recharge" their positive attitudes if given the opportunity to spend time in a pasture with other horses.[7] This fulfills their innate need for exploration, play, social grooming, and social interaction—a reason pasturing with social peers is often part of treatment protocols.

As behavioral science progresses, problems are being catalogued more accurately by expression or cause, rather than being lumped into one large "vice" category. That said, trying to organize various problems is a lot like herding cats. Some fit nicely into a specific category. Others can be classified in several categories because they can be expressed in multiple ways. Horse owners divide problems into five broad categories (handling issues, frustration behavior, abnormal oral/ingestive behavior, aggression toward people, and locomotor stereotypies).[6] Unfortunately, this does not cover all types of potential problems, includes a judgment of motivation ("frustration"), and mixes types of problems between categories ("eat bedding" is listed as a frustration

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behavior rather than an abnormal oral/ingestive one). The many variations of a particular behavior problem suggest different or complex causes, or at least differences in how individual horses express the same thing. Because of all these complications, the descriptions of certain problems have to be placed under one heading but could just as plausibly be put under another. Those generally considered to be a nuisance are covered in appropriate chapters. Complex problems that have a neurologic or medical component are included here.

THE BASIS OF REPETITIVE BEHAVIOR PROBLEMS

Repetitive behaviors can happen for a number of reasons. Behaviorally, stereotypies and obsessive-compulsive disorders (OCDs) fit into this category. For other behaviors, owners may inadvertently reinforce an undesired behavior by giving the horse attention. They may also attempt to withhold rewards while the horse expresses the problem behavior but eventually give in before the behavior stops. This is a strong reinforcer. Some problem behaviors, such as pawing, are learned and are only shown when the owner is present. Other repetitive behaviors are situationally dependent, such as fence walking when a social peer is gone—a form of separation anxiety.

Medical problems are associated with some repetitive behaviors. "Ticks" can be manifestations of psychomotor seizures. Some headshaking is similar to trigeminal neuralgia in humans.[8] Visual problems are blamed for some repetitive behaviors, as are occasional expressions of pain or dermatologic conditions.[9,10]

Individual horses can have more than one behavior problem. A cribbing horse might also walk off when the rider is mounting, as an example. Multiple stereotypic behaviors can occur in the same horse. Of approximately 4000 horses, 10 will stall walk and weave (0.25%), 7 will weave and crib (0.18%), and 4 will do both stall walking and cribbing (0.1%).[11]

Specific stereotypic and OCD problems will be discussed separately, but a general discussion is appropriate for a better frame of reference. As will be described under cribbing, the understanding of stereotypies is complicated because the motivation is unknown. The use of certain drugs hints at possible mechanisms. Unfortunately, no magic pill works on every case of a specific stereotypy—further suggesting their complexity. Interventions can be problematic because they do not identify or address the cause, and interrupting one component in a complex system can disrupt that system even though that specific component only has an indirect relationship.[12]

Stereotypies

Stereotypies are repetitive behaviors that gradually become ritualistic, have no obvious goal or function, and are recognizably abnormal in the context, frequency, and pattern.[2,13,14] The specific behavior may start as something the

horse is motivated to do or as a substitute for what the horse is highly motivated to do.[15] The pattern solidifies over time and, once developed, the stereotypy will occupy at least 5%, and often over 25%, of the total daily time budget.[16,17] By then, the behavior is difficult to eliminate. Even if the frequency can be reduced significantly, any stress is likely to trigger the behavior again. It becomes a "default" behavior.

In humans, stereotypies begin while a child is very young. This can happen in horses, as exemplified by foals that are just a few days old circling the edges of a stall, but they generally develop within a few months after weaning. It might relate to the significant changes in the foal's nutritional management and social environment.[18] For horses that ultimately develop a stereotypy, 10.5% develop cribbing at a median age of 20 weeks, 30.3% show wood chewing by 30 weeks, 4.6% weave by 60 weeks, and 2.3% stall walk by 64 weeks.[19] Young colts are affected more than fillies, but by 3 years of age, the sex difference has disappeared.[11] Based on rodent models, it has been suggested that when an older horse develops a stereotypy, it had previously experienced significant stress while very young. This emotional "scar" remains so that when a major stress occurs to the adult, abnormal behavior surfaces.[20]

The incidence of stereotypies is highly variable due to several factors, particularly how the data was gathered. This explains the range between 5.6% and 32.5%.[3,11,19,21–27] Under poor management conditions, rates may be as high as 85%. In appropriately managed stables, the rate is closer to 20%.[2,21,28] The frequency of stereotypic behaviors will vary by breed and by the type of event the horse is trained to do.[28–30] Closely related horses show stereotypies at a rate higher than would be expected by chance, suggesting that genetics may play some role in this problem.[13] Discrepancies in data are also found when evaluating the horse's training. For example, the incidence ranges from 32.5% to 88.2% for dressage horses.[28,30] A great deal of additional data will be required to sort out the true incidence of stereotypies and assorted factors.

Today's horses live in significantly different conditions from those of their ancestors, with exercise, diet, and reproduction under human control. As a result, stereotypies are thought to develop as a coping mechanism when a horse cannot avoid stressors like social isolation or fearful stimuli, release tension or "frustration," or show species-specific behavior.[14,16,31–34] The horse is stimulated to show a particular behavior (*appetitive behavior*), typically by excitement or stress, but the environmental conditions prevent the animal from acting out that particular behavior (*consummatory behavior*) (Figure 10-1). Environmental situations are closely associated with the expression of the stereotypies. As will be mentioned for several specific problems, food plays a big role in stereotypic activity. In long barns where it takes several minutes to feed all the horses, the ones on the far end listen to grain being dumped and others eating. This could increase anticipatory stress levels. There is evidence that the personality type of affected horses is such that these individuals react more strongly to acute stressors.[35–37]

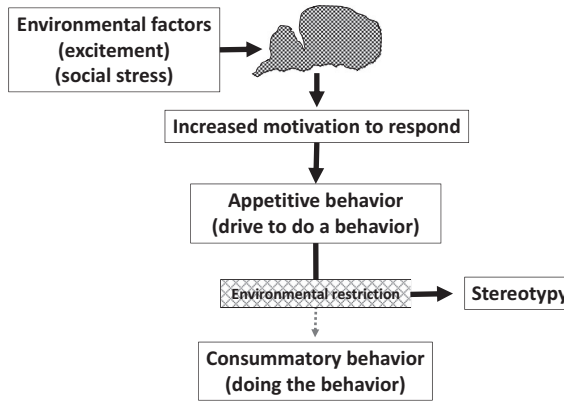

FIGURE 10-1 The interrelationship of the brain and environment in the development of stereotypic behaviors.

Physiological data gathered from horses with a variety of stereotypies and OCDs are often confusing and contradictory.[38] Test results can be higher, lower, or no different from those of controls. Both plasma and salivary cortisol levels are the same in normal horses and those with most stereotypies; however, increased levels are found in horses with oral stereotypies.[36] Timing of the samples may be important too since cortisol is significantly higher immediately before the onset of the stereotypy and greatly reduced after it is done.[39,40]

Neurologically, sensitization of the striatal region of the basal ganglia is the area thought to be primarily involved with stereotypies. Dopamine is the neurotransmitter associated with stereotypies in several species, including horses.[13,25,33,41,42]

Recently cytokines have been investigated, prompted by the known association of pain and stress and a correlation between cytokine levels and behavior changes.[43] Cytokines are nonantibody proteins released by one type of cell that then influence surrounding cells. Both of the antiinflammatory cytokines (IL-4 and IL-10) are significantly higher in cribbers than in normal horses. They were also higher in weavers but not at the same level of significance. The proinflammatory cytokine TNF-α is significantly higher in control horses that are either cribbers or weavers. These findings are opening up a new area to investigate relative to stereotypies and potentially genetic analyses.

Because stereotypic behaviors are not observed in free-ranging horses, onset must be related to how tamed horses are kept.[10,33,44–46] Certain environmental conditions increase the likelihood of stereotypic behavior and should be part of strategies used to prevent problem development. Free-ranging and pastured horses spend 60% of their time grazing. If given a choice, domestic horses will spend only 10%–20% of their time in a stall and 50%–60% in visual contact with other horses.[47] Longer duration stalling increases the risk of problems.

This is also associated with high arousal situations like waiting for food or removal of a nearby horse. Additionally, general access to food and conspecifics is limited. Other associations to stereotypy development include reductions of eating time (associated with eating cereals/concentrates rather than grazing), frequency of feeding, amount of forage, and locomotor time; conflicting rider cues; high-ranking dams; managed rather than natural weaning; confined weaning; postweaning confinement; certain types of bedding; and reduced social/visual contact with other horses.[5,13,18,19,26,28,29,33,48–55] These represent the horse's inability to control its environment.[13]

Which specific stereotypic behavior develops may relate to the type of riding the horse is used for and to the horse's perception of stress. Similar horses from the same barn have shown that repetitive licking/biting is more common if they are used for eventing, while cribbing is more common if they are used for dressage.[28] Mildly stressful events seem to be associated with cribbing. As the stress level increases, weaving and occasionally head shaking appear.[56] Because weaving is most common when the horse is relatively isolated or a social peer is removed, the response emphasizes the importance of social contact.[56]

Why does one horse develop a stereotypy when other horses in the same environment, managed the same way, do not? This suggests a neurologic/physiologic/genetic predisposition that it is easily triggered under certain environmental conditions. Stereotypic research is showing that causation is very complex. Theories suggest that stereotypic behavior releases brain endorphins to calm the stress, but it is not a linear relationship. Using the cribbing model, affected horses have resting brain β-endorphin levels lower than unaffected horses, higher than unaffected horses, and not different from unaffected horses.[35–37,57–59] Yet, the use of a narcotic antagonist like naloxone will block the expression of some stereotypies. This suggests that either plasma levels of β-endorphins do not correlate with brain levels or that opioid receptors are more sensitive in stereotypic horses.[37] Other physiological measures show thyroid stimulating hormone (TSH) and melatonin levels to be lower in weaving horses, but serotonin levels are higher.[60]

Stereotypies are very undesirable, so the horse's value and salability are greatly reduced, regardless of its ability to perform.[33,61] People go to great lengths to hide the fact that their horse has a problem. They are also concerned that nonaffected horses in the barn will learn the undesirable behavior, particularly cribbing, from affected ones. A correlation is actually very low, just 1.0%.[62] The only correlation shown is for horses at riding schools.[18,52,63] What people fail to take into account are the similarities under which all the horses are being managed and ridden, and perhaps genetic relationships as well.

Stereotypies are abnormal behaviors that have other associated costs. The cost to the horse can be physical, as happens in cribbers with abnormal wear of the teeth, loss of body condition, or colic. It has also been shown that broodmares with a stereotypy have a significantly lower conception rate than do

unaffected mares.[64] Costs can also be psychological when the stereotypy becomes the preferred behavior. It interferes with the ability to learn new tasks or extinguish previously learned ones.[13,14,41,45,65] The horse is also less aware of external events, has reduced arousal, and has less distress.[14]

No single treatment is effective for all stereotypies, and treatments rarely "cure" the problem. This makes prevention important. General recommendations include low stress weaning of foals, daily pasture time, social groups, multiple meals with more roughage and less concentrates, predictability in the environment, and improved rider skills.

At least 50% of trainers and probably significantly more owners will try to deal with the stereotypy only by physically preventing it.[3,61] Another 35%–45% will try to remove factors related to the causation.[61] Only preventing expression of the stereotypy is stressful to the horse, as shown by an associated rise in cortisol.[66] Ultimately, it does not work, and as soon as possible the horse will show a rebound effect by doing the behavior longer or more frequently than it did before the prevention. The internal drive to show the behavior has not been changed, and the stress of not being able to perform it increases.

Long-term pasturing is helpful for locomotor stereotypies, but confinement at some point in the future is likely to trigger the unwanted behavior again. Oral behaviors may be less responsive to pasture management. Food dispensers as enrichment are not helpful, even for horses with orally directed behaviors.[66] Drug therapy rarely eliminates the problem either. Even if it did, treatment would probably be required for the duration of the horse's life.

Obsessive-Compulsive Disorders

OCD is a second broad category of abnormal behavior that encompasses a number of different conditions. Exactly which behavior problems can be classified as OCD is fuzzy, but there are clues. By definition an *obsession* is a haunting thought that is constantly intrusive. *Compulsion* is the uncontrollable need to act on a particular thought or obsession. OCDs are defined by their expression, their frequency and persistence, consumption of significant amounts of time, lack of an apparent function, and irrelevance to where they occur.[10] The clinical manifestations may show that the compulsion is severe enough to cause physical injury, interfere with normal activities, or become a nuisance to others.[2]

We can never know what the horse is thinking and so can never prove an "obsession," but it can be measured. As an example, a cribber typically cribs on one location in its stall. A barrier is placed between the horse and cribbing area such that the horse must push past the barrier to get to the cribbing area. By gradually increasing the difficulty of pushing open the barrier, researchers can get a quantitative measure of the significance of the behavior to the horse by how hard it is willing to work to get past the barrier. This gives some measure of the amount of "obsession."

Obsessive-compulsive behaviors are often stereotypic behaviors that have become OCDs over time. It is important to note that not all OCDs are stereotypies, and not all stereotypies are OCDs. In spite of this, some authors incorrectly equate the two. For a stereotypy to become obsessive-compulsive, it must first become emancipated from the original environment and occur as a favored behavior at any time and place. As an example, some horses will only circle their stall when confined within it—that is a stereotypy. It becomes an obsessive-compulsive problem when that horse starts to walk the same small circle when put into a large paddock or pasture too.

Research in humans and other species is providing more information about causes of compulsive behaviors. Very recent research on the genetic expression of OCDs is finding links to abnormalities in glutamate signaling and the brain's cortico-striatal circuit. Four specific genes (*NRXN1*, *HTR2A*, *CTTNBP2*, and *REEP3*) are being implicated.[67] Glutamate is the excitatory neurotransmitter that triggers postsynaptic excitation of contact neurons affecting memory and learning. When postsynaptic binding is interfered with, as is expected through these genes, excitatory levels continue to build until stereotypic/compulsive behavior results.

Dopamine is a second neurotransmitter that might be involved in stereotypies and/or compulsive behavior. It is associated with the internal reward system. By blocking this reward system with drugs like dextromethorphan, a *N*-methyl-D-aspartate (NMDA) receptor antagonist, expression of some stereotypies and compulsive behaviors is altered. This has been demonstrated in some cribbing horses. Of nine horses, four stopped cribbing for 35 to just over 60 min, four others had a reduction in their cribbing rate for a shorter period of time, and one increased its cribbing rate following dextromethorphan administration.[68]

While punishment for OCD behaviors is popular, it is ineffective at best and increases the anxiety to potentiate the problem at worst.[10] Providing free access to pastures and friendly herdmates and removing stressors are important in minimizing expressions of OCDs. Medications are usually necessary and typically include long-term use of selected serotonin reuptake inhibitors (SSRIs) and situational use of anxiolytics. "Cure" is rare, and like stereotypies, this is the default behavior that will appear in any stressful situation.

REPETITIVE ORAL AND HEAD PROBLEMS

Oral behavior problems come in many forms. While the overall incidence of these problems varies based on how the data is collected, it might be as high as 48%.[6] Some oral problems are random and situationally dependent, as discussed elsewhere. Some are repetitive stereotypies or OCDs. Studies of oral problems in general show they commonly develop around the time of weaning and are slightly more likely to happen shortly after weaning.[69] Wood chewing problems are the most common.[69] Of all serious oral problems, cribbing (cribbiting) is the one most studied.

Many oral problems are linked to the diet of the horse, particularly to foods high in digestibility but low in fiber. The fact that frequency of performance of these stereotypies is reduced with the addition of hay supports the link. There are many theories as to causes, but coexisting factors make studying the problems difficult.

Cribbing, Windsucking

The current understanding of cribbing is that it is a stereotypic OCD, is very complex, involves several body systems, and is progressive. While generally accepted that stereotypies do not exist in free-ranging horses, teeth from horses that lived 15,000–30,000 years ago show evidence of cribbing. This does not suggest they were domesticated, but more likely were wild caught and held tethered for prolonged periods for some unknown but specific purpose.[44]

Defining the Behavior

There are three closely related behavior problems: wood chewing, cribbing, and windsucking. The first is generally considered to be a nuisance behavior related to eating. It is suggested that wood eating may lead to cribbing. Cribbing begins with the horse licking the object to be grasped a couple of times. This occurs 1.7 times before each cribbing event while the horse is eating grain and 1.1 times if eating hay.[70] Next, the horse puts its upper incisors on some hard object that is about chest height, extends its neck slightly, pushes down on that object while tensing the ventral muscles of its neck, and pulls back as it puts pressure on the object (Figure 10-2). The amount of neck tension is enough to lift a 110-lb (50 kg) weight.[71] Some horses crib and suck in so hard that they produce a

FIGURE 10-2 A cribbing horse places its upper teeth on the fence. She then tenses her neck muscles as she puts downward and slightly backward pressure on the board.

characteristic, loud gasping sound. These horses are the windsuckers. The behavior has been called *aeorphagia* because it was believed that the horse is swallowing air in addition to cribbing. Fluoroscopic and endoscopic studies show that windsucking is either a variation of cribbing or a more advanced form of cribbing, not a separate stereotypy. The sound is caused by the rapid introduction of air into the proximal esophagus, expanding it to approach a diameter of 80% that of the trachea.[72,73] Tension in the ventral neck muscles is thought to create a pressure gradient in soft tissues of the throat that results in air being drawn into the esophagus.[73] Most of the air returns to the pharynx. Only a small amount moves on to the stomach, usually in association with the ingestion of food or water shortly after the air intake.[72–74] Because cribbing and windsucking are really the same, the terms are interchangeable.

A few horses show all the behaviors of cribbing without having their teeth contact a hard surface. In the past, these have been called windsuckers,[75] but now that the imaging studies have been done, it is more appropriate to call them "air cribbers" instead.

The incidence of cribbing/windsucking varies with how data was gathered and the management practices for horses being studied. Overall, the problems exist in 2.3%–10.5% of horses.[1,5,24,29,33,35,62,69,71,75] Foals can show cribbing prior to weaning. Affected foals tend to have had more early suckling terminations, show more bunting behaviors while nursing, and spend less time lying alert than other foals.[69] The likelihood of cribbing increases right after weaning occurs, perhaps as a reaction to associated stresses. Affected weanlings differ from those affected prior to weaning in that these spent more time suckling, spent approximately twice as much time nuzzling, and vocalized less than other foals.[34,69] By 20 weeks of age, there is a 10.5% incidence of cribbing in Thoroughbred and Thoroughbred-cross foals.[19,34]

The frequency of cribbing varies with the longevity of the problem, time of day, presence/absence of forage, and individual variation. Figures range from one to eight crib-bites per minute, lasting 2.5–3.5 s each. Horses typically spend 17 min/h cribbing.[68,76] This amounts to spending approximately 23% of a 24-h period cribbing.[70,76] Observations suggest how important the behavior can be. One foal spent 50% of its time cribbing.[77,78] Reports of horses cribbing for 30 s of every 5-min period for 22 h, or an average of 1603 crib-bites each 24 h, are common.[77,79,80] These examples suggest a strong motivation to perform the behavior and illustrate how extreme it can become. Tests of motivation show horses will work harder to crib (push a barrier 350 times to get to a cribbing space) than to get food (push approximately 200 times), social interaction (40–50 pushes), or released from a stall.[71] A few horses crib to the exclusion of eating.[26]

Associated Factors

Several factors contribute to the development, or at least the expression, of cribbing/windsucking. The first of these is neurological and certain brain pathways

have also been implicated. Normally, the frontal cortex sends "worry" signals through the caudate nucleus, which puts a brake on the amount of signal passed on to the thalamus. The thalamus triggers excitement and sends a feedback loop to the frontal cortex. If the caudate nucleus does not reduce the input from the frontal cortex, the loop continues to escalate the stress. Secondly, cribbers show a bias toward keeping habitual response patterns, correlating with upregulation of the ventral striatum and basal ganglia dysfunction.[41,45,81] The dorsomedial striatum, an area associated with learning and exploratory behavior, is downregulated too.[41,42,81] The cribbing stereotypy is preferred above all else, suggesting a decreased output of the caudate nucleus and increased reliance on the sensorimotor putamen circuit. The result is an accelerated habit formation.[25,82]

Neurotransmitters and endogenous steroids seem to be involved as well. Cribbing is a stereotypic compulsion that probably has an associated internal reward related to opioid release. Administration of opiate drugs can induce cribbing in affected horses, and opiate antagonists reduce the incidence by 84%.[26,40] Administration of antagonists also increases resting behavior and reduces plasma β-endorphins. Cribbers commonly have significantly lower "anxiety" levels compared to nonaffected horses, supporting the theory that the behavior serves as a passive coping mechanism.[83] Like β-endorphins, baseline cortisol levels have been reported as higher, the same, or lower than in nonaffected horses. An ACTH challenge, however, shows cribbers have significantly higher cortisol levels if they do not crib during the test compared to either horses that did crib during the test or unaffected controls.[39] Even with mixed test results, evidence suggests cribbers might be more stress-susceptible.[84] This may be related to their lower vagal and higher sympathetic tone.[21] These findings alone do not make the horse a cribber; however, they probably predispose it to developing the condition if triggered by other factors.

In cribbing horses, the D1 and D2 dopamine receptor subtypes are significantly higher in number in the nucleus accumbens (ventral striatum), an area thought to be crucial in goal-directed learning by mediating the effects of the reinforcement from goal attainment.[41,81] D1 receptors are lower in the caudate nuclei.[25,33,41,85] There is a corresponding downregulation of dopamine transmission in the nigrostriatal pathways such that horses with stereotypies have difficulty changing out of habitual reinforced responses, just as do chronic amphetamine users.[42] Cribbers have a significantly lower spontaneous blink rate, indicative of dopamine receptor sensitization.[25,86] Confirmation of this is shown by administration of dopamine agonists resulting in cribbing and with attenuation of the problem by dopamine antagonists. There is also a difference in the autonomous nervous system and stress reactivity between horses that crib and those that do not.[21] Stereotypic behavior appears to reduce these.[14]

A genetic component might be the second factor related to development of cribbing. As a breed, Thoroughbreds are overrepresented in cribbing data at approximately 13%, followed by Warmbloods (7%) and Quarter Horses (5%).[48,62,71,87] While a genetic component is strongly suggested, it is

difficult to prove. Within certain Thoroughbred bloodlines, the incidence of stereotypies is 13%–30%, and in Finnhorses, cribbing is considered to be 68% heritable.[88,89] To date, tests for the involvement of eight candidate genes have not revealed a connection.[90] Abnormal genetic expressions of four genes that link the cortico-striatal circuit and abnormalities in glutamate signaling have been related to OCDs in multiple species, but not yet in the horse.[67]

Physiologically, cribbers have a lower thermal threshold and heart rate while cribbing.[59] Since both are measures of stress, a reduction suggests the horse is less stressed while performing the behavior. In humans, oxidative stress has been implicated in the pathophysiology of several psychiatric disorders and pathological anxiety.[84] In horses, oxidative stress is lower in cribbers than controls and is reduced even farther while they actively crib.[84] What the significance of this is to stereotypies in general and cribbing in particular is yet to be determined.

There are a number of medical or physiological changes associated with the gastrointestinal tract of cribbers. Ulcers and gastric inflammation have been found in cribbing horses, but the reports of the number of them compared to findings in normal horses vary. Some reports indicate that these horses have a higher number of gastric ulcers than do noncribbers.[25,78] Others show there is no difference.[80] This might suggest that some animals are more sensitive to associated discomforts. A second gastric relationship is between stomach acid and management. Stomach acid is constantly being released but management systems have changed from continuous grazing to meal feeding. Acid may now be a stomach irritant. Evidence pointed to is the higher incidence of gastric ulcers and inflammation in some studies.[20,34,75,78] In addition, there is less neutralizing saliva produced and swallowed because of less chewing or biting.[77] The theory that cribbing behavior is done to increase saliva production to act as a natural antacid has been shown to be incorrect.[77,91,92] Cribbing produces 1–2 mL of saliva during 20 crib bites. Eating grain produces 15–30 times more from the same horse.[91] Some foals seem to be more sensitive to the stresses of weaning, using abnormal oral activities to cope with abdominal discomfort.[34,77,78] Antacids reduce the frequency of cribbing.[34,93]

Three hormones have been implicated in cribbing. Gastrin is secreted from G cells in the stomach and causes the release of gastric acid. After eating grain, serum levels of gastrin are higher in horses that crib than in normal horses.[80] Ghrelin is a gastroprotective hormone produced in the stomach X-A-like cells following stimulation by gastrin. The two work synergistically to stimulate gastric acid production in anticipation of food.[94] Some studies find that levels of ghrelin are higher in cribbers, but other studies do not.[58,95] Leptin is the third hormone related to eating. It influences the hypothalamic regulation of appetite and modulates the reward of eating in association with body mass. Leptin concentrations are lower in cribbers compared to nonaffected horses.[95] If prevented from cribbing, horses will increase ingestive behavior. If that is blocked too,

there is a relative stasis of foregut motility, suggesting these are important for normal gut function.[35]

The lower intestinal tract is part of the complexity of cribbing. There is conflicting information about whether cribbers are more likely to colic, but once they have colicked, there is a high rate of additional colic bouts.[75,96–98] There is an 85.7% likelihood of a repeat colic, compared to 34.9% in noncribbers that previously colicked.[98] An environmental effect for this has not been ruled out, however. Between 47% and 68% of horses affected with epiploic foramen entrapment are cribbers, and cribbers that colic are eight times more likely to colic due to epiploic foramen entrapment than other types of colic.[96,99–101] There is a dramatic increase in intraabdominal pressure that begins when cribbing starts, increases throughout the duration of the cribbing bout, and continues for at least 30 min after it has stopped.[102] It is likely this is a cause and effect relationship.

Even near the terminal end of the intestines, there are differences in cribbers from nonaffected horses. Cribbing behavior tends to peak about the time that ingesta reaches the cecum, and fecal pH is lower in affected horses as well.[75,78] The transit time for food is altered too. While there is no difference in the time it takes food to go from the mouth to the cecum, it takes much longer to get from the cecum to the anus.[103] What the connection of these findings is to cribbing has yet to be determined.

Sleep patterns are altered. Cribbers spend significantly less time resting than do normal horses.[103] It is not known if the problem behavior reduces the desire to sleep, or if the lack of sleep causes the horse to start cribbing.

Stress and cribbing are closely associated, with stressful environments more likely to be associated with high cribbing rates. Temperaments of certain individuals suggest they are prone to stress responses. These horses are more likely to develop aggression toward neighboring horses, as an example. For horses that have no visual or physical contact with other horses, the incidence of cribbing is twice as high as for those with contact, and it is higher in horses stabled next to an aggressive neighbor.[104] Horses with only visual contact with other horses crib more commonly than do those having physical contact, suggesting another type of stress.[29]

Diet is a cribbing associative factor. Feeding programs that are high in concentrates and low in forage are related to the increased development and performance of cribbing.[19,34,49,51,57,105] Sweet feed diets increase the likelihood that cribbing will start after weaning fourfold.[75] An adult cribber getting sweet feed will spend 33% of the day cribbing, but this is reduced to 17% if fed oats instead.[70,106] Studies suggest it is the taste of the food that increases cribbing, perhaps through opioid and dopaminergic systems.[105] Horses are most likely to crib in the 2- to 8-h period after eating concentrated feed.[79] Those fed twice a day, when compared to three times a day, are also more likely to crib.[29] Serum selenium levels are significantly lower in cribbers than in noncribbers, especially while showing the problem behavior.[107]

While horse owners frequently comment that their horse "learned" to crib by watching other horses, studies suggest that observational learning is rare in horses. Learning to crib has only been correlated to an incidence of 1%.[62]

The type of show events and the amount of exercise a horse gets affect which stereotypy the animal will show, even when other things are constant. Cribbing is related to dressage and high school horses.[28] Horses exercised for 20 min a day spend 30.6% of the day cribbing, while those not exercised spend 25.3%.[70]

Treating the Cribber

A number of different treatments have been tried to get cribbers to stop. Of the various treatments, physically preventing the behavior is the most common, and several ways have been tried. Physical limitations were the first used. Muzzles will reduce the behavior by approximately one-half.[108,109] Of the various physical methods, the cribbing strap remains one of the most popular. When a cribbing strap is used alone, the frequency of cribbing is reduced by half to two-thirds. Use of a cribbing strap significantly elevates cortisol levels.[40] Also supporting this evidence that physically preventing cribbing is stressful, research shows there is a highly significant increase in the cribbing rate rebound when the strap is removed.[75,110] Another study contradicts this because it found no differences in cortisol levels and no rebound effect.[16] Use of a cribbing strap and other preventative measures is accompanied by an elevation in plasma beta-endorphin levels, at least in some studies.[35]

Another treatment suggestion is that surfaces where a horse could crib can be covered in ways that discourage the behavior.[108,109] Spike strips and rounded metal surfaces are examples.

Punishing the behavior with electric shock has also been tried. This extreme measure first used electric fencing inside the stall. When dog shock collars came out, they were tried on cribbers under the guise of being positive punishment. Equine versions of electric shock collars now come in styles that are triggered remotely by the owner or by neck tension. The remote-controlled versions depend on a trigger person being present 24/7 to punish each and every attempt at cribbing—not very realistic. In addition, horses quickly equate the presence of person with "do not crib." The behavior will resume as soon as the person leaves. If the person hides to activate the shock, a dummy collar might fool the horse when no one was around.[109] Only shock collars that do not depend on a person being present are helpful, because the unwanted behavior must be punished every time for the technique to work.

Crib rings are "C" shaped metal wires placed between the upper incisor teeth. They are then mechanically pinched into the gums to form almost a complete ring. When used, cribbing is significantly reduced from 6.75 h/day before insertion to 0.5 h/day afterwards.[16] The initial day of surgical implantation is associated with a rise in cortisol levels, but not thereafter. The rings are not a long-term solution, however, because they fall out in a week or less. The associated pain, even when eating, has significant welfare considerations too.

Several surgical techniques have been tried to stop cribbing. One of the first techniques created a permanent fistula from the buccal cavity to the outside, making it difficult for the horse to keep its mouth airtight.[109] In subsequent years, the myectomy of the sternomandibular, omohyoid, and sternothyrohyoid muscles has shown success in 80%–88% of cribbing cases.[111,112] Another procedure involves the bilateral neurectomy of the ventral branch of the spinal accessory nerve, which innervates the sternomandibular muscle. The success rate for this surgery approximates 60%.[111] Combinations of the myectomy and neurectomy procedures have success rates falling somewhere in-between. The results of surgery are reasonably good for eliminating the expression of the behavior, reducing the number of colics, promoting weight gain, and improving performance.[112] On the negative side, surgical treatments do not address the initial cause of the behavior nor the ongoing stress experienced from not being able to show the stereotypy.[113] The outcomes are disfiguring, sometimes ineffective, and may have secondary complications.[113] The rebound effect is the reason the behavior reappears in some horses. Most try to crib postsurgery, but only some can physically manage to do so.

Drug therapy can be tried to stop cribbing. Antacids reduce the frequency of cribbing, improve the condition of the stomach, and make the horse with ulcers or inflammation more comfortable.[25,34,75,78,93] Coconut oil has been suggested to have the same soothing quality. Narcotic antagonists like naloxone work to block the β-endorphin internal reward that cribbing produces. Unfortunately, narcotic antagonists are expensive, require intravenous administration, only work for a short time, and do not work on every cribber.[26,114] Other drug choices target various neurotransmitters. SSRIs and tricyclic antidepressants (TCAs) have become popular for stereotypic conditions. The associated increase in interneuron serotonin helps reduce anxiety levels from environmental factors. On the down side, SSRIs and TCAs do not work on all cribbers and they are expensive. Dextromethorphan, an NMDA receptor antagonist, reduces cribbing in some horses.[68] It works by blocking receptors where dopamine would attach and thus blocking dopamine's reinforcement of the behavior. Dopamine antagonists like acepromazine reduce the behavior, but the amount of accompanying sedation is considered too great.[26] One of the newer products tried on cribbers is the equine appeasing pheromone. Controlled studies are yet to be done, but there is some anecdotal evidence that it reduces cribbing.

Welfare concerns of only preventing the behavior must be raised because the internal drive remains. As soon as possible, the behavior rebounds, often at a higher rate, at least for a while. A more reasonable treatment goal should be to reduce the behavior rather than to eliminate it. This requires incorporating several strategies into a treatment plan, including some of those described previously.

Diet is an important consideration in any cribbing/windsucking treatment protocol. Frequent or continuous feeding of forage, ideally in a pasture setting,

is appropriate. While it is best to eliminate concentrated feeds, if they must be fed, doing so multiple times a day can help reduce cribbing frequency.[23,34]

Since cribbing is rarely stopped, it is helpful to provide an appropriate surface that will reduce the amount of wear on the teeth. A steel bar with a dense rubber coating is one suggestion. Other techniques attempt to redirect the oral behavior from cribbing to an alternative like using the horse's muzzle or tongue instead. Licking a roller that dispenses a sweet flavored liquid does not significantly change the behavior[27]; however, a device that requires the horse to push a wheel to dispense small portions of its food does.[115]

Acupuncture has been tried as a cribbing treatment. In one study, 64% of horses with gastrointestinal symptoms improved or stopped cribbing when treatment used seven acupuncture points, three of which are specific for gastrointestinal disorders.[75]

Behavior modification alone is not particularly successful. There are certain precautions that should be taken to prevent accidentally reinforcing the behavior. The horse should not be fed while it is actively cribbing, as an example. Punishing the behavior is also inappropriate.[26]

Different types of environmental enrichment have anecdotally shown evidence of successfully reducing cribbing.[109] Pasture access not only modifies the diet but also allows social interaction with other horses. At the very least, horses that spend 12 or more hours a day in pasture are half as likely to colic.

Prevention

Preventing the onset of cribbing is difficult because there are numerous contributing factors, although certain management techniques can help reduce the likelihood it will develop. Multiple meals throughout the day are best, especially if concentrated feeds must be given. Even then, oats are better than sweet feed. Keeping horses on pasture with herdmates is desirable, but if 24-h pasture access is not practical, the longer it can be made available, the better. When stalled, horses on straw bedding are less likely to crib, probably because straw provides additional fiber when hay and grass are not available. Reducing stress is important in preventing cribbing. Foals of submissive mares are best protected from stereotypy development if there are no bossy mares in the herd and if gradual weaning is used instead of forced weaning. Training techniques emphasizing positive reinforcement are considered less stressful as well. A final recommendation is to avoid neighbor horses that crib. This is suggested more for the owner's comfort than the horse's likelihood of learning from its neighbor.

Excessive Licking

All horses will occasionally lick, but some show extreme repetitive licking. The behavior is commonly directed toward the inside of feed boxes or stall walls, but

other objects can be targeted, including human skin. Excessive licking is a problem in approximately 14% of horses.[5] Excessive licking is more common in eventing and jumping horses and is significantly more frequent in reining horses than in horses used for general pleasure riding.[28,116] Individually stalled weanlings are another subset of affected horses.[50]

Specific causes of excessive licking have not been identified, suggesting multifactorial causation. In dogs, excessive licking of objects is often associated with some problem in the gastrointestinal tract. Since horses are commonly affected with ulcers and gastric inflammation, a similar connection seems likely. Treatment depends on the results of a medical workup. A second concern is associated with horses that are deficient in minerals, particularly salt. There are also horses that lick people excessively. Some do so when nervous, as at a horse show, while others seem to "like" licking people but were never discouraged. Treatment for them is a matter of stepping back from the horse. If that is insufficient, a firm "No" accompanied by a firm thump on the forehead with the flat of a hand usually works.

In general, excessive licking does not harm facilities or the horse, so it draws less attention than cribbing. Yet it is an abnormal behavior and suggests that the horse might be experiencing stress.

Head Nodding (Tossing)

Head nodding (tossing) represents a different problem than headshaking. Here the nose is repetitively moved up and down. Head nodding is a normal response to insect pests, but when there is no obvious physical stimulus, the behavior is worrisome at best and serious if it makes the horse unstable. The vertical up and down nodding behavior is often blamed on rider error, resistance to tucked head positions, or ill-fitting tack, but sometimes it is a stereotypy. Affected horses are more likely to develop the problem gradually and be relatively young. The nodding is most common when the horse is socially isolated, decreasing significantly once the barnmate returns.[75] An aluminum mirror or life-size picture of another horse's face will reduce the incidence of nodding if a social peer is not possible.[117,118]

Head nodding or bobbing is also used to describe the head motion associated with lameness. This is unrelated to the stereotypic expression.

Headshaking

Headshaking is a behavior problem characterized by recurrent, sudden, and severe shaking of the head up and down and/or side to side. The three most common clinical presentations described by owners are flipping of the head, acting as if an insect was flying up the nostril, and rubbing the muzzle on objects. Approximately 55% of affected horses show the behavior at rest and when exercising. Only 4% headshake only at rest.[8] The motion can be severe enough

to throw the horse and rider off balance, making the horse dangerous to ride.[75] Owners frequently comment that when not headshaking the horse was very reliable.[8] Headshaking occurs in approximately 1.4% of horses.[2]

When the onset occurs in an older horse or begins abruptly in the spring or early summer, medical conditions must be considered. In 64% of cases, headshaking is seasonal. Light seems to play a role in the seasonal onset, because the condition is significantly exaggerated in spring and early summer. It is described as worse in bright light and improves on rainy days in 57.8% of affected horses, at night (74.4%), and when indoors (76.9%). In a fourth of these horses, the duration of each shaking bout tends to increase in subsequent years.[8,75,119] It is thought the behavior is a response to pain or irritation, or that it is an extreme form of nodding. Unfortunately, extensive medical workups seldom reveal a specific cause. In one study of 78 horses, only 4 horses had a specific diagnosis.[8] Thoroughbreds are three times more likely to be affected than other breeds, and geldings are twice as likely to be affected than nongeldings.

A number of treatments have been tried with minimal success. The ones that work best include percutaneous electrical stimulation and medicating with cyproheptadine and/or carbamazepine. While helpful, they do not completely relieve symptoms in most horses.[8,120–122] It is speculated that affected horses have a condition similar to trigeminal neuralgia in humans. In the case of horses, headshaking may involve the ophthalmic branch of the trigeminal as well as the maxillary portion.[8]

Head Shy

Horses that are head shy are not showing a repetitive behavior, but this problem can resemble nodding or shaking. Head shy horses are usually just difficult to bridle or halter, because they quickly move their head away. Some are reactive to any hand movement near the head. Causes usually relate to vision or learning. People forget that a horse's vision is compromised around its head. There are several blind areas, such as under the jaw and directly in front of the forehead. Even for areas not blinded, the ability to focus on items within a few feet is diminished. Items brought toward the face may seem to disappear and then startle the animal when it is suddenly touched. Specific spoken cues can be helpful to avoid startling the horse so it learns to anticipate that something is about to touch it.

Avoidance of certain situations can be related to shying. As a lazy animal, a horse does not want to work, and for them, riding is work. They learn that being caught in pasture, having a halter put on, or being bridled ultimately leads to work. If the person attempting to do these things stops before catching the horse, avoidance is rewarded, and the horse continues the behavior. Avoidance can also be part of an interactive "game." Horses purposefully trying to avoid having a halter or bridle put on by moving their head exasperate the owner. Prolonging the horse-human battle can be rewarding to the animal. A quick, firm "No"

coupled with a firm thump on the forehead with the flat of a hand is a reminder to hold still. It also has a surprise value that helps reinforce the lesson. Avoidance of halter or bridle must be differentiated from the head shy behavior resulting from fear of closeness of a hand or other object. A horse that has been ear twitched, beaten, or abused in other ways can be head shy or show avoidance as a protective reaction. Desensitization is necessary to regain the horse's trust.

Lip/Tongue Flapping

Some horses will flap their lower lip as they rapidly move their head up and down. Others stick their tongue out the side of their mouth where it may just hang or flap as the head goes up and down. These behaviors are usually associated with stressful situations, representing a coping mechanism. Young horses that roll their tongue out the side often show the behavior when asked to begin learning something new.[123] This suggests that uncertainty of what is now expected is stressful. As the task is mastered, the frequency of the tongue protrusions decreases.

Anecdotally, tryptophan has helped some of these animals, suggesting dietary tryptophan was insufficient for normal serotonin levels.[124] When flapping behaviors occur in stalled horses, enriching the environment with toys, a licking ball, or additional hay can provide things to occupy the horse. Lip and tongue flapping become ingrained over time. When a horse is ridden, head nodding becomes problematic, while a droopy lower lip or protruding tongue are more unsightly than worrisome to the rider.

Teeth Grating

Teeth grating involves the horse rubbing its teeth against an object, such as bars on a stall, a board, or the wall to produce a sound reminiscent of chalk screeching on a blackboard. This vice results in abnormal wear on the incisors, so it is important to investigate possible causes. Medical problems such as ulcers or oral problems should be ruled out. Once eliminated, other causes are considered. Some horses grate their teeth when they are anxious or upset by a nearby new horse. For others, the behavior is triggered by anticipation, particularly for food. Horses that lack environmental stimuli can show it too. If the behavior is immediately followed by attention or feed, the horse may learn to do it for the associated reward.

Treatments for teeth grating not due to medical problems relate to associated events. The need for social contact with other horses and pasture access are important. If occurrences only happen in the presence of a particular person who increases interactions while the behavior is occurring, that specific person needs to be part of the solution. As soon as the behavior starts, the horse should be given no attention, not even eye contact, until the behavior stops. Human attention is then given immediately when appropriate behavior occurs.

As the horse learns it no longer gets attention for making the noise, the time between its stopping and the human's attention reward can gradually increase. Similarly, no food is given unless the behavior is appropriate. With consistency, the teeth grating will be extinguished.

Teeth Grinding

Teeth grinding, also called *bruxism*, occurs when the teeth in the upper and lower arcades are rubbed against each other. The sound produced here is an "I-know-it-when-I-hear-it" type of noise that is almost always associated with pain or discomfort. The behavior is common with gastrointestinal (GI) pains in particular, occurring in approximately 1% of horses.[1]

After an appropriate medical workup for possible GI issues, treatment should begin with pain and other appropriate medication. Consideration should be given to long-term ulcer treatment because of the high frequency of ulcers in horses. If teeth grinding continues or if stress is expected to be a contributing factor, antianxiety medications, including SSRIs, may be added to the protocol.

REPETITIVE LOCOMOTOR PROBLEMS

Many common behavior problems like bucking or rearing result from a specific stimulus such as an inappropriate cue or an attempt to avoid having to do something. There are, however, movement problems, other than lameness, that have a medical or neurologic component. Additionally, modern management practices may relate to the cause. Free-ranging horses spend a significant portion of their day in motion: stalled horses do not. As a result, the drive to move and the high-energy diets most horses eat provide motivation to do something. This partially accounts for the high incidence of locomotor stereotypies like stall walking or weaving in stabled horses.[125]

Circling/Stall Walking

The stereotypic behavior of walking in circles is a relatively common locomotor problem. The problem is usually called stall walking (*box-walking*) because that is where it is usually seen. As the stereotypy becomes an OCD, horses will walk in circles of the same size even though they are in a large paddock or pasture. It is suggested that rapid circling is related to separation anxiety or a desire to get out of the stall, and slower circling is stereotypic.[71]

The incidence of stall walking ranges from 0.7% of horses to 8%, with one outlier of 19% reported.[1,2,5,24,29,33,34,36,75,87] The behavior is more common in mares and young horses, with the average age of onset being 64 weeks.[19,29,75] Just over 2% of foals show stall walking by 16 months of age,[19] with some circling when only a few days of age. The frequency and duration of stall walking bouts increase over time too.[87] Arabians are the breed most affected, followed

by Thoroughbreds and then Warmbloods.[48,75,87] Of locomotor problems, this is more common than weaving in endurance horses compared to eventing or dressage horses.[30,75]

As with most stereotypies, this one can be associated with management issues, particularly minimal social contact with other horses. Another association is the need for exercise. Horses turned out more often and for long periods in warm seasons but confined in winter are more likely to be affected.[75,87]

Treatment and prevention are similar in nature. Social contact between horses; significant time in paddocks or pastures; forage, particularly grass, rather than concentrates; multiple small meals spread throughout the day; and gradual weaning with a group of foals are helpful in preventing the development of and managing circling, just as they are for other stereotypies.[19,34,48]

Fence Walking

Fence walking is the behavior named for the repetitive back-and-forth walking along a fence. Characteristically, the horse walks a certain distance, turns toward the fence, and returns on the same path. As the behavior becomes more ingrained in its expression, the horse will flip its nose up as it turns at each end of the path. As fence walking continues, a well-worn path develops (Figure 10-3). While showing the behavior, the horse is aware of things going on around it. As an example, it might kick out at a dog that comes up from behind. The most common trigger is the departure of another horse to which the fence walker is closely attached. It can also be triggered when access is prevented from other nearby horses.

FIGURE 10-3 This arena is used to exercise the Lipizzaner breeding stallions for the Spanish Riding School of Vienna at their Piber, Austria farm. The path along the fence is limited to this area of the arena as the result of stereotypic fence walking by this Lipizzaner stallion. He directs his attention toward the mare barn on the other side. Notice that the stallions have also chewed the fence, but only in the same section of the arena.

Pawing

Pawing is recognized as a problem in 0.2% to 3.6% of horses.[1,2] Origins of this repetitive behavior are probably numerous. Pawing is reinforced with the presentation of food, attention, or release. Horses quickly make the connection between pawing and reward, even though the owner does not. Once the horse equates pawing with reinforcement, breaking that connection is difficult. In one controlled study to reduce pawing, positive reinforcement with a food treat was given only when the horse stood with all 4 ft. on the ground. It took between 25 and 40 training sessions to reduce pawing to less than 14% of the original amount.[126] Pawing in anticipation of being fed usually stops as soon as the feed is put in the stall, but not always. While chewing, the horse may continue to paw the ground or paw the air. Continued pawing is indicative of a stereotypy. Besides anticipation, pawing can be related to impatience, discomfort, and learning. Individually stalled weanlings are also commonly affected.[50]

Treatment for pawing begins with a medical examination, especially knowing the high incidence of ulcers in horses. While not all discomfort is related to ulcers and not all ulcers are related to discomfort, any detectable problem should be ruled out as a cause or contributing factor. For horses that paw until the feed is put into the feedbox, the owner should stop moving toward the stall, and even take a step back, as soon as the pawing begins. If pawing continues, the person takes another step back, and then another. Putting the food in the stall rewards the undesired behavior, but stopping or backing away does not. Then when the pawing stops, the person begins to walk forward again until the pawing resumes. No food is put into the stall if the horse is pawing. By giving small portions each time instead of a full meal, the "no paw" sessions can be done multiple times a day to help speed learning. For the horse that paws while eating, lowering the level of the feeder or feeding on the ground makes it harder to paw (Figure 10-4).

Young horses, in particular, tend to paw when they are tied in one location. Lessons of patience are important for standing tied to trailers or other objects when necessary. Until this is learned, the area must be safe for them, including softer ground, the rope tied at head level or above, and minimal slack in the rope to avoid the chance the horse could get its foot caught. For safety reasons, someone should be nearby with a sharp pocket knife just in case the horse gets into trouble and the rope has to be cut. Many people will begin by tying the horse to a stout rubber inner tube that is securely attached to an object.[127] This permits some give if the horse fights the restraint but snaps back to ensure the horse does not win the battle.

Weaving

Weaving is a relatively common stereotypy in which a horse rhythmically shifts its weight between right and left forelimbs while swinging its head back and

FIGURE 10-4 This gelding paws when anticipating food as well as while chewing it, to the point of wearing a hole near the feeder. When he is fed out of a tub on the ground, he will try to paw but stops after a few low-level attempts.

forth. Careful observation shows that the rear feet also move in cadence of walking. This problem is not well researched, but the estimated incidence is 0.6%–9.5%.[1,2,5,24,29,33,34,36,75,87] In foals, 4.6% show the weaving behavior by 15 months of age.[19,118] Then, the incidence of weaving increases with age.[87] Stallions are affected significantly more often than mares or geldings, and Thoroughbreds have the highest incidence of the various breeds, followed by Warmbloods.[48,87,128]

In the long term, physical problems can develop as a result of weaving behavior. Affected horses can develop strained ligaments and often lose condition. They also are poor performers.[33]

Environmental events are most commonly identified as triggers for weaving. The behavior is anticipatory in stables where management is highly predictable, being most common during periods of activity, like feed preparation, and in the hour before daily turnout.[25,60,79,129] Horses with minimal social contact and those that can only see another horse across an aisle have a higher incidence of weaving.[25,29,51,54,128] Horses having visual closeness, and perhaps with the ability to touch horses in adjoining stalls, show less weaving (Figure 5.3).[129] This suggests the behavior relates to the horse's social needs and the resulting "frustration" of not being able to get that contact.[34,118] The concept of "frustration" or stress is supported by the fact that weaving behavior is not reduced with naloxone, indicating there is no accompanying internal reward.[40] The association of feeding protocols with weaving is questionable. Twice a day meals make weaving more likely than do three times a day meals.[29] On the other hand,

increasing the number of feedings of concentrated food results in a higher frequency of weaving, particularly in the time preceding the food presentation.[23] Forage intake of less than 6.8 kg/day reduces the risk of weaving, while nonstraw bedding increases the risk for abnormal behaviors in general and weaving in particular.[51]

Neurological studies suggest that weaving, like cribbing, may be complex and involve multiple neurotransmitters. Serotonin levels are higher in weavers than in nonaffected horses. They also have reduced levels of blood magnesium, TSH, melatonin, and adrenocorticotropic hormone (ACTH).[60] SSRIs can reduce symptoms by as much as 95%, where 43.5 weaving motions per minute dropped to less than 1.[130] Even with a stressor such as social separation, the number of motions remained low, at approximately 19 motions/min. Dopamine antagonists like acepromazine reduce the behavior by approximately 40% (24 motions/min), although there is also sedation. Opioid antagonists reduce it by 30% (32 motions/min).[130]

Medically, weavers are almost four times more likely to have a repeat colic than are nonweavers.[131] While this is not as high as the incidence associated with cribbing, it is significant.

Treatment often incorporates the use of antiweave panels in the stall door (Figure 10-5). Used as a lone treatment, these panels are associated with a significant increase in plasma cortisol, and thus should be considered stressful.[40] To address this stress, horses often learn to back away from the door and resume the weaving motion inside the stall.[33,40]

The goal of therapy for weaving horses should be directed at reducing the frequency of the behavior by minimizing its triggers, not at stopping the behavior altogether. Since feed anticipation is common, concentrates should be eliminated from the diet or fed multiple times, perhaps by a dispenser on a timer. The alternative is ad libitum forage. Lack of social peers is another causative factor, so paddock/pasture time with other horses is important. When this is not possible, than some type of stablemate, such as a dog, goat, or pony, might make an acceptable substitute. If adjacent stall contact is not feasible, an aluminum mirror or life-size picture of another horse's face can significantly reduce the incidence of weaving.[117,118] The addition of exercise as pasture or riding time reduces the incidence of weaving. Free-ranging horses take an estimated 10,000 strides daily as part of their normal feeding pattern, an amount far more than what a stabled horse would take.[25] Drug therapy using SSRIs or dopamine antagonists can be used for severe cases.

NEUROLOGICAL AND MEDICALLY RELATED BEHAVIOR PROBLEMS

Physiological causes of behavior problems are the ones that veterinarians are most comfortable dealing with because they are the closest to traditional illnesses. Medical conditions can be reported as a "behavior problem," but a

FIGURE 10-5 Many barns have antiweave panels on the stall doors, even for horses that are not weavers. It allows the horse to put its head outside the stall to watch barn activities and see other horses more easily. For weavers, these panels severely limit the amount of left-to-right head movement, although most learn to step back to weave.

diagnostic workup shows the physiological origin. As science untangles the mysteries of stereotypies and obsessive-compulsive behaviors, it is likely they will be included within this broad category in the future.

Blindness

Blindness in one or both eyes occurs in approximately 2% of the horse population, presenting some unique considerations for the animal's long-term care.[132] With the loss of one sense, horses begin to substitute other senses. In humans, vision is the primary sense, but in horses, several senses are of approximately equal importance. Hearing will become more important for the blind horse, so lots of soft talking is helpful to it to let it know where the person is and even what they want. The typical head tilt will develop over time.

At first, blind horses are cautious in their paddocks and stalls, but over time, they develop a mental map of their surroundings. They can also do well in

pastures that do not have significant obstacles and when ridden by a trusted person who signals obstacles. Precautions include being sure the horse can identify water and feeding locations. Care must be taken to eliminate low-hanging and sharp objects, including barbed wire, to avoid injuries. Gravel can be used in less safe areas of a pasture to signal a warning. When no changes occur in these areas, blind horses do fine. Cases are reported where another horse, or even a dog or goat, becomes a leader for the blind animal, allowing it to go into less familiar pasture areas.

Depression

Clinical depression is a controversial diagnosis in animals, even dogs. There are studies that suggest horses can experience this condition. Support for this diagnosis includes the horse standing, eyes fixed and open, with the neck flat and the same height as the withers. In addition, there is the absence of ear and head movements, reduced response to tactile stimulation, indifference to the sudden approach of a human, higher reactivity to novel objects in familiar locations, and lower than normal cortisol levels following exercise.[133,134] Unfortunately, the number of animals studied has been small, so additional data is needed before this can be identified as a true condition in the horse.

Narcolepsy

Narcolepsy is a sleep disorder that can be confused with sleep deprivation. The condition of narcolepsy is a brain disorder characterized by excessive daytime sleepiness, rapid eye movement (REM) sleep, cataplexy, and collapse. The condition can be genetically transmitted. In Suffolks, Shetland ponies, and American Miniature horses, the condition typically shows up in foals by the age of 6 months.[135–137] Narcolepsy can also occur spontaneously in adult horses of varying breeds.

The specific pathophysiology has not been identified in horses, but in humans and dogs, there is a suggested relationship to a deficiency in the hypothalamic hypocretin (orexin) system. A mutation in the *hypocretin receptor-2* gene affects postsynaptic hypocretin neurotransmission. The acquired form of narcolepsy in dogs is thought to relate to low hypocretin-1 levels in the central nervous system.[135,137,138] Similarly, low hypocretin-1 levels have been reported in narcoleptic horses.[135] Dogs also have a hypersensitive state in the overall muscarinic cholinergic system. The upregulated muscarinic receptors in the pontine reticular formation impair dopamine release, which then affects the emotional state.[139] This is the relationship between pleasurable things triggering narcoleptic attacks.

In humans and dogs, excitement or anticipation are commonly associated with the onset of a narcoleptic episode. While food anticipation can trigger

an equine episode, other reported triggers include being tied in a wash rack, saddling, and standing in a stall or pasture.[137]

Two variations of narcolepsy have been reported in horses. Foals tend to show a sudden buckling of the knees and then fall into recumbency with a flaccid paralysis.[139] They appear to be in rapid eye movement (REM) sleep and all spinal reflexes are lost during the attack. These attacks are often triggered by specific stimuli, particularly restraint. The second variation begins when the horse is at least 2 years old.[139] The head gradually lowers and the horse's front end begins to lower and the weight is shifted caudally. The fetlocks may flex, resulting in lesions on the dorsal aspects of fetlocks and carpi. Most horses recover quickly without falling all the way to the ground. Triggering events may be specific, such as when being groomed or saddled.

Because resolution of an episode may occur with noise or touch, it is hard to differentiate narcolepsy or atypical narcolepsy from sleep deprivation. The diagnosis can be confirmed by drugs that stimulate cholinergic activity in the brain, such as with the slow intravenous injection of the anticholinesterase drug physostigmine salicylate.[139,140] A narcoleptic attack occurs in an affected horse within a few minutes, but not in normal animals. Atropine can reverse the effects.

Treatments are not always successful, and controlled studies regarding effectiveness of various treatment protocols have not been done. Drugs that stimulate the monoamine systems in the brain are used to suppress or minimize narcolepsy in several species.[140] Imipramine is the drug of choice because it simultaneously stimulates the aminergic activity of norepinephrine, dopamine, and serotonin related neurons by blocking reuptake and inhibiting cholinergic activity.[140] This is a normal part of keeping animals awake. In some cases, particularly Miniature Horse foals and Thoroughbreds, narcolepsy completely resolves spontaneously.[136,139]

Seizures

While seizures are a neurologic disorder, their manifestation can be confused with behavior problems. Therefore, they need to be included in many lists of possible differential diagnoses. Seizure disorders occur in horses, with the grand mal seizure being the easiest to recognize as a neurologically important medical condition. Fortunately, grand mal seizures are not as common in horses as they are in humans and dogs.[141] Focal (partial) seizures are more likely to be confused with behavior problems because of their limited scope of expression. Depending on what part of the brain is affected, focal seizures can result in a sensation or a motor sign in an otherwise alert and conscious horse that could be confused with a behavior problem. Headshaking and self-mutilation in stallions are conditions where focal seizures should be included as a differential diagnosis. Complex focal seizures affect mentation and would need to be considered as a differential for depression and chronic pain.

Sleep Deprivation

Horses can become sleep deprived and show behaviors similar to those of narcoleptic animals. As the standing horse rapidly slips into deep sleep, weight is shifted caudally and the front end lowers. Individuals affected over a prolonged period of time will show wear lesions on the front of the fetlocks, and/or they will just lie down a lot. Six categories of causes for sleep deprivation have been described.[142] The first category relates to horses that have pain or physical discomfort. Severe arthritis, myopathies, gastric ulcers, and even late-term pregnancy can be associated with this category. A second category relates to the environment—not adjusting to a new stall, too much light, or bad weather. Long-term standing without mental stimulation (also called "*monotony-associated*") is a third category of sleep deprivation causes.[142] A fourth category relates to very aggressive horses, particularly geldings, that are continuously aggressive to one or all horses in a group, missing sleep in order to keep watch. These horses can be helped with the addition of an alpha mare. Lyme disease, even without evidence of joint pain, is responsible for the fifth type of sleep deprivation. Lastly, the most recently identified category resembles sleep terror in humans and is diagnosed using videography.[142]

Equine Self-Mutilation Syndrome

Several years ago, a variation of excessive grooming was identified that had other behavior components. The sequence of behaviors begins with the horse glancing at its flank or occasionally at the chest area.[143] This progresses to biting of the area, resulting in skin lesions (Figure 10-6). There is a squeal, followed by the horse kicking out with a hind leg, bucking, spinning, or rolling. Random muscle twitching of the head or neck might also occur.[132] The equine self-mutilation syndrome (ESMS) primarily occurs in stallions and has a reported incidence of 1.9% in stallions, 0.7% in geldings, and rare in mares.[143,144] Symptoms may begin before sexual maturity but can start in adult stallions too.[132,143,145] As with other stereotypies, stress or anticipation are associated with the expression of this behavior, particularly the anticipation of food. A genetic component is suggested, at least in some of the horses.[132,143,144,146] There may be a relationship with medical problems including pain and lameness.[147] Management protocols are sometimes implicated when the horse has been stalled for a prolonged healing time while being maintained on a high-energy diet. Compounding this is social isolation for the stallion.[145]

A few horses show the behavior almost constantly and are totally dissociated from anything else in the environment. At this point, the behavior is probably an OCD.[144] These horses are usually euthanized because of quality of life issues.

Treatment should be directed at reducing the frequency of the behavior, with the knowledge that it cannot be eliminated completely in most horses. Castration of affected stallions results in improvement in about 70% of them.[143]

FIGURE 10-6 Horses with the self-mutilation syndrome may bite themselves in the chest, thorax, forelimb, or flank region, resulting in skin lesions. This stallion directed his bites to the chest and forearm.

Changes in social stabling helps 83%.[143] While diet changes alone do not make a difference, increased roughage and minimal grain is recommended to reduce energy intake. Increased exercise such as hand walking and increased social interactions are important too. Even if social contact with other horses is not possible, visual contact or the addition of a nonequine companion can be helpful.[145,148] Several medications have been tried for therapeutic management of the self-mutilation syndrome. Nalmefene, a narcotic antagonist, reduces the behavior's frequency in proportion to the dose used.[146] Dopamine antagonists like acepromazine and fluphenazine are also helpful, as expected with stereotypies in general.[143,149] Alpha-2 antagonists like detomidine and serotonin agonists like buspirone and fluoxetine are somewhat helpful.[144,149]

There is a similar condition that is speculated to have a different etiology. The horse will look at its flank, circle, kick, and perhaps squeal. The self-biting

is absent. Visual observation strongly suggests the horse is "feeling" something. There is a condition in humans (inclusion body myositis) and in cats (feline hyperesthesia syndrome) where affected individuals show spontaneous electromyography (EMG) activity in the lumbar epaxial muscles. While EMGs have not been done on affected horses, the possibility of some type of myositis/myopathy needs to be considered in extremely affected animals. Current treatment recommendations in cats include not touching the areas because of hypersensitivity, use of pain medications, and doses of an SSRI to reduce anxiety. Treatment is palliative rather than curative.

REFERENCES

1. Borstel UKV, Erdmann C, Maier M, Garlipp F. Relationships between owner-reported behavior problems and husbandry; use and management of horses. *J Vet Behav* 2016;**15**:92–3.
2. Dallaire A. Stress and behavior in domestic animals: temperament as a predisposing factor to stereotypies. *Ann N Y Acad Sci* 1993;**697**:269–74.
3. Tadich T, Weber C, Nicol CJ. Prevalence and factors associated with abnormal behaviors in Chilean racehorses: a direct observational study. *J Equine Vet Sci* 2013;**33**(2):95–100.
4. American Veterinary Medical Association. *U.S. Pet Ownership & Demographics Sourcebook*. Schaumburg, IL: American Veterinary Medical Association; 2012.
5. Hockenhull J, Creighton E. The day-to-day management of UK leisure horses and the prevalence of owner-reported stable-related and handling behaviour problems. *Anim Welf* 2015;**24**(1):29–36.
6. Hockenhull J, Creighton E. Management practices associated with owner-reported stable-related and handling behavior problems in UK leisure horses. *Appl Anim Behav Sci* 2014;**155**:49–55.
7. Löckener S, Reese S, Erhard M, Wöhr A-C. Pasturing in herds after housing in horseboxes induces a positive cognitive bias in horses. *J Vet Behav* 2016;**11**:50–5.
8. Madigan JE, Bell SA. Owner survey of headshaking in horses. *J Am Vet Med Assoc* 2001;**219**(3):334–7.
9. Christoffersen M, Lehn-Jensen H, Bøgh IB. Referred vaginal pain: cause of hypersensitivity and performance problems in Mares? A clinical case study. *J Equine Vet Sci* 2007;**27**(1):32–6.
10. Crowell-Davis SL. Stereotypic behavior and compulsive disorder. *Compendium Equine* 2008;**3**(5):248–50251.
11. Mills DS, Alston RD, Rogers V, Longford NT. Factors associated with the prevalence of stereotypic behavior amongst thoroughbred horses passing through auctioneer sales. *Appl Anim Behav Sci* 2002;**78**(2–4):115–24.
12. Low M. Stereotypies and behavioural medicine: confusions in current thinking. *Aust Vet J* 2003;**81**(4):192–8.
13. Broom DM, Kennedy MJ. Stereotypies in horses: their relevance to welfare and causation. *Equine Vet Educ* 1993;**5**(3):151–4.
14. Mason GJ. Stereotypies: a critical review. *Anim Behav* 1991;**41**(6):1015–37.
15. Latham NR, Mason GJ. Maternal deprivation and the development of stereotypic behavior. *Appl Anim Behav Sci* 2008;**110**(10):84–108.
16. Albright JD, Witte TH, Rohrbach BW, Reed A, Houpt KA. Efficacy and effects of various anti-crib devices on behaviour and physiology of crib-biting horses. *Equine Vet J* 2016;**48**(6):727–31.
17. Flannigan G, Stookey JM. Day-time time budgets of pregnant mares housed in tie stalls: a comparison of draft versus light mares. *Appl Anim Behav Sci* 2002;**78**(2–4):125–43.

18. Nicol C. Understanding equine stereotypies. *Equine Vet J Suppl* 1999;**28**:20–5.
19. Waters AJ, Nicol CJ, French NP. Factors influencing the development of stereotypic and redirected behaviours in young horses: findings of a four year prospective epidemiological study. *Equine Vet J* 2002;**34**(6):572–9.
20. Nicol, C.J. (2000): Equine stereotypies. In: Recent advances in companion animal behavior problems, Houpt, K.A., ed., International Veterinary Information Service, Ithaca, NY (www.ivis.org) [downloaded October 27,2017].
21. Bachmann I, Bernasconi P, Herrmann R, Weishaupt MA, Stauffacher M. Behavioural and physiological responses to an acute stressor in crib-biting and control horses. *Appl Anim Behav Sci* 2003;**82**(4):297–311.
22. Christie JL, Hewson CJ, Riley CB, McNiven MA, Dohoo IR, Bate LA. Management factors affecting stereotypies and body condition score in nonracing horses in Prince Edward Island. *Can Vet J* 2006;**47**(2):136–43.
23. Cooper JJ, Mcall N, Johnson S, Davidson HPB. The short-term effects of increasing meal frequency on stereotypic behaviour of stabled horses. *Appl Anim Behav Sci* 2005;**90**(3–4):351–64.
24. Muñoz L, Torres J, Sepúlveda O, Rehhof C, Ortiz R. Frequency of stereotyped abnormal behaviour in stabled Chilean horses. *Arch Med Vet* 2009;**41**(1):73–6.
25. Roberts K, Hemmings AJ, McBride SD, Parker MO. Causal factors of oral versus locomotor stereotypy in the horse. *J Vet Behav* 2017;**20**:37–43.
26. Simpson BS. Behavior problems in horses: cribbing and wood chewing. *Vet Med* 1998;**93**(11):999–1004.
27. Stanley SO, Cant JP, Osborne VR. A pilot study to determine whether a tongue-activated liquid dispenser would mitigate abnormal behavior in pasture-restricted horses. *J Equine Vet Sci* 2015;**35**(11 – 12):973–6.
28. Hausberger M, Gautier E, Biquand V, Lunel C, Jégo P. Could work be a source of behavioural disorders? A study in horses. *PLoS One* 2009;**4**(10). https://doi.org/10.1371/journal.pone.0007625.
29. Dezfouli MM, Tavanaeimanesh H, Naghadeh BD, Bokaei S, Corley K. Factors associated with stereotypic behavior in Iranian stabled horses. *Comp Clin Pathol* 2014;**23**(5):1651–7.
30. McGreevy PD, French NP, Nicol CJ. The prevalence of abnormal behaviours in dressage, eventing and endurance horses in relation to stabling. *Vet Rec* 1995;**137**(2):36–7.
31. Cooper JJ, Albentosa MJ. Behavioural adaptation in the domestic horse: potential role of apparently abnormal responses including stereotypic behaviour. *Livest Prod Sci* 2005;**92**(2):177–82.
32. Hothersall B, Casey R. Undesired behavior in horses: A review of their development, prevention, management and association with welfare. *Equine Vet Educ* 2012;**24**(9):479–85.
33. McBride S, Hemmings A. A neurologic perspective of equine stereotypy. *J Equine Vet Sci* 2009;**29**(1):10–6.
34. Waran NK, Clarke N, Farnworth M. The effects of weaning on the domestic horse (*Equus caballus*). *Appl Anim Behav Sci* 2008;**110**(1–2):42–57.
35. McGreevy P, Nicol C. Physiological and behavioral consequences associated with short-term prevention of crib-biting in horses. *Physiol Behav* 1998;**65**(1):15–23.
36. Pell SM, McGreevy PD. A study of cortisol and beta-endorphin levels in stereotypic and normal Thoroughbreds. *Appl Anim Behav Sci* 1999;**64**(2):81–90.
37. Wickens CL, Heleski CR. Crib-biting behavior in horses: a review. *Appl Anim Behav Sci* 2010;**128**(1–4):1–9.
38. Fureix C, Benhajali H, Henry S, Bruchet A, Prunier A, Ezzaouia M, Coste C, Hausberger M, Palme R, Jego P. Plasma cortisol and faecal cortisol metabolites concentrations in stereotypic and non-stereotypic horses: do stereotypic horses cope better with poor environmental conditions? *BMC Vet Res* 2013;**9**:3.

39. Briefer Freymond S, Bardou D, Briefer EF, Bruckmaier R, Fouché N, Fleury J, Maigrot A-L, Ramseyer A, Zuberbühler K, Bachmann I. The physiological consequences of crib-biting in horses in response to an ACTH challenge test. *Physiol Behav* 2015;**151**:121–8.
40. McBride SD, Cuddleford D. The putative welfare-reducing effects of preventing equine stereotypic behaviour. *Anim Welf* 2001;**10**(2):173–89.
41. Parker M, Redhead ES, Goodwin D, McBride SD. Impaired instrumental choice in crib-biting horses (*Equus caballus*). *Behav Brain Res* 2008;**191**(1):137–40.
42. Parker MO. *Behavioural correlates of the equine stereotypy phenotype*. https://eprints.soton.ac.uk/67410/1/Matt_Parker_PhD_FINAL_pdf; 2008 [downloaded September 7,2017].
43. Alberghina D, De Pasquale A, Piccione G, Vitale F, Panzera M. Gene expression profile of cytokines in leukocytes from stereotypic horses. *J Vet Behav* 2015;**10**(6):556–60.
44. Bahn PG. Crib-biting: tethered horses in the paleolithic? *World Archeol* 1980;**12**(2):212–7.
45. Hemmings A, McBride SD, Hale CE. Perseverative responding and the aetiology of equine oral stereotypy. *Appl Anim Behav Sci* 2007;**104**(1–2):143–50.
46. McDonnell SM. Important lessons from free-running equids. *Equine Vet J* 1998;**30**(S27):58–9.
47. Houpt KA. Equine behavior problems in relation to humane care. *Anthrozoös* 1987;**1**(3):184–7.
48. Bachmann I, Audigé L, Stauffacher M. Risk factors associated with behavioural disorders of crib-biting, weaving and box-walking in Swiss horses. *Equine Vet J* 2003;**35**(2):158–63.
49. Cooper JJ, Mason GJ. The identification of abnormal behavior and behavioural problems in stabled horses and their relationship to horse welfare: a comparative review. *Equine Vet J* 1998;**30**(S27):5–9.
50. Heleski CR, Shelle AC, Nielsen BD, Zanella AJ. Influence of housing on weanling horse behavior and subsequent welfare. *Appl Anim Behav Sci* 2002;**78**(2–3):291–302.
51. McGreevy PD, Cripps PJ, French NP, Green LE, Nicol CJ. Management factors associated with stereotypic and redirected behavior in the Thoroughbred horse. *Equine Vet J* 1995;**27**(2):86–91.
52. Ninomiya S. Social leaning and stereotypy in horses. *Behav Process* 2007;**76**(1):22–3.
53. Parker M, Goodwin D, Redhead ES. Survey of breeders' management of horses in Europe, North America and Australia: comparison of factors associated with the development of abnormal behaviour. *Appl Anim Behav Sci* 2008;**114**(1–2):206–15.
54. Redbo I, Redbo-Torstensson P, Odberg FO, Hedendahl A, Holm J. Factors affecting behavioural disturbances in race-horses. *Anim Sci* 1998;**66**(2):475–81.
55. Sarrafchi A, Blokhuis HJ. Equine stereotypic behaviors: causation, occurrence, and prevention. *J Vet Behav* 2013;**8**(5):386–94.
56. Young T, Creighton E, Smith T, Hosie C. A novel scale of behavioural indicators of stress for use with domestic horses. *Appl Anim Behav Sci* 2012;**140**(1–2):33–43.
57. Gillham SB, Dodman NH, Shuster L, Kream R, Rand W. The effect of diet on cribbing behavior and plasma β-endorphin in horses. *Appl Anim Behav Sci* 1994;**41**(3–4):147–53.
58. Hemmann K, Radkallio M, Kanerva K, Hänninen L, Pastell M, Palviainen M, Vainio O. Circadian variation in ghrelin and certain stress hormones in crib-biting horses. *Vet J* 2012;**193**(1):97–102.
59. Lebelt D, Zanella AJ, Unshelm J. Physiological correlates associated with cribbing behavior in horses: changes in thermal threshold, heart rate, plasma β-endorphin and serotonin. *Equine Vet J* 1998;**30**(S27):21–7.
60. Binev R. Weaving horses. Etiological, clinical and paraclinical investigation. *Int J Adv Res* 2015;**3**(3):629–36.
61. McBride SD, Long L. Management of horses showing stereotypic behavior, owner perception and the implications for welfare. *Vet Rec* 2001;**148**(26):799–802.

62. Albright JD, Mohammed HO, Heleski CR, Wickens CL, Houpt KA. Crib-biting in US horses: breed predispositions and owner perceptions of aetiology. *Equine Vet J* 2009;**41**(5):455–8.
63. Nagy K, Schrott A, Kabai P. Possible influence of neighbours on stereotypic behaviour in horses. *Appl Anim Behav Sci* 2008;**111**(3–4):321–8.
64. Benhajali H, Ezzaouia M, Lunel C, Charfi F, Hausberger M. Stereotypic behaviours and mating success in domestic mares. *Appl Anim Behav Sci* 2014;**153**:36–42.
65. Hausberger M. Lower learning abilities in stereotypic horses. *Appl Anim Behav Sci* 2007;**107**(3–4):299–306.
66. Henderson JV, Waran NK. Reducing equine stereotypies using an Equiball™. *Anim Welf* 2001;**10**(1):73–80.
67. Noh HJ, Tang R, Flannick J, O'Dushlaine C, Swofford R, Howrigan D, Genereux DP, Johnson J, van Grootheest G, Grünblatt E, Andersson E, Djurfeldt DR, Patel PD, Koltookian M, Hultman CM, Pato MT, Pato CN, Rasmussen SA, Jenike MA, Hanna GL, Stewart SE, Knowles JA, Ruhrmann S, Grabe H-J, Wagner M, Rück C, Mathews CA, Walitza S, Cath DC, Feng G, Karlsson EK, Lindblad-Toh K. Integrating evolutionary and regulatory information with multispecies approach implicates genes and pathways in obsessive-compulsive disorder. *Nat Commun* 2017;**8**:https://doi.org/10.1038/s41467-017-00831-x[Article Number 774].
68. Rendon RA, Shuster L, Dodman NH. The effect of the NMDA receptor blocker, dextromethorphan, on cribbing in horses. *Pharmacol Biochem Behav* 2001;**68**(1):49–51.
69. Nicol CJ, Badnell-Waters AJ. Suckling behaviour in domestic foals and the development of abnormal oral behaviour. *Anim Behav* 2005;**70**(1):21–9.
70. Whisher L, Raum M, Pina L, Pérez L, Erb H, Houpt C, Houpt K. Effects of environmental factors on cribbing activity by horses. *Appl Anim Behav Sci* 2011;**135**(1–2):63–9.
71. Houpt KA. Behavior in horses, In: *Notes from talk given at the southwest veterinary symposium, Ft. Worth, TX*; 2010.
72. Lane JG. Recent studies on crib-biting horses. *Equine Vet J* 1998;**30**(S27):59–61.
73. McGreevy PD, Richardson JD, Nicol CJ, Lane JG. Radiographic and endoscopic study of horses performing an oral based stereotypy. *Equine Vet J* 1995;**27**(2):92–5.
74. Houpt KA. New perspectives on equine stereotypic behavior. *Equine Vet J* 1995;**27**(2):82–3.
75. Mills DS, Taylor KD, Cooper JJ. Weaving, headshaking, cribbing, and other stereotypies. *Am Assoc Equine Pract Proc* 2005;**51**:221–30.
76. Ellis AD, Redgate S, Zinchenko S, Owen H, Barfoot C, Harris P. The effect of presenting forage in multi-layered haynets and at multiple sites on night time budgets of stables horses. *Appl Anim Behav Sci* 2015;**171**:108–16.
77. Hothersall B, Nicol C. Role of diet and feeding in normal and stereotypic behaviors in horses. *Vet Clin N Am Equine Pract* 2009;**25**(1):167–81.
78. Nicol CJ, Davidson HPD, Harris PA, Waters AJ, Wilson AD. Study of crib-biting and gastric inflammation and ulceration in young horses. *Vet Rec* 2002;**151**(22):658–62.
79. Clegg HA, Buckley P, Friend MA, McGreevy PD. The ethological and physiological characteristics of cribbing and weaving horses. *Appl Anim Behav Sci* 2008;**109**(1):68–76.
80. Wickens CL, McCall CA, Bursian S, Hanson R, Heleski CR, Liesman JS, McElhenney WH, Trottier NL. Assessment of gastric ulceration and gastrin response in horses with history of crib-biting. *J Equine Vet Sci* 2013;**33**(9):739–45.
81. Roberts K, Hemmings A, Moore-Colyer M, Hale C. Cognitive differences in horses performing locomotor versus oral stereotypic behavior. *Appl Anim Behav Sci* 2015;**168**:37–44.
82. Parker M, McBride SD, Redhead ES, Goodwin D. Differential place and response learning in horses displaying an oral stereotypy. *Behav Brain Res* 2009;**200**(1):100–5.

83. Nagy K, Bodó G, Bárdos G, Bánszky N, Kabai P. Differences in temperament traits between crib-biting and control horses. *Appl Anim Behav Sci* 2010;**122**(1):41–7.
84. Omidi A, Vakili S, Nazifi S, Parker MO. Acute-phase proteins, oxidative stress, and antioxidant defense in crib-biting horses. *J Vet Behav* 2017;**20**:31–6.
85. McBride SD, Hemmings A. Altered mesoaccumbens and nigro-striatal dopamine physiology is associated with stereotypy development in a non-rodent species. *Behav Brain Res* 2005;**159**(1):113–8.
86. Karson CN. Spontaneous eye-blink rates and dopaminergic systems. *Brain* 1983;**106**(3):643–53.
87. Luescher UA, McKeown DB, Dean H. A cross-sectional study on compulsive behavior (stable vices) in horses. *Equine Vet J* 1998;**30**(S27):14–8.
88. Hemmann K, Raekallio M, Vainio O, Juga J. Crib-biting and its heritability in Finnhorses. *Appl Anim Behav Sci* 2014;**156**:37–43.
89. Vecchiotti GG, Galanti R. Evidence of heredity of cribbing, weaving and stall-walking in Thoroughbred horses. *Livest Prod Sci* 1986;**14**(1):91–5.
90. Hemmann K, Ahonen S, Raekallio M, Vainio O, Lohi H. Exploration of known stereotypic behaviour-related candidate genes in equine crib-biting. *Animal* 2014;**8**(3):347–53.
91. Houpt KA. A preliminary answer to the question of whether cribbing causes salivary secretion. *J Vet Behav* 2012;**7**(5):322–4.
92. Moeller BA, McCall CA, Silverman SJ, McElhenney WH. Estimation of saliva production in crib-biting and normal horses. *J Equine Vet Sci* 2008;**28**(2):85–90.
93. Mills DS, Macleod CA. The response of crib-biting and windsucking in horses to dietary supplementation with an antacid mixture. *Ippologia* 2002;**13**(2):33–41.
94. Fukumoto K, Katayama K, Katayma T, Miyazatao M, Kangawa K, Murakami N. Synergistic action of gastrin and ghrelin on gastric acid secretion in rats. *Biochem Biophys Res Commun* 2008;**374**(1):60–3.
95. Hemmann KE, Koho NM, Vainio OM, Raekallio MR. Effects of feed on plasma leptin and ghrelin concentrations in crib-biting horses. *Vet J* 2013;**198**(1):122–6.
96. Archer DC, Pinchbeck GL, French NP, Proudman CJ. Risk factors for epiploic foramen entrapment colic: an international study. *Equine Vet J* 2008;**40**(3):224–30.
97. Malamed R, Berger J, Bain MJ, Kass P, Spier SJ. Retrospective evaluation of crib-biting and windsucking behaviours and owner-perceived behavioural traits as risk factors for colic in horses. *Equine Vet J* 2010;**42**(8):686–92.
98. Scantlebury CE, Archer DC, Proudman CJ, Pinchbeck GL. Recurrent colic in the horse: incidence and risk factors for recurrence in the general practice population. *Equine Vet J* 2011;**43**(Suppl. 39):81–8.
99. Archer DC, Freeman DE, Doyle AJ, Proudman CJ, Edwards GB. Association between cribbing and entrapment of the small intestine in the epiploic foramen in horses: 68 cases (1991–2002). *J Am Vet Med Assoc* 2004;**224**(4):562–4.
100. Archer DC, Pinchbeck GL, French NP, Proudman CJ. Risk factors for epiploic foramen entrapment colic in a UK horse population: a prospective case-control study. *Equine Vet J* 2008;**40**(4):405–10.
101. Archer DC, Proudman CJ, Pinchbeck G, Smith JE, French NP, Edwards GB. Entrapment of the small intestine in the epiploic foramen in horses: a retrospective analysis of 71 cases recorded between 1991 and 2001. *Vet Rec* 2004;**155**(25):793–7.
102. Albanese V, Munsterman AS, DeGraves FJ, Hanson RR. Evaluation of intra-abdominal pressure in horses that crib. *Vet Surg* 2013;**42**(6):658–62.

103. McGreevy PD, Webster AJF, Nicol CJ. Study of the behavior, digestive efficiency and gut transit times of crib-biting horses. *Vet Rec* 2001;**148**(19):592–6.
104. Houpt, K.A. (1994): Personal communication.
105. Albright J, Sun X, Houpt K. Does cribbing behavior in horses vary with dietary taste or direct gastric stimuli? *Appl Anim Behav Sci* 2017;**189**:36–40.
106. Houpt KA. The effect of diet on cribbing, In: *Proceedings of the American College of Veterinary Behaviorists Scientific paper session*; 2003. p. 76.
107. Omidi A, Jafari R, Nazifi S, Parker MO. Potential roles of selenium and zinc in the pathophysiology of crib-biting behavior in horses. *J Vet Behav* 2018;**23**:10–4.
108. Kennedy MJ, Schwabe AE, Broom DM. Crib-biting and wind-sucking stereotypies in the horse. *Equine Vet Educ* 1993;**5**(3):142–7.
109. McGreevy PD, Nicol CJ. Prevention of crib-biting: a review. *Equine Vet J* 1998;-**30**:35–8Supplement 27.
110. McGreevy PD, Nicol CJ. The effect of short term prevention on the subsequent rate of crib-biting in Thoroughbred horses. *Equine Vet J* 1998;**30**:30–4. Supplement 27.
111. Fjeldborg J. Evaluation of two different surgical techniques in the treatment of cribbing. *Equine Vet J* 1998;**30**(S27):61–2.
112. Ritzberger-Matter G, Kaegi B. Retrospective analysis of the success rate of surgical treatment of aerophagia in horses at the veterinary surgical clinic, University of Zurich. *Equine Vet J* 1998;**30**(S27):62.
113. Marcella KL. Common behavior problems in horses. *Equine Pract* 1988;**10**(6):22–6.
114. Dodman NH, Shuster L, Court MH, Dixon R. Investigation into the use of narcotic antagonists in the treatment of a stereotypic behavior pattern (crib-biting) in the horse. *Am J Vet Res* 1987;**48**(2):311–9.
115. Mazzola, S., Palestrini, C., Cannas, S., Fè, E., Bagnato, G.L., Vigo, D., Frank, D. and Minero, M. (2016): Efficacy of a feed dispenser for horses in decreasing cribbing behaviour. Vet Med Int 2016: ID 4698602 [downloaded February 13,2017].
116. Leme DP, Parsekian ABH, Kanaan V, Hötzel MJ. Management, health, and abnormal behaviors of horses: a survey in small equestrian centers in Brazil. *J Vet Behav* 2014;**9**(3):114–8.
117. McAfee LM, Mills DS, Cooper JJ. The use of mirrors for the control of stereotypic weaving behavior in the stabled horse. *Appl Anim Behav Sci* 2002;**78**(2–4):159–73.
118. Mills DS, Riezebos M. The role of the image of a conspecific in the regulation of stereotypic head movements in the horse. *Appl Anim Behav Sci* 2005;**91**(1–2):155–65.
119. Mills DS, Cook S, Taylor K, Jones B. Analysis of the variations in clinical signs shown by 254 cases of equine headshaking. *Vet Rec* 2002;**150**(8):236–40.
120. Newton SA, Knottenbelt DC, Eldridge PR. Headshaking in horses: possible aetiopathogenesis suggested by the results of diagnostic tests and several treatment regimes used in 20 cases. *Equine Vet J* 2000;**32**(3):208–16.
121. Roberts VLH, Patel NK, Tremaine WH. Neuromodulation using percutaneous electrical nerve stimulation for the management of trigeminal-mediated headshaking: a safe procedure resulting in medium-term remission in five of seven horses. *Equine Vet J* 2016;**48**(2):201–4.
122. Wilkins, P.A. (1997): Cyproheptadine: Medical treatment for photic headshakers. Compend Contin Educ Pract Vet: Equine, 98–99,111.
123. McDonnell SM. Tongue trouble. *The Horse* 2009;**XXVI**(9):54–5.
124. McDonnell SM. Young horse habits. *The Horse* 2010;**XXVII**(4):64–5.
125. Normando S, Meers L, Samuels WE, Faustini M, Ödberg FO. Variables affecting the prevalence of behavioural problems in horses. Can riding style and other management factors be significant? *Appl Anim Behav Sci* 2011;**133**(3–4):186–98.

126. Fox AE, Belding DL. Reducing pawing in horses using positive reinforcement. *J Appl Behav Anal* 2015;**48**(4):1–5.
127. Miller RM. Common misbehaviors (vices in hand and under saddle). *J Equine Vet Sci* 1997;**17**(2):67–9.
128. Ninomiya S, Sato S, Sugawara K. Weaving in stabled horses and its relationship to other behavioural traits. *Appl Anim Behav Sci* 2007;**106**(1–3):134–43.
129. Cooper JJ, McDonald L, Mills DS. The effect of increasing visual horizons on stereotypic weaving: implications for the social housing of stabled horses. *Appl Anim Behav Sci* 2000;**69**(1):67–83.
130. Nurnberg HG, Keith SJ, Paxton DM. Consideration of the relevance of ethological animal models for human repetitive behavioral spectrum disorders. *Biol Psychiatry* 1997;**41**(2):226–9.
131. Scantlebury CE, Archer DC, Proudman CJ, Pinchbeck GL. Management and horse-level risk factors for recurrent colic in the UK general equine practice population. *Equine Vet J* 2015;**47**(2):202–6.
132. Marcella KL. *Poor socialization can stem from a variety of circumstances*. DVM Newsmagazine; 2006. p. 2E–5E.
133. Fureix C, Jego P, Henry S, Lansade L, Hausberger M. Towards an ethological animal model of depression? A study on horses. *PLoS One* 2012;**7**(6). https://doi.org/10.1371/journal.pone.0039280.
134. Rochais C, Henry S, Fureix C, Hausberger M. Investigating attentional processes in depressive-like domestic horses (*Equus caballus*). *Behav Process* 2016;**124**:93–6.
135. Aleman M, Williams DC, Holliday T. Sleep and sleep disorders in horses. *Am Assoc Equine Pract Proc* 2008;**54**:180–5.
136. Geering RR. Clinical aspects of equine narcolepsy. *Equine Vet J* 1998;**30**(S27):50.
137. Hines MT. *Narcolepsy: more common than you think?* In: *Proceedings of the North American veterinary conference*; 2005. p. 189–90. www.ivis.org/ [downloaded 4/6/2017].
138. Reed SM, Andrews FM. Disorders of the neurologic system. In: Reed SM, Bayley WM, Sellon DC, editors. *Equine internal medicine*. St. Louis: Saunders; 2010. p. 545–681.
139. Moore LA, Johnson PJ. Narcolepsy in horses. *Compend Contin Educ Pract Vet* 2000;**21**(1):86–90.
140. Peck KE, Hines MT, Mealey KL, Mealey RH. Pharmacokinetics of imipramine in narcoleptic horses. *Am J Vet Res* 2001;**62**(5):783–6.
141. Lacombe VA. Seizures in horses: diagnosis and classification. *Vet Med Res Rep* 2015;**6**:301–8.
142. Bertone JJ. 6 types of sleep deprivation in horses. *The Horse* 2017;**XXXIV**(12):14.
143. Dodman NH, Normile JA, Shuster L, Rand W. Equine self-mutilation syndrome. *J Am Vet Med Assoc* 1994;**204**(8):1219–23.
144. Luescher UA. More on self-mutilative behavior in horses. *J Am Vet Med Assoc* 1993;**203**(9):1252–3.
145. McClure SR, Chaffin KM, Beaver BV. Nonpharmacologic management of stereotypic self-mutilative behavior in a stallion. *J Am Vet Med Assoc* 1992;**200**(12):1975–7.
146. Dodman NH, Shuster L, Court MH, Patel J. Use of a narcotic antagonist (nalmefene) to suppress self-mutilative behavior in a stallion. *J Am Vet Med Assoc* 1988;**192**(11):1585–6.
147. Bedford SJ, McDonnell SM, Tulleners E, King D, Habecker P. Squamous cell carcinoma of the urethral process in a horse with hemospermia and self-mutilation behavior. *J Am Vet Med Assoc* 2000;**216**(4):551–3.
148. Houpt KA. Self-directed aggression: a stallion behavior problem. *Equine Pract* 1983;**5**(2):6–8.
149. Dodman NH, Shuster L, Patronek GJ, Kinney L. Pharmacologic treatment of equine self-mutilation syndrome. *Int J Appl Res Vet Med* 2004;**2**(2):90–8.