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POINT-COUNTERPOINT

Horse-training techniques that may defy the principles of learning theory and compromise welfare

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Abstract This review considers some contemporary training and restraining techniques that may lead to confusion or abuse in ridden and nonridden horses. As competitive equestrian sports boom, the welfare of the horse is under increasing scrutiny. The current focus on hyperflexion of the neck in dressage warm-up has exposed the problems with relying on subjective opinions when attempting to safeguard horse welfare. The discussion also highlights an opportunity for equestrian federations to evaluate practices within the various horse sports. Our review considers numerous examples of unorthodox practices that modify locomotion and posture. It offers a scientific framework for consideration of many contentious techniques in horse sports and emphasizes the role of Equitation Science in generating evidence-based enlightenment.

Introduction

This article examines some potential sources of compromised welfare in ridden and non-ridden horses. Many of the practices involved are unusual or radical, and some of the interventions we describe are popular but not orthodox in terms of optimal equestrian practice or prescribed by governing federations.

As a background to this article, it is an implicit assumption that certain principles arise from the application of learning theory to horse training (see McGreevy and McLean, 2007 for an extensive review). These include the correct application and timing of negative reinforcement; placing the locomotory responses under the stimulus control of the appropriate light signals of the rein(s), lead, or rider's leg(s); eliciting responses separately; and ensuring that each cue is associated with only one particular response.

The techniques and devices described here are discussed in terms of their potential to inhibit learning, create confusion, or compromise welfare. They include hyperflexion of the neck (including what is commonly referred to as rollkur), inducing confusion by using one signal for two or more different responses, simultaneous and contradictory signals or pressures, rapping, gingering, soring, sedation and nerve blocks, electric shock-collars, horse-walkers, water deprivation, apparatus intended to increase control or alter the horse's head and neck position, certain nosebands, whips and spurs, and finally hobbles. We speculate that these techniques have arisen not only through a lack of knowledge of learning theory, but also from the influences that arise in the context of equestrian sports. The use of animals in sport results in their altered economic value and encourages a foreshortening of training in many instances

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to the detriment of the animal's welfare. Such shortcuts may have become entrenched as *modus operandi* in equestrian culture.

Of the practices discussed here, the most confusing to a horse are those that apply contradictory pressures (e.g., that send it forward while simultaneously slowing it). Even without using mechanical devices, riders can coerce their horses to assume certain gaits and postural responses with strong permanent pressure. In more acceptable training methods, the horse's head and neck posture can be varied to some extent by negative reinforcement provided by the reins and rider's legs. It is generally seen as essential in the sport of dressage to place a horse "on the bit" which is defined as "when the neck is more or less raised and arched according to the stage of training and the extension or collection of the pace, accepting the bridle with a light and consistent soft submissive contact. The head should remain in a steady position, as a rule slightly in front of the vertical, with a supple poll as the highest point of the neck, and no resistance should be offered to the athlete" (Fédération Equestre Internationale, 2009). The mild arching of the neck where the horse's nose comes a little closer to its chest causes, through the nuchal ligament, a change in the tonus of the musculature in the horse's back. This is reputed to confer biomechanical advantages for equitation and create a softer back to sit on.

In equestrian parlance, three types of flexion or head and neck position that arise in all dressage movements and that are directly associated with being "on the bit" are considered. During turns and some lateral movements, the horse should show lateral flexion (head turning to one side or the other). The horse should show longitudinal flexion (stretching the neck longer while maintaining the poll above the withers and with very slight neck arching) when the stride is lengthened, and according to its stage of training, vertical flexion (arching the neck and further raising of the poll) where even greater tonus on the nuchal ligament and/or long muscles apparatus occurs as the horse becomes more collected. (Longitudinal flexion may confuse some scientifically educated readers as it implies flexion that is at right angles to the vertical plane and yet it involves *mild* cervical flexion accompanied by atlanto-occipital flexion, both of which occur in a dorso-ventral [vertical] plane and as such the term does not immediately distinguish itself from vertical flexion. It is important that, instead of blindly following equestrian dogma, science offers equestrianism clarity in its definitions. We propose that these labels should eventually be replaced by terms that identify the elements of the vertebral column that are being flexed).

Some of the ways in which "on the bit" head and neck position can be achieved can compromise horse welfare, as is evident from this article. Although such techniques may seemingly bring some short-term benefits to the rider, they may have deleterious side-effects for the horse (McGreevy and McLean, 2007). In all cases, we propose that such techniques may be avoided if trainers, coaches, riders, and handlers were educated in training principles that emerge from learning theory, ethology, and cognition (McGreevy and McLean, 2007). Our goal is to offer a scientific framework from which to evaluate interventions in horse training so that federations and other agencies can make more-informed decisions rather than relying solely on subjective opinion.

Forcing the "on the bit" head and neck position

In what is commonly referred to as classic dressage, the "on the bit" position, including arching of the neck, is seen as an emergent property of correct biomechanical training of locomotory responses (Henriquet, 2004). A so-called broken neck is not a reference to a fractured vertebral column but a description of how horses with their necks flexed artificially by force (e.g., side-reins or running reins in the high or low head position) appear to show the greatest amount of flexion at the junctions of cervical vertebrae 3, 4, and 5. An abrupt change in the vertical flexion can be seen in the crest of horses undergoing this intervention. It is unclear as to whether there are associated pathologic changes.

Many contemporary riders use increasingly strong rein pressure until the horse brings its mouth toward the rider's hands, and thus shortens its neck in an attempt to relieve the bit pressure. This forced head and neck outline is an attempt to achieve the "on the bit" position and, to many present-day observers, is a correct facsimile even though it is contrary to academic or classical principles. As a result, the neck may be shortened while the head is in the high, intermediate, or lowered position where the nose comes behind the vertical line. This technique may be carried out for several reasons. For example, there may be some perceived improvement in athletic or behavioral responses in the horse or, it may be that riders, trainers, and judges are unaware of or disregard the classic method of achieving this outline. In contrast, the correct neck outline prescribed by the rules of dressage that arose from classic principles requires the nasal plane to be just in front of the vertical line (FEI, 2009). These principles arose to reflect the outline of self-carriage, where the horse is able to maintain the posture freely (Karl, 2006). If the horse has been forced to show this posture with strong permanent pressure, it is powerless to relieve the pressure in its mouth.

The horse's mouth never evolved to accommodate a bit and when the tongue is depressed by a bit, it does not fit in the narrow inter-mandibular space, so many bits press the tongue against the bars of the mouth. Fluoroscopic studies show that the bit rests on the tongue, which may be retracted, rather than on the bars of the mouth, as was originally believed (Clayton, 1985). The incident in 2009 in which a dressage horse was filmed at an international competition, with its ischemic tongue drooping out of its mouth, was a catalyst for calls for immediate improvements in sport horse welfare by the International Society for

Equitation Science, and a subsequent shift to focus on the deleterious effects of relentless mouth pressure as the salient culprit in the debate surrounding head and neck postures coerced by the reins.

Using the reins for flexing the neck can also induce confusion, because the earliest and most fundamental learned response from bit pressure is one of deceleration. Thus, any alternative bit pressure response trained by riders or apparatus will have a detraining effect on the deceleration response. This may lead to deficits in training (i.e., the quality of the slow/stop/step-back response declines) and subsequent conflict behaviors that result from the confusion.

As we mentioned earlier, various stages of neck arching are required in the sport of dressage, although the rules stipulate, at least 7 times, that the nose should always be slightly in front of the vertical (FEI, 2009). When the horse carries (or is forced to carry) its nasal plane *behind* the vertical, it is said to be over-bent and this is considered a training error.

Hyperflexion of the neck (rollkur)

In recent years, we have seen the emergence of dressage training techniques that involve extreme over-bending for various lengths of time. Although profound cervical flexion can occur in free-ranging horses, it lasts for only brief periods. In contrast, since the rise of horse sports after the Second World War, sustained over-bending has become increasingly common in equestrian contexts.

Hyperflexion or rollkur is the term used to describe a technique in which the horse's neck is dorsoventrally hyperflexed as a result of bit pressure to the point where the horse's chin may touch its pectoral region. It is used in training and warming-up horses before competition but would attract penalty if seen in dressage competitions because the horse would be judged to be over-bent (the nasal plane being carried behind the vertical). Proponents of this method claim that they shape this response gradually and that the horse is ridden in this "frame" (posture) for only short periods. However, many observers have described longer durations (Jenkins, 2007; Thomsen and Taylor, 2009), and the mechanisms by which this technique might achieve greater flexion of the hock joints (as is claimed) are not yet known. It is plausible that any advantages conferred by this technique in achieving higher steps occur as a result of postinhibitory rebound where the extension of the nuchal ligament and concomitant alterations in the back muscles may, when released, permit higher steps.

Hyperflexion is believed to decrease stride length and increase elevation of the hindlimbs, while also increasing the dorsoventral oscillation of the lumbar vertebrae (van Weeren et al., 2006). Certainly, the current prevalence of hyperflexion among elite dressage competitors strongly suggests that it lends some competitive advantage in that its use helps to give a performance the judges wish to see, even though it is a warm-up practice that is at odds with what is required in the competition itself.

The veterinary committee of the FEI stated that hyperflexion of the neck is a type of flexion of the mid-region of the neck that cannot be self-maintained by the horse for a prolonged time or imposed by the rider without welfare implications (FEI, 2006). Over the ensuing 4 years, it became clear that this definition was too complex to be workable because it did not specify how much flexion is too much and there are no current tests for self-maintenance. Furthermore, the FEI stated that hyperflexion as a training aid must be used correctly because it can be an abuse when attempted by an inexperienced or unskilled rider or trainer. This again was a troubling directive. The FEI instructed stewards to penalize riders who practice prolonged or excessive hyperflexion. The word "prolonged" was too vague to be of much help to stewards required to police it and seemed to spare no horses from abuse. The term "excessive" implied that the working definition at the time was insufficient and that hyperflexion in itself was acceptable. Given that horses do not maintain a hyperflexed posture spontaneously and that, therefore, some degree of sustained bit pressure must play a role in this technique, there was a clear need for an objective measure of lightness. Stewards in the warm-up arena should not be expected to make assessments of oral abuse without empirical data, given that trained judges have difficulty in detecting lightness (Ödberg and de Cartier d'Yves, 2005).

There is opposition to sustained hyperflexion because it is said to "stiffen the horse," "cause excessive flexion," and "induce discomfort to the animal" while providing riders with "complete domination" and control (FEI, 2006). Some dressage experts criticize the technique because it not only creates hollow loins and a less rhythmical cadence (pause) but also a jerkiness of the hindlegs (Karl, 2006). There is also a concern that the practice may create physical stress at the level of the intervertebral discs, in the nuchal ligament, and in the withers, and that, although such extreme posturing may not necessarily cause primary lesions, it may cause pain in horses with pre-existing conditions (Denoix, 2006). A counter argument is that some top-class dressage horses known to have been trained using hyperflexion techniques have competed well into their 20s, and that this would not be possible if they were in discomfort or if their welfare had been seriously jeopardized by any particular technique or practice. In 2007, a high-profile trainer was subjected to disciplinary action by the FEI for inducing hyperflexion in a horse by lunging for an extended period in side-reins that were considered too tight (Jenkins, 2007).

The 2006 FEI workshop on hyperflexion also drew attention to the effect of head posture on the respiratory tract of healthy horses and on vision, as well as many other issues that surround the use of horses in modern dressage, including lameness in the dressage horse and the

consequences of equestrianism generally on horse welfare (Harman et al., 1999; Kold and Dyson, 2003; McGreevy and McLean, 2009; Ödberg and Bouissou, 1999; Petsche et al., 1995; Racklyeft and Love, 1990).

In 2010, the FEI claimed to have resolved the issue by redefining hyperflexion or rollkur as flexion of the horse's neck that results from the use of aggressive force (FEI, 2010). The same statement went on to assert that flexion without undue force, a technique they referred to as low, deep, and round, is acceptable. The authors of this statement unanimously agreed that any form of aggressive riding must be condemned but made no mention of how this might be defined or measured. If the only force that is unacceptable is characterized by the intention of the rider (i.e., the rider's aggression), then stewards will struggle to be sure that a breach has occurred.

It is worth considering whether some amount of hyperflexion can be achieved with the correct use of learning principles and lightness, and whether rein gauges or tests for self-carriage might be used to distinguish between good and bad hyperflexion. We propose that rein tensiometers can assist in providing the solution (Warren-Smith et al., 2007). These devices are now at a stage where they can be unobtrusive, telemetric, time-date stamped, tamperproof, and transferable from one set of reins to another. To evaluate welfare or discomfort in horses, rein tensiometer data should be correlated with other measures (e.g., behavioral and physiological stress parameters). It is likely that there is variation in the levels of stress that can be tolerated by horses and this range should be identified. Rein tensiometer data collected in warm-up contexts should show whether horses are being hyperflexed with tension beyond an acceptable range of rein contact.

In competition itself, it may be appropriate to introduce compulsory actions that demonstrate lightness by the rider; for example, the technique known as Überstreichen or testing for self-carriage could be adopted throughout dressage tests at all levels. In this technique, the rider surrenders the reins forward toward the horse's head for 2 strides to demonstrate that the horse's speed, direction, and outline are not held by the rider but are, instead, trained responses.

To detect whether Überstreichen has been contrived by excessive force, a further measure could be included in all dressage tests in which the rider surrenders the reins for more than 2 strides. The carefully and kindly trained horse may stretch his neck forward during this period as if he is, as dressage exponents claim, "seeking the contact." This stretching forward is unlikely to occur if the horse is fearful of the bit.

But what is acceptable rein contact? This question may trigger a healthy debate on the acceptable range of contact for various sports and the introduction of tensiometers throughout horse sports covered by the FEI. Collecting data from top-level performance horses during their warm-up before competition would be an important first step, as it would allow the governing bodies to consider the mean tensions being applied in the sport and decide on what tensions and durations are acceptable.

Waran (personal communication, 2009) has pointed out that hyperflexion may be achieved with very little contact once the horses are trained on this technique, and so there is a possibility that a rein tensiometer may not record excessive force when the horse is being warmed-up in public. Hyperflexion is only one of a number of training techniques that may include stronger pressures during training. However, after the horse learns the desired posture or response, the strength of the signal can diminish and strong rein pressure may not be apparent. Although this may be possible, an issue of great importance to the hyperflexion debate is one of confusion as a result of using rein signals for multiple responses; which is discussed in the following paragraph.

Waran (personal communication, 2009) highlights 4 important questions that may provide a framework for any contentious responses in horse sports:

1. How are such behaviors trained?
2. What is acceptable in terms of unnatural gaits and postures in performance?
3. How can judges reward good training?
4. How can we use the scientific process to safeguard the welfare of the horse?

From a behavioral perspective, the application of sustained pressure by the rider or relentless resistance from the horse amount to the same thing: pressure in the mouth, which can lead to habituation. Research is needed to remove emotiveness from the hyperflexion debate by establishing, for a range of equine athletes, what range of contact is neutral, how much rein tension is too much, how could discomfort and pain be measured, and how learned helplessness manifests in horses (McGreevy and McLean, 2007).

Inducing confusion by using 1 signal for 2 or more separate responses

It is likely that horses with 2 separate responses (deceleration as well as neck flexion) to a single cue (e.g., rein pressure) are likely to be less responsive to deceleration cues than those trained simply to decelerate. In other words, such horses will inevitably lose some of their stop response, which could present as danger to the rider. Presumably, such confusion will mean that the rein tension required for deceleration has to be significantly elevated. One might expect to see hyperflexed horses showing more signs of rushing, bolting, and other hyper-reactive behaviors, such as bucking, if their deceleration responses are diminished. Such horses show habituation to rein signals. This confusion regarding rein responses and habituation to heavy and perhaps intolerable mouth pressures is an enduring side-effect of false collection, where the neck has been

shortened only by rein pressure and which is contra-indicated in most equestrian texts (German National Equestrian Federation, 1997; British Horse Society, 2001). False collection occurs when, among other features, the neck is visibly shortened and the gullet is closed like an upside down "V" rather than as an upside down "U," as it should be when the horse's neck posture is self-maintained.

When young horses undergo foundation training, they learn that increased pressure on a single rein is the signal for turning the forequarters by a sequential process of abduction, followed by adduction of the forelegs (in equestrian parlance, this rein signal is known as the direct turn signal). It is an important early response because during challenging moments the reins, among an array of other classically conditioned signals such as seat or postural signals, provide the deepest signals (learned by negative reinforcement) that can induce the turn. Hence, maintaining the integrity of the basic operantly conditioned response is important for safety. However, it is becoming common for some trainers and coaches to use the single rein not for its original locomotory response, but simply to laterally bend the horse's neck extremely to one side as a way of stopping the horse instead of using or re-training the operantly conditioned foundation response of equal pressure on both reins. Sometimes this neck bending procedure is used to allegedly "supple" the horse's neck, but this technique implies that the stiff neck is independent of an otherwise relaxed body. It is more likely that the locomotory responses are not sufficiently under stimulus control and the horse is consequently hyper-reactive. Forcing the horse to bend its neck from rein pressure blurs the distinction between cues for an effective change of direction and simply bending the neck. This is because the signal is the same or similar while the response is different, with the result that the turn is detrained.

Simultaneous, contradictory pressure

Perhaps the most insidious and widespread of all unorthodox techniques is the concurrent stimulation of 2 opposing operantly conditioned signals, such as reins (the stop response) and legs (the go response). This concurrent signaling places the horse in a biomechanically impossible situation because the muscles it uses for *go forward* and *stop* are antagonistic, so again the result is a detraining effect. Detraining is not just a matter of losing the brakes or accelerator; the subsequent confusion can induce conflict resolution behaviors in horses. Like all animals, horses seek to avoid pain. When they are prevented from doing so (e.g., when trapped between the rider's reins and leg pressures) they may become hyper-reactive, using *active* coping mechanisms. They are actively trying to escape, but escape is thwarted. Hyper-reactive escape behavior switches to other active-coping strategies such as hyper-reactive predator removal behaviors (e.g., bucking, rearing, and shying). Active-coping mechanisms and cutaneous pain share similar characteristics and brain pathways: in rats, they include hyper-reactivity, increased vigilance, raised heart rate, and raised blood pressure (Keay and Bandler, 2008).

If the pain persists over a sufficiently long period, and the horse cannot resolve the pain issue, hyper-reactive behavior can spiral down into passive coping behaviors, where the horse is now hypo-reactive and seemingly gives up. Its bucking and shying may diminish, but the horse is heading down the slippery slope of learned helplessness where it is, on the surface at least, careless about pain. Internally, the horse may show all the physiological signs of chronic stress. Passive-coping states, such as learned helplessness, show similar characteristics and brain pathways as deep visceral pain: hypo-reactivity, apathy, decreased vigilance, lowered heart rate, and lowered blood pressure (Keay and Bandler, 2008).

Rapping

Rapping is the technique of striking a horse's legs (usually hindlegs) as they pass over a rail during jumping. The dorsally directed strike, often achieved by raising a whip or cane at the height of the horse's trajectory, punishes it for jumping adequately and thus trains it to overcompensate when estimating obstacle heights. This is believed to make the horse more careful when jumping and reduce the risk of it dropping a rail when pushed in competition (e.g., when forced to flatten its trajectory when jumping against the clock). A strong argument against rapping is that it punishes horses for making any effort. It is forbidden both at events and during training, but the ban is extremely difficult to enforce during training. Although it is appropriate that the FEI takes a dim view of this practice, many observers feel that practices known to accompany dressage training (such as tight nosebands) are even more of a priority, because they are arguably harsher and certainly more relentless.

Gingering

Gingering is the use of irritants (traditionally peeled ginger) *per rectum,* with the aim of causing rectal discomfort. It is a practice known to occur in the show-ring, especially where high postural tonus (e.g., a raised tail carriage) is considered desirable. For this reason, it is more likely to be found in shows for Arabians than for other breeds. Although considered a breach of the rules under most codes of showing, it is difficult to detect after the agent itself has been passed by defecation. Inarguably, any manipulations of horse's tail carriage or conformation (including docking) should be undertaken only when there is a sound veterinary reason (Lefebvre et al., 2007).

Soring

Damaging the skin of the pasterns with caustic topical applications and then fitting chains or beads so that they lie on the damaged tissue can cause extravagant lifting of the lower limbs and flexion of the fetlocks. It is practiced in show classes where high limb action is highly desired (e.g., for Tennessee Walkers). Practices such as this are more likely to be controlled if veterinarians remain aware of them and prioritize the welfare of the animals in their care. Legislation may have outlawed many such interventions, but policing the emergent rules relies on the cooperation of the profession. Detection depends on being able to correctly age any evidence of scarification in the horse's limbs; old lesions are not likely to cause current behavioral modifications and can easily be blamed on a previous owner, handler, or groom.

Sedation and nerve blocks

Where a lack of reactivity in horses is highly prized in the show-ring (e.g., in Western pleasure riding), a raised tail carriage may detract from the horse's score. So competitors may surreptitiously use nerve blocks or even neurectomy to reduce tail movement (Houpt, 2001). The tail may appear to be clamped between the hindlegs or suspiciously inactive, but detection is difficult and depends on the use of electromyography.

There are also numerous reports of competitors using psycho-pharmaceuticals (notably sedatives) to make horses more tractable. One of the ironies of this practice is that the recipients of these treatments are often horses that have, just before the event, been overfed with concentrates and so are less likely to be manageable. Overfeeding horses so that they look in the top condition and confining them to contain their energy and reduce the need to groom them just increases their ebullience.

The practice of manipulating the behavior of horses with pharmaceuticals (including benzodiazepines, fluphenazine, acepromazine, and zuclophenthixol) is unethical and is rigorously monitored by the FEI. Nevertheless, even in local shows, competitors may be tempted to eliminate undesirable responses, usually ones that make the horse difficult to control. Largely confined to the show-ring, this intervention is also dangerous because it can affect the horse's ability to move safely and so is of particular concern when it arises in jumping competitions.

Electric shock-collars

Electric shock-collars, which can be triggered remotely to release a discharge, have received considerable attention from animal trainers. Undesirable long- and short-term behavioral changes in dogs, notably those indicating distress (Schilder and van der Borg, 2004), and problems with the use of electric shock-collars in horse-training have been described (McGreevy and Boakes, 2007). Dogs that have received shocks (even remotely triggered shocks) may begin to react fearfully to their owners (who become a predictor of the aversive stimuli; McGreevy and Boakes, 2007).

Shock-colars have also been used to punish crib-biting but horses often moderate their stereotypic behavior when wearing the collar only to resume it as soon as the collar is removed, sometimes with a transient increase in the response, possibly as the result of a postinhibitory rebound (McGreevy and Nicol, 1998).

Horse-walkers

Although a mainstream means of exercising stabled horses, horse-walking machines have come under scrutiny because of the concern that they can be dragging machines that force horses, especially younger naive ones, to undertake locomotion and that they provide none of the usual environmental stimulation that is afforded by free-ranging, ridden, or led locomotion. Until horses have learned to lead correctly by shaping each step forward, they may simply resist the head pressure and take a considerably longer time to learn to lead that way. However, horse-walking machines are frequently used without tethering the horse because these devices also feature rubber boarding that taps the horse's hindquarters should it begin to lag. Either way, negative reinforcement is certainly involved but, paradoxically, the coercive forces may be more consistent than many handlers, and this may explain why accidents involving horse-walkers are rare.

The use of horse-walkers in foundation training for horses, especially during backing, has been reported recently (Murphy, 2007). Effectively, it is a form of overshadowing in that the pressure of the head-collar that evokes a leading response is used to overshadow the pressure of the rider on the horse's back, resulting in habituation to the rider. There are concerns about the dangers to both horse and rider should a flight response emerge within this sort of assembly, which is clearly not designed with foundation training (horse-breaking) in mind.

Water deprivation

It is believed by some that water deprivation makes horses appear more compliant. Certainly, clinical dehydration will compromise the ability of horses to show flight responses, many of which are seen in confused and poorly trained horses and few of which are desirable. Furthermore, as Xenophon ([translated by Morgan] 1962) proposed, depriving a horse of water allows one to use water as a reward. For example, this is seen in methods that advocate the imposition of dehydration as a valid step in remediating horses that refuse to be led into a trailer. Horses may have the ability to adapt to considerable periods with little water, but dehydration is highly questionable on ethical grounds

and should never be advocated because it can cause irreversible renal damage.

Apparatus intended to increase control or alter the horse's head and neck position

Side-reins, martingales, and tie-downs that apply pressure to the nasal planum through the noseband (in the case of the standing martingale and tie-downs) or the mouth through the reins (in the case of the running martingale or draw reins) prevent evasive raising of the head. The rider can use the lever action of the running martingale to pull the head lower. Critics rightly point out that these gadgets force the horse into an outline rather than train self-carriage through lightness. Rather, when the head is forced downward, the muscles of the neck and topline are not "suspending" the head and neck but, instead, the horse is attempting to raise its head against aversive pressure. Gadgets that fix the head position deny the horse's biomechanical requirement to move its head forward and backward in the walk and the canter, which consequently become stilted.

Other "training" devices that are used include curb bits with chains, gags, draw reins, balancing reins, chambons, de gogues, Thiedemann reins, the rubberband neck extender, and the Abbot-Davies balancing rein where the ridden horse's tail is directly tied to its mouth (Sandin, 2001). In lunged horses, the bit is sometimes connected to the hindlegs above the hocks, so the movement of the legs causes pain in the mouth, resulting in giving to the bit (e.g., the Pessoa system). All of these devices when connected to the horse's mouth interfere with the deceleration effect of the bit and can thus be a significant source of confusion.

Unrelenting pressure from a bit can prompt a horse to trial hyper-reactive behaviors, as described previously. Unorthodox bits apply pressure with greater severity or to different parts of the mouth. Even though they can, and sometimes do, sever the tongue (Rollin, 2000), saw-chain bits (so-called mule bits and correction bits) are readily available to riders who are ill-informed on how to train deceleration responses in their horses with a milder bit (McLean and McLean, 2008).

Curb bits generally use first-class levers that amplify rein tension as a result of their lever action and so can create a misleading impression of lightness. The length of the shank magnifies the leverage through the bit so that the rider may be duped into believing that the lightness in his hands correlates with lightness in the horse's mouth. However, the tendency is to develop a reliance on these extra pulleys, rather than to use them solely for re-training.

Nosebands

When horses open their mouths to evade the bit, one short-term response by riders and trainers is to use a noseband that keeps the mouth tightly closed. Clearly, this does nothing to help the horse relax its jaw and is likely to act as an additional stressor. The same criticism can be leveled at tongue ties, as they restrict normal movement of the tongue (such as during swallowing) and also stop the horse finding comfort. Tongue ties cause ischemia and can cause long-lasting damage to the horse's highly vascularized tongue (McGreevy and McLean, in press). As equestrian sports became more popular and competitive in the 1970s, dropped nosebands gave way to Hanoverian, crossover, and grackle nosebands. Then in the 1980s, "crank" nosebands emerged. These have an added feature: they can be tightened much further than regular nosebands because of a lever action. This highly aversive action seems to sensitize the horse's mouth, making the horse much more responsive to rein pressure and, to some observers, this gives the appearance of the horse becoming more "submissive." In addition, they minimize the horse's ability to resist the bit, for example, by opening its mouth. In this way, such tight nosebands restrict unwelcome movement and so allow competitors to attract higher collective marks for submission, the only element of the FEI dressage scoring system that rewards lightness and compliance (Hawson et al., 2010). Banning nosebands that can be so restrictive would allow the horses to express their discomfort. By permitting horses to move naturally, such a ruling would align with FEI's approach to other restraints in dressage, such as martingales.

Cheek pieces may prevent the bit from being pulled through the horse's mouth and equally may make turning pressures on the lateral aspect of the horse's lips clearer to the horse. Anti-rearing bits (also known as the chifney or stallion bit) also have this feature but are generally thinner and have no joint; therefore, they have a more severe action than riding bits, such as a regular snaffle. The action of an anti-rearing bit presses the tongue against the bars and, not uncommonly, may cut the tongue itself. Most anti-rearing bits have an inverted port in the middle and this is the most controversial feature of the bit as it drives the tongue into the cavity where it cannot fit and thus severely onto the bars of the mouth.

Whips and spurs

If a horse fails to show sufficient forward movement or impulsion, trainers may increase the pressure by using whips and spurs to negatively reinforce forward locomotion more effectively. Although, for some, these stimulants are distasteful, they are not necessarily contraindicated. They can be used minimally and with precision as a mild signal to fortify the rider's leg signals. That said, whips fortify effectively only if the horse has a clear learned locomotory response to a light tapping motion of the whip. Whips should never be used to punish nonperformance because of the cognitive difficulty in associating the punishment

with the incorrect response to the cue, and the various detrimental effects of punishment and fear (McGreevy and McLean, in press).

Among veterinary professionals, physical restraint of horses (e.g., with twitches or hobbles) during painful procedures is often possible but rarely preferable to chemical restraint. This is legitimate, if the alternative is a brutal struggle or an opportunity for the horse to learn dangerous evasions. Fundamentally, force can escalate the aversiveness of the procedure and is ultimately likely to compromise the horse–human interaction and make the horse less compliant for future procedures. Numerous handling problems are the legacy of previous mistakes in timing and consistency. Others can have proximate causes in physical pathologies, so handlers should always consider seeking veterinary advice before embarking on any course of behavior modification. For example, a horse that is reluctant to step backward must be checked for back pain (referred or otherwise) or for specific problems such as wobbler syndrome (Moore et al., 1994).

Roping techniques used to pacify horses during aversive interventions are described exhaustively elsewhere (e.g., Fraser, 1992; Waring, 1983; Rose and Hodgson, 1993). Generally, these have been superseded by chemical agents because there is no justification for allowing horses to fight against physical restraint when there is no evidence that they can predict that the episode will end. If, during a handling procedure, a horse is not likely to learn good associations with personnel, we should avoid it learning anything. The use of overshadowing techniques to reduce fearful responses to interventions such as farriery, clipping, and injections is yet to be fully explored but holds tremendous promise in the hands of skilled practitioners (McLean, 2008).

Hobbles

Hobbles are sometimes used during foundation training or colt-starting. This practice involves securing one foreleg from the metacarpo-phalangeal joint (fetlock) to the antebrachium so that the knee is maximally flexed. This limits the horse's abilities to run or buck and practitioners claim that the inhibition of this hyper-reactive experience results in horses learning not to run or buck. Sometimes, young horses are ridden with one foreleg hobbled. Hobbling can be a dangerous practice for the horse because it may slip over as it does attempt to run or leap forward during its early experience of hobbling. Sidelines follow similar principles but the ipsilateral limbs are secured. Hobbling the forelegs together at the level of the carpal joints (knees), the metacarpo-phalangeal joints (fetlocks), or the first phalanges (pasterns) (e.g., with so-called dinner hobbles) is sometimes used as a means of retarding a horse's progress when leaving it untethered. It is also used for horses that habitually strike or kick during travelling. When first applied, hobbles prompt most horses to fight against the restraint. Hobbles should not be used by novice handlers and, initially, they must be used in conjunction with soft but not slippery surfaces (in case of falling).

Serving hobbles are designed to limit a mare's ability to kick a stallion during mating. Most designs of serving hobbles restrain the hindlegs by roping them to a band around the horse's neck, and are fitted with some form of quick-release device. Serving hobbles should be used only in combination with deep, soft, bedding materials because occasionally cause horses to fall (usually while struggling).

Reports on Welsh ponies (Debbie Goodwin, personal communication, 2007) and the Blackfoot Native American remounts (Ewers, 1955) being run into boggy ground as a preliminary step in the breaking process may sound inhumane. After all, they cannot escape and can easily be flooded with aversive stimuli because the boggy ground acts as a form of restraint. However, in a similar vein, Grandin (2007) has reported on the use of pressure all over the body and legs of unhandled horses as a means of restraining them for habituation and training. In this method, pressure is applied using wheat that is poured over and around the horse as it stands in a holding box at the end of a corral chute through which its head and neck emerge. The calmative effect of this restraint is reported to last only 20 minutes and the reason for this is not clear. However, it has been shown that preventing mobility by restraint can cause habituation to aversive stimuli (Baum, 1970). Further investigation of the role of overshadowing in this and other methods of achieving full body restraint is needed. There is a clear link between the prevention of locomotory responses and the development of habituation to aversive stimuli. This would help to explain the mechanisms that underpin hobbling techniques in the early training of dairy cattle, horses, and elephants.

Conclusions

There are numerous questionable practices in current equitation. It is usually, but not always, easy to see why they might work, but the ethics and sustainability of their use are subject to ongoing debate. Some practices will have to be abandoned or adapted, whereas the usefulness of others will have to be confirmed, regardless of whether they are in expert hands. As science gathers data that inform the debate, the welfare of horses will become more evidence-based and less a matter of opinion. The golden age of horsemanship may yet come.

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