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Cutting to the chase: How round-pen, lunging, and high-speed liberty work may compromise horse welfare

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ABSTRACT

Round-pen, lunging, and liberty training has grown in popularity in recent years in a number of equestrian contexts, due in part to the popularity of contemporary training methods and colt-starting competitions. When well applied, the round-pen can become a classroom, but when poorly applied and without an understanding of learning theory, training in the round-pen or on a lunge-line can pose significant risks to both horse welfare and handler safety. The most serious problems arise when exceeding optimal and safe thresholds of arousal in the horse, which can be detrimental to both human safety and horse welfare in at least 2 ways. First, through the appearance of conflict (e.g., behaviors indicating that the horse is not managing stress-inducing circumstances well) and defensive behaviors that are often associated with a flight response. Second, there is a risk of increased resistance to extinction of flight behavior and the subsequent spontaneous recovery of high levels of arousal and dangerous behaviors. Thus, if the arousal levels are very high, learning and performance are repressed. When arousal levels are insufficient to engage the horse (i.e., acquire and maintain its attention), learning and performance may also be inhibited. Thus, there is an optimal threshold level of arousal where learning can be optimized, and such thresholds are likely unique for individual horses. The precise range of these arousal thresholds is yet to be identified. It therefore follows that in the absence of this information, trainers should adopt a precautionary conservative principle and avoid high arousal levels. Doing so, coupled with optimal application of knowledge of learning theory, can make the round-pen or lunge-line as a safe and useful addition to the horse's training. To minimize the risks associated with training in the round-pen and working horses on a lunge-line, training goals, lesson plans, and training methodologies must apply scientific knowledge on equine ethology, cognition, and learning. Given recent increases in scientific interest in round-pen training, now is an appropriate time to discuss good practice in the context of lunging, round-pens, and other training techniques that may involve the chasing of horses. This review examines current usage, potential risks to horse welfare, and how to ensure training using these methods fosters positive learning outcome and promotes horse welfare.

Introduction

The use of circular pens in horse training is thought to date back at least as far as Roman times (Waran et al., 2002). Compared with rectangular enclosures, circular pens have the advantage of no corners. This reduces the possibility of horses stalling (becoming immobile) in a corner, thus impeding the flight response and increasing anxiety and arousal levels. Flooding is a training technique where animals are forcibly subjected to an aversive stimuli, such as a frightening object or noise, without the possibility of escape. This technique is extremely stressful for horses and is not recommended (Pearson, 2015). With both lunging and round-pen work, escape learning—where the horse is released from the pressure exerted by the trainer's physical presence by removing itself from the situation—is thwarted. The animal moving around the perimeter learns that it is unable to increase distance between itself and the person in the center of pen urging the animal forward.

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This allows the trainer to use subtler postural cues without the need of moving physically close to the horse, which may inadvertently increase pressure to the point of chasing. Round-pens enable the trainer to remain predominantly in the center of the enclosure and to use variations in their posture to both elicit and negatively and positively reinforce acceleration, deceleration, and changes of direction through the addition or removal of primary and secondary reinforcers (e.g., ceasing to urge the horse forward, as well as verbal secondary reinforcers) (McLean & Christensen, 2017).

Given the ease with which trainers can chase the horse, even inadvertently, in the round-pen and on the lunge-line, to justify the potential risks of injury and compromise of horse welfare associated with chasing, the intended aim of the activities needs to be clearly defined and assessed against the principles of learning theory (McGreevy and McLean, 2007) and ethical equitation (Jones & McGreevy, 2010). One of the major welfare risks associated with chasing in the round-pen, on the lunge, or during high-speed liberty training may reflect the absence of consensus on how to identify optimal arousal thresholds. Yerkes-Dodson's Law (Dodson, 1915) describes a model of optimal arousal thresholds for learning and performance in animals. Optimal arousal levels are likely to show considerable variation between horses. For example, there may be breed and sex differences as well as experiential effects in individual horse arousal thresholds.

In the 1990s, round-pen practitioners believed that round-pen training techniques were based on equine intraspecific interactions with the implication that the trainers' actions are interpreted by the horse similarly to those that arise in social interactions among free-ranging horses (Anderson, 2010; Balyley & Maxwell, 1996; Maxwell & Sharples, 1998; Parelli, 1993; Roberts, 2001). This belief continues to be promoted by some trainers (Kydd et al., 2017), and many horse people have extended this notion to imply that these interactions are based on "respect" (ISES, 2017). More recently, and popularized by "New Age" trainers and colt-starting competitions, such as *The Way of the Horse* (Australia) (Events, 2016) and *The Road to the Horse* (USA) (Bland, 2007), the round-pen has been considered an essential element of foundation training of horses. Colt-starting competitions began in Texas in 2003 with an event called the "In A Whisper Challenge." These competitions have developed into a form of entertainment at many large equine events and involve training unhandled horses from a first contact to riding an obstacle course or freestyle pattern, in a limited time frame (often 3 to 5 hours) and in front of large audiences. All the early training in these events takes place within a round-pen, one for each contestant, situated within the main arena of the event. However, in such competitive atmospheres, significant concerns for horse welfare are raised by the possibility of horses being aroused to the point of distress by accelerating cues from the handler (Loftus et al., 2016). Many advocates of the round-pen also recognize that the round-pen can be misused, and its use is problematic in the hands of novices (Kydd et al., 2017; Roberts, 2001). High levels of horse arousal in the round-pen can greatly increase the risk to horse welfare. Several factors such as the use of accelerating pressures and cues, the trainer's level of experience, the timeliness of application of negative reinforcement, the use of positive reinforcement, the horse's level of education and prior experience, and the physical construction of the pen itself all contribute to best practice round-pen training.

While round-pens can be valuable in horse training because of convenient geometry that restricts the horse's ability to increase its distance from the handler in the center, it is essential for horse welfare that all interactions within them be predicated on adherence to the ISES principles of training (ISES, 2015). These principles are derived from the current scientific understanding of equine ethology and learning. In the current review, we refer to the adherence of these principles when using the term "ethical training."

Common uses and potential risks

Commonly used lunging, round-pen, and high-speed liberty techniques carry potential risk factors to both the horse and the handler. The physical construction of the round-pen, any assumptions made concerning the horses' underlying motivation for particular behaviors, the physical fitness level of the horse, and the intended lesson can all pose a potential risk to both horse welfare and trainer safety when not properly addressed.

Educational—lunging, liberty, and round-pen techniques

While horses' behavior in the round-pen has previously been believed to reflect intraspecific interactions, a more parsimonious explanation would simply describe these interactions as an expression of the horse's natural ethogram with some learned components. Therefore, instead of interpreting the delayed or nonemergence of trainer's desired responses as a lack of respect on the horse's part, a more appropriate explanation in terms of training is that this noncompliance is simply a manifestation of an incorrect response (ISES, 2017). Misinterpretation of horse behavior in training can encourage undesirable reactions in trainers (Abbey and Randle, 2016) when using the round-pen, lunging, and high-speed liberty work, such as more vigorously sending the horse away and possibly provoking increased and above optimal flight response. A number of studies (Warren-Smith and McGreevy, 2008b; Koster et al., 2009) clearly show that, when alone in the round-pen, there is no evidence that unfamiliar horse dyads pursue each other and demand "respect," indicating that trainers claiming to interact with the horse as a herd leader or herd member are misinterpreting the horse's behavior. Space, like other resources, is something that horses value more or less, and there are simpler reasons than lack of "respect" for horses' lack of compliance with the trainer's commands in a round-pen. None of the possible reasons indicate the need for excessive arousal levels or so-called "dominant" body postures. It is possible that fear is mistaken for disrespect and pushing the fearful horse away, thereby further increasing arousal levels, is unlikely to alter the behavior. Such "dominant" body postures have been found to discourage horses from approaching trainers and others, which may further exacerbate the flight instinct (Smith et al., 2018).

Erroneous assumptions about the attitude of disadvantaged school students and the reasons for any perceived lack of respect and motivation have been found to have a detrimental effect on student learning (Sullivan et al., 2016). Similar problems arise in the horse-human dyad. Users of the round-pen and lunging often claim that their primary aims of use include training "respect," instilling trust, asserting "dominance," and achieving leadership. However, because these notions lack evidence and can promote techniques that can jeopardize welfare (ISES, 2017), it is important to point out that the most significant aim of round-pen training should be to establish stimulus control in the horse. This simply means to establish cues that enable behavioral control. Because of the attendant negative welfare implications, the terms "respect," "trust," "dominance," and "leadership" should be replaced in the horse training literature by the concept achieving stimulus control of the horse, or obedience. Obedience can be defined as an immediate response to a light signal or cue (McGreevy and McLean, 2010). Obedience can be trained in a clear and systematic manner following the Principle of Learning Theory in Equitation as set out by the International Society for Equitation Science (ISES, 2015).

Risk to the rider/handler

It has been suggested that risks to the handler increase when training moves further away from principles of ethical training because when this happens, the horse is most likely to become confused, frustrated, and anxious (McGreevy et al., 2014). These outcomes may increase the chance of the horse kicking or striking at the trainer. Kydd et al., (2015) found that amateur trainers elicited significantly more conflict behaviors from the horse during round-pen training than professional trainers. It is possible that amateur trainers are missing some of the subtler behavioral signals exhibited by the horse, which could lead to the increase in conflict behavior. Professional trainers are also likely to be more skilled at, not only administering minimal necessary levels of pressure but also releasing that pressure in a timely manner.

A fear-induced flight response, characterized by a high head position, lordosis, vocalization, escape attempts (Wilk and Janczarek, 2015), outward focus, and rapid variable ear positions, may not be recognized as such by the amateur or inexperienced trainer and could become established as a context-specific response. When the horse is believed to be under the stimulus control of the trainer because some of the desired behaviors are learned, but during the same training session the horse is also exhibiting a fear-induced flight response, a similar flight response is likely to occur in this context in the future. This pattern may increase risk to the rider when the horse is under saddle. Future studies examining the stress response to training in an entertainment environment need to measure these behavioral indictors and not rely solely on 1 physiological parameter.

There are some specific risks to handlers that arise in round-pen and high-speed liberty training. In contrast to working with the horse in hand, working at liberty in round-pens increases the physical risk to the trainer because the horse is freely able to move around the pen. Behavioral indications of fear, confusion, or frustration are sometimes difficult to differentiate from the normal raised arousal levels of the various gaits. When trainers fail to recognize these signs (Wilk and Janczarek, 2015) in the horse, they may subsequently fail to reduce the pressure they are applying to the horse (Henshall and McGreevy, 2014). This error can put the trainers at risk of the horse's aggressive or defensive behaviors. Data on human death and injury arising from general horse handling reveal are alarming, and most death or injury is preventable (Hawson et al., 2010). Handler inexperience can also severely limit training success and may inadvertently introduce additional, undesirable responses in the horse, such as unwanted flight response.

Round-pens have become increasingly popular since the first colt-starting competition, "In A Whisper," was held in Fort Worth, Texas (Michaelson & Litchie, 2002). These competitions, whether intentionally or not, give the impression that horses can be successfully and safely started in 3 to 8 hours (USA's *The Road to the Horse* and Australia's *The Way of the Horse*). This belief ignores the importance of exposing the horse to a range of environmental stimuli under saddle that is essential for a safe and calm riding horse. While they are mostly about entertainment, these competitions nevertheless offer a forum from which many horse owners and trainers draw information. The implication that anyone can rapidly change a horse's behavior through round-pen training puts many horses at risk from injury and can catalyze myriad behavioral problems resulting from poor training techniques.

An additional risk, unlikely to be immediately apparent, arises when the trainer assumes that the horse has learned the lessons that the trainer believes are being taught. If the horse has been inadvertently chased and becomes fearful but shows a decline in flightiness, it is possible that the horse has not been behaviorally conditioned but is either too tired to respond or expressing a passive coping strategy because active coping strategies such as escape have been thwarted. This outcome is likely for some horses in colt-starting competitions. It is a mistake to assume that lessons learned under the pressure of competitive training could be considered in any way optimal foundation training. Misuse of the round-pen with inaccurate incompetent training techniques is likely to result in poor learning outcomes that are context specific and not generalizable to other circumstances.

While Krueger (2007) trained horses to follow the trainer in the round-pen after 30 minutes of chasing around the round-pen, this behavior appeared to be context specific in that it did not transfer to the field. Krueger (2007) was unable to conclude that the new relationship between the horse and the handler was one of the trainer's "dominance" and the horse's relative "submission." It should be pointed out however that not all components of the interrelationship between the author and the horses were tested. No physiological measures, such as cardiac or cortisol measures, were taken, and the horse's behavior was not observed, recorded, or compared before, during or after the lengthy chasing bout. All high-speed liberty work, lunging for lengthy periods, and round-pen training put the horse at risk of being chased. Chasing the horse and thereby encouraging innate flight response is in direct contradiction of the International Society for Equitation Science training principles (ISES, 2015). High levels of stress have been found not only to inhibit learning but also to negatively impact motivation, making it increasingly difficult to successfully reward the horse with a release of pressure (Olczak et al., 2016).

Running and often chasing in circles, whether in the round-pen or on the lunge, is frequently used as a means of expurgating postinhibitory rebound (getting rid of a horse's extra energy), often after a period of confinement (Freire et al., 2009). If overdone, such "training" can lead to the horse beginning the actual lesson physically and mentally tired, an outcome that can reduce learning capacity (Goodwin et al., 2009). Learning theory predicts when a pattern is established—here, a habit of lunging or running the overenergized horse before riding it—the horse can learn to buck, bolt, or become hyperactive when first ridden, if not corrected through regaining locomotory stimulus control (ISES, 2015). Once established, this pattern may become habitual and present a significant problem under saddle. Remediation of the response may expose the horse to the risk of being punished for the very response that the pattern in the round-pen or on the lunge-line has, however inadvertently, established.

Deleterious effects on horse welfare

Perhaps, one of the biggest risks to horse welfare arises when a training philosophy encourages anthropomorphism. Anthropomorphic explanations of animal behavior characterize human history and are appealing because they offer explanations that are inherently conceivable to most humans, in the absence of formal studies in animal learning processes. Anthropomorphic interpretations of equine responses, such as laziness and "dominance" in lunging and in the round-pen, are therefore commonplace (McGreevy et al., 2009). Unfortunately, punishment is often used in horse training and is a particularly inappropriate response to noncompliance. If handlers maintain that the purpose of lunging or round-pen training is to gain "respect" or become the "leader" or the "dominant" one, any response that appears to fail to align with or to jeopardize this outcome can elicit punishment. Manifestation of perceived "dominance" can quickly lead to the horse being labeled as not merely "stubborn" but even "arrogant" or "rude" (Anderson, 2010) but can additionally transform the way the horse is regarded and therefore treated. Roberts, 2001 warns that

abuse is more likely to occur under these conditions. Again, we insist that for optimal learning outcomes, noncompliant behavior is more accurately seen as training failures and lack of stimulus control or obedience. Lloyd Morgan's canon, one of the most significant tenets in behavioral science, asserts that parsimonious explanations of animal behavior are always preferable: "In no case is an animal activity to be interpreted in terms of higher psychological processes if it can be fairly interpreted in terms of processes which stand lower in the scale of psychological evolution and development." It is proposed that solutions to problem behaviors are to be found in ethical training and in particular the correct use of operant and classical conditioning.

The way that any individual horse reacts to being forcefully sent forward during lunging or round-pen training may differ depending on factors such as the horse's breed (Wilk & Janczarek, 2015), age, temperament, and prior training. The chief concern is that training techniques that encourage eliciting flight response and rely on fear as a motivator may compromise horse welfare and actually reduce training efficiency. Escape is thwarted, as it will be when the horse is attached to the handler by a line or confined to a round-pen, and the horse has no choice but to flee forward. In the hands of a naïve or inhumane trainer, the challenge for the horse is to learn how to respond correctly (i.e., to comply) before fatigue or alternative active or passive coping strategies set in. It is likely that the horse does not know the trainer's goals and further likely that the highly aroused horse does not understand that the trainer is not a predator.

We believe that if the horse is not worked into exhaustion, when the pursuing pressure in lunging or in the round-pen is unrelenting, horses may escalate their attempts to flee. When active coping fails under these circumstances and the horse is unable to escape, an alternative coping strategy may be sought. Some horses may adopt passive coping, behaviorally characterized by decreased vigilance and responsiveness, which may then be anthropomorphically interpreted as obstinacy or laziness. Continuation of the inescapable stressor or regular exposure to it may result in learned helplessness (Hall et al., 2008). This could manifest as a more permanent apathy and disengagement with the environment (including the trainer) but again can be misinterpreted as stubbornness and lead to punishment for noncompliance.

The round-pen is often used to desensitize the horse to novel or aversive stimuli. This is especially prevalent in colt-starting competitions (Bland, 2007) where horses are routinely subjected to flooding of both the human and the environment in that they either are restrained in the pen with a lead-rope in high arousal states or, when simply too fatigued to flee, are forcibly exposed to the aversive stimuli (McGreevy & McLean, 2010). Passive coping is apparent in these circumstances when these horses are described as anything from "dull" (McGreevy & McLean, 2009; McLean & Christensen, 2017) to "bombproof" (Anderson, 2010). The passive coping strategy adopted by some horses in such cases may also be context specific and result in a serious risk to horse and rider safety when the horse encounters similar aversive stimuli in a novel situation.

Poor training techniques pose a welfare risk to the horse, whether being worked in the round-pen or any other environment (Henshall & McGreevy, 2014). One reason the round-pen has been viewed cautiously in equitation science circles (McGreevy & McLean, 2007) is the significant risk that trainers, most notably novices, may use this arena inappropriately (Kydd et al., 2017). The physical shape of the round-pen makes it easy to forcefully chase the horse, and a trainer must be acutely aware of this when they are applying and releasing pressure. The flight response that is not subjected to extinction and shows spontaneous recovery may be difficult to recognize because these largely unexplored arousal thresholds are likely to show individual variation. Characteristics of a chased horse include a high head carriage, lordosis, rapidly moving ears, and an outward focus away from the trainer while traveling at a high-speed, higher adrenaline gait such as canter (Wilk & Janczarek, 2015).

It is a fundamental principle of animal learning that horses repeat the behaviors that are regularly reinforced. Chasing the horse in any environment will elicit a fear response. Practicing this flight response in the round-pen helps the horse to establish flight as an available response to novel cues later in training (McLean & McGreevy, 2015). Chasing the horse can result in the horse becoming generally fearful of the trainer and other horse-human interactions. Not only is this fear response resistant to erasure, it may generalize to other humans and other environmental contexts but the simple anticipation of such activity has been shown to increase the arousal level in other species (Gillette et al., 2011). Trainers should therefore adopt a precautionary conservative principle and elicit as minimal a level of arousal as possible and remain conscious of the horses' effective state to optimize learning outcomes during training (Starling et al., 2013).

Ethical approach—equitation science based

Lunging and the round-pen can be used, with a knowledge and understanding of equine learning abilities, simply to exercise the horse. In countries where weather or management practices dictate that horses be kept indoors, lunging and round-pen work can be used not only to exercise the horse but also to decrease post-inhibitory rebound effects (McGreevy et al., 2007). When horses have well-trained in-hand deceleration and acceleration responses, they can be kept at minimal levels of arousal during lunging and round-pen work by correcting them when they randomly accelerate or decelerate out of stimulus control. In addition, when horses are already under consistent stimulus control, lunging can be used as a technique for physical development effects such as in dressage.

Lunging and the round-pen can also be places where horses can learn important responses in a safely enclosed environment. Negative reinforcement is the most common form of reinforcement in horse training (Ahrendt et al., 2015; McLean & Winther Christensen, 2017; Murphy & Arkins, 2007) and, when applied correctly at the beginning of the horse's education, can effectively train the horse to trial solutions as soon as pressure is applied. In the round-pen, negative reinforcement can be used to train specific responses and low levels of pressure can easily be applied and removed while the horse continues to travel forward. This reduces the likelihood of the horse being unable to escape and thus reduces the risk of panic and the dangers associated with increasing arousal levels. In lunging and the round-pen, horses can acquire further levels of stimulus control through voice cues or human gestures, thus extending the horse's repertoire of cued responses.

Introducing negative reinforcement—training patterns

Consistent and correct use of negative reinforcement is imperative in ethical horse training where physical pressure on the horse's body is used (McGreevy & McLean, 2007; McLean & Winther Christensen, 2017). Rein tension and leg and seat pressure, together with the use of whips and spurs, are all forms of negative reinforcement which, in light of knowledge of equine learning, should be applied only if necessary and released as soon as the horse responds correctly, to ensure optimal learning. The round-pen possibly allows negative reinforcement to be introduced to the horse in a safe and controlled environment. An example of this would be the training of acceleration and deceleration, which is of fundamental importance. Most dangerous behavior responses

occur because of pain, fear, and overarousal and become especially problematic when the horse accelerates out of stimulus control and fails to respond to deceleration cues. Chasing the horse at liberty, in the round-pen or on the lunge-line, can result in such dangerous behaviors, as can a variety of physical and emotional factors such as fear, pain, confusion, and frustration. In-hand work in training deceleration responses is therefore the most important safety lesson that the horse should learn, and the round-pen is an ideal place to begin. This may begin with training the horse to take a single step in reverse, which musculoskeletally is synonymous with all deceleration responses (McGreevy and McLean, 2010).

Another early example can be seen in training the young horse to turn clockwise and counter-clockwise at liberty in the pen (Lyons & Kirkham, 2012). The most humane way to introduce negative reinforcement in the round-pen may be to train acceleration, cuing the horse forward and releasing pressure when the horse moves forward. This can be followed by training turns, initially only small approximations of a turn and rewarding each one by immediately removing pressure (Lyons & Denison, 2002). If the foundations have been properly laid, full turns can be very easily shaped, by releasing pressure when part of a turn is accomplished and building on that movement. Round-pen training and lunging are often the first context in which horses are formally educated, and it is important that these experiences in these contexts are not accompanied by chasing, elicitation of the flight response, and excessive arousal levels. Learning appears to be optimized when arousal levels are minimally elevated (Fenner et al., 2017).

Starting under saddle

When the criteria for construction safety are met, the round-pen provides a safe place to start horses under saddle when used by an effective and humane trainer. This training begins with habituation to tack, training acceleration, deceleration, and directional control, first in-hand and then often with long-reins or lunging, and finally, the first several short rides can take place in the round-pen. Once the horse is under the stimulus control of the rider and stop, go, and turns are established, it is appropriate to ride the horse in a larger area such as an arena (Lyons, 2003).

Problem solving

When horses adopt unwanted and dangerous behaviors, such as bucking, their welfare is often at risk as it can lead to the horse being punished (McLean & Winther Christensen, 2017; Waran & Randle, 2017). A well-proportioned round-pen allows the trainer to address unwanted behaviors in a relatively safe environment while remaining on the ground at a safe proximity to the horse. If a rider were to be unseated by bucking, it would result in an immediate release of pressure, reinforcing the bucking response. Flight response behaviors such as bucking can be learned in just 1 trial. Horses may be inadvertently trained to buck when first saddled or when cued to canter on the lunge or in the round-pen before the riding phase. Such context-specific learning may occur in a round-pen and is more likely to occur when horses are chased in these situations as bucking often accompanies flight. To suppress this response, bucking can be overshadowed via well-established downward transitions or turning to the inside in the round-pen with the trainer safely on the ground (Fenner, 2009). By overshadowing the bucking response with well-trained responses that are under clear stimulus control, a competent trainer can quickly diminish the bucking response without ever having to resort to punishment or attempting to correct the behavior under saddle. That said, if a horse does not buck in the round-pen/at liberty/on the lunge, it will not necessarily transfer this nonbucking behavior to the ridden context.

Ridden work

First rides on horses during foundation training are best undertaken in an enclosed area (McGreevy & McLean, 2010) with enough room for the horse to move freely. First rides should be short and concentrate on reinforcing and shaping go, stop, and turn as well as mounting and dismounting. The context-specific characteristic of training the horse in a familiar yard and with less visibility of external distractions also adds to the safety of foundation training.

Minimizing risk

Minimizing risks associated with physical constraints

When properly constructed and used, the round-pen can be a safe place for a skilled trainer to handle horses (Lyons & Kirkham, 2012). A round-pen of 18 to 20 meters in diameter is anecdotally reported (Lyons & Kirkham, 2012) to be sufficient to protect the horse from musculoskeletal damage. However, there is no empirical evidence to confirm the safety of working horses in pens of this size. In an 18-m diameter round-pen, approximately 20 circuits equal 1 km. In just 20 minutes of lunging or round-pen work, a horse may cover around 5 km in distance which, as we postulate, poses musculoskeletal risks due to the constant circular track. Therefore, round-pen/lunging sessions exceeding 20 minutes should be avoided. Trainers should also be cautious of overexercising horses in round-pens and on the lunge because of potential physiological damage, especially if the horse is side-reined with its nasal planum behind the vertical. Respiratory and cardiovascular system compromise occurs in such cases because of the reduction in airways that accompanies such postures (Zebisch et al., 2014).

It is important that a round-pen surface provides traction and maintains integrity when the horse turns (Chateau et al., 2013; Pearce & Bayley, 2001). Synthetic surfaces, originally designed for racing and now commonly used for show-jumping, are ideal, but it should be noted that high-speed locomotion in the round-pen is largely contraindicated. For young and inexperienced horses or those with a history of being chased, the pen should be of a solid construction and over 2 m high to safely accommodate even those horses that may have inadvertently been put under too much pressure (Lyons & Kirkham, 2012). Being able to get its head over the top of the pen increases the likelihood of an anxious horse attempting to jump out of the pen as an escape response because, unsurprisingly, horses have been found to be less likely to voluntarily jump higher obstacles than lower obstacles (Gorecka-Bruzda et al., 2013). That said, when the round-pen is used for well-trained, experienced horses, the panels may be lower than 2 m. Parelli (1993), for example, advocates the use of low panels on the round-pen for horses trained in his system where liberty work arises as a progression from prerequisites on the long (lunge) rope/line. His insistence on low panels is to deter trainers from using too much pressure to cause horses to jump over the round-pen sides.

Round-pen size is also important because a small pen increases the trainer's proximity to the horse, which could increase anxiety levels in the horse. Whether schooling at liberty or on a lunge-line, a minimum diameter of 18 m should allow the trainer enough space to move away from the horse to release some of the pressure of proximity. When using an 18-m round-pen, experienced trainers can stand far enough away from the horse to avoid exerting pressure inadvertently and can also provide sufficient release from pressure to deliver timely reinforcement. The trainer can remain in

the center of the pen if required and, to motivate movement, can use an extension device, such as a rope, lariat lunge-line, or lunge-whip, without ever having to move toward the horse.

Minimizing risk with trainer education

As explained earlier, one of the most positive aspects of the round-pen is its lack of corners so that the horse never feels trapped. Similar to lunging, from the training point of view, the circular track of the round-pen means that the trainer is always able to increase, decrease, or maintain his distance to the horse with only a step or 2 steps. Paradoxically, this latter feature is also one of the negative aspects of lunging and round-pen use because it makes it extremely easy for the trainer to induce excessive levels of arousal in the horse. In the hands of an inexperienced trainer, a horse can easily be overwhelmed because it is difficult not to chase the horse. Therefore, one of the dangers lies in the possibility of conflict behavior escalating because of confusion acquired in lunging or the round-pen. When a lesson aim is unclear, ambiguous, or open to misinterpretation, such as teaching "respect" or asserting "dominance," aggression from the trainer manifesting as raised levels of arousal is often the end result.

Trainers must be clear on the precise learning outcomes of each round-pen lesson. Anthropomorphic interpretations of behavior need to be replaced with language based on the consistent reinforcement of responses as embodied in the notion of obedience to cues. Running around the lunge or round-pen may simply waste limited energy that could otherwise have been used to educate the horse appropriately and more precisely. A round-pen lesson aimed at training the horse to accelerate, decelerate, or turn, for example, using negative reinforcement, has clear and measurable outcomes, whereas the putative goals of gaining respect or becoming herd leader are arguably less attainable simply because they are vague and subjective. Lessons at sufficiently low arousal levels focused on reinforcing acceleration, deceleration, and alterations of direction and training the horse to trial mobility responses to release pressure. In the round-pen, the pressure is exerted from a distance by the trainer's acceleration, deceleration, or turning cues, but this training of locomotory responses may transfer to ridden contexts later in the horse's education when the horse trials locomotory responses to receive a release of bit or leg pressure.

Educating trainers and handlers in the fundamental principles of learning theory (Starling et al., 2016) has the potential to minimize the risk associated with lunging and round-pen training to the human. When the trainer not only understands how the horse learns but also enters the round-yard with a clear lesson plan and aligned objectives, the horse is considerably less likely to become fearful, confused, or frustrated. In 2008, Warren-Smith and McGreevy (2008a) found that knowledge of learning theory among trainers and coaches was sparse. With the more widespread acceptance of the informative benefits of Equitation Science, now might be a practical time to introduce the subject of learning theory to national coaching examinations.

The round-pen can be a safe place to introduce horses to training when used by experienced handlers who are less inclined to chase the horse (Kydd et al., 2017; Kydd et al., 2015). When negative reinforcement is applied with tact and subtlety, the horse learns to trial new responses that deliver release of pressure (Lyons & Denison, 2002). Locomotory responses are fundamental to early training because without the ability to control acceleration and deceleration in particular, the horse's speed and direction become random, leading to increased stress during training sessions (McGreevy and McLean, 2010).

Training new behaviors in incremental steps simplifies lessons for the horse and is a further way to avoid compromising welfare. It is not appropriate to flood the horse during lunging or in the round-pen, for example, saddling a naïve horse, and allowing the horse to "buck it out" especially if this is repeated. This presents a risk to horse welfare during the training period. Lessons incorporating the introduction of new tack need to be structured into smaller steps, habituating the horse to each item of tack gradually and allowing the horse the time to accept novel tactile, auditory, and visual stimuli (McGreevy & McLean, 2010).

Minimizing risk with horse selection

Horse age, temperament, and training history must be considered before engaging in round-pen training at liberty. Extremely nervous horses will be more at risk of high and unacceptable levels of arousal than their calmer counterparts. However, the type of training is possibly even more important than experience *per se*. Horses that have previously been chased in the round-pen or on lunge-lines will require counterconditioning (McGreevy & McLean, 2010) before any structured liberty work can safely commence or resume.

While trainer experience is clearly important (Kydd et al., 2015), Wilk and Janczarek (2015) conclude that behavioral assessments alone cannot adequately reveal the emotional status of horses being worked in the round-pen. These researchers found it impossible to assess the emotional reactions of horses based solely on human body gestures due to lack of significant correlations between behavioral responses, heart rate, and heart rate variability parameters (Wilk & Janczarek, 2015). Many New Age training techniques use behavioral responses to assess learning outcomes. For example, the trainer is sometimes considered to have been accepted as a herd leader when the horse shows behaviors such as head-lowering, licking, and chewing. However, the precise mechanism behind these behaviors is not yet fully understood and requires more research. For example, it has been found that when handled by amateurs, horses showing submissive behaviors such as head-lowering, licking, and chewing also exhibited more conflict behavior than horses not exhibiting these behaviors (Kydd et al., 2017; Kydd et al., 2015). By contrast, horses that were worked by professional trainers showed fewer conflict behaviors and less head-lowering, licking, and chewing. These researchers concluded that amateur trainers likely induced more stress in their horses, which may have led to an increase in conflict behaviors, head-lowering, licking, and chewing. Trainer experience was found to be predictive of both conflict and submissive behaviors (Kydd et al., 2015; Starling et al., 2016). In addition, Wilk and Janczarek (2015) found significant breed differences in head-lowering behavior and concluded that these responses were not a useful assessment tool in all horses. The round-pen, like any other training tool, can become an effective classroom or a source of fear and confusion, depending on the nature of the learning experience and the methodology used. Fear-induced arousal can be difficult for any horse trainer to recognize, and therefore, the precautionary conservative principle should be maintained in horse training. Excessively accelerating horses on the lunge or in the round-pen should always be avoided because high arousal states and flight can quickly become default responses when learning any new behavior in the future.

Conclusion

When training aims and methodology have been properly considered and aligned, the round-pen can be a useful and safe place for foundation training for the horse and rider. However, when poorly applied, training in the round-pen can pose significant risks to both horse welfare and rider safety. Given recent increases

in scientific interest in round-pen training, now is an appropriate time to develop and recommend best practice lunging and round-pen techniques that foster positive learning outcomes and advance horse welfare.

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Conflict of interest

The authors declare no conflict of interest.

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