Journal of Veterinary Behavior (2007) 2, 108-118

ELSEVIER

Journal of Veterinary Behavior
Clinical Applications and Research

REVIEW

Roles of learning theory and ethology in equitation

Paul D. McGreevy, BVSc, PhD, MRCVS, MACVSc (Animal Welfare),[a] Andrew N. McLean, BSc, PhD[b]

[a]*From the Faculty of Veterinary Science (B19), University of Sydney, NSW 2006, Australia; and the* [b]*Australian Equine Behaviour Centre, Broadford, VIC 3658, Australia.*

KEYWORDS:
ethological training;
equine ethology;
equitation;
horse behavior;
learning theory

Abstract By definition, ethology is primarily the scientific study of animal behavior, especially as it occurs in a natural environment; applied ethology being the study of animal behavior in the human domain. The terms *equine ethology* and *ethological training* are becoming commonplace in the equestrian domain, yet they seem to be used with a conspicuous lack of clarity and with no mention of learning theory. Most of what we do to train horses runs counter to their innate preferences. This article summarizes the ethological challenges encountered by working horses and considers the merits and limitations of ethological solutions. It also questions the use of terms such as "alpha" and "leader" and examines aspects of learning theory, equine cognition, and ethology as applied to horse training and clinical behavior modification. We propose 7 training principles that optimally account for the horse's ethological and learning abilities and maintain maximal responsivity in the trained horse. These principles can be summarized as: (1) use learning theory appropriately; (2) train easy-to-discriminate signals; (3) train and subsequently elicit responses singularly; (4) train only one response per signal; (5) train all responses to be initiated and subsequently completed within a consistent structure; (6) train persistence of current operantly conditioned responses; and (7) avoid and disassociate flight responses. Adherence to these principles and incorporating them into all horse training methodologies should accelerate training success, reduce behavioral wastage of horses, and improve safety for both humans and horses.

Introduction

Although humans have been interacting with horses for many millennia through hunting, it is only relatively recently that horses have become beasts of burden and been used for transport, war, agriculture, and more recently, sport and leisure. Direct evidence suggests that horses were domesticated at around the end of the second millennium BC (Levine, 2005). Since the beginnings of domestication, various techniques for training them have been developed and handed to subsequent generations through word of mouth or literature.

It is likely that since domestication, selective breeding has reduced the hyper-reactive tendencies of the horse. That said, it has not eradicated the tendency for some horses to buck as a result of the girth pressure during foundation training. Thus, even though the percentage of horses that buck when first saddled is low, this response is still generally expected in some horses. Although it is probable that during the process of selective breeding over 4 millennia of domestication the associative learning abilities of the horse have not changed, the same may not be true for habituation. Therefore, it is proposed here that the major cognitive change that occurred during selective breeding over the millennia was the capacity for habituation. The domestic

Address reprint requests and correspondence: Paul D. McGreevy, BVSc, Faculty of Veterinary Science (B19), University of Sydney, NSW 2006, Australia.
E-mail: paulm@vetsci.uysd.edu.au

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doi:10.1016/j.jveb.2007.05.003

horse habituates readily to a wide array of environmental and social stimuli. Such an extreme ability to habituate may have been maladaptive for the wild horse.

The terms *equine ethology* and *ethological training* are becoming increasingly common in the equestrian domain and yet they seem to be used with a conspicuous lack of clarity. Among the more outrageous examples are recent attempts to establish *Equine Ethology* as a brand of training system. This is rather like a paracetamol (acetaminophen) manufacturer calling itself 'Pharmacology' or a religious sect dubbing itself 'Theology.' The term *ethologically sound training* has appeared in the scientific literature but without an adequate definition or an explanation of what constitutes ethologically flawed training. Effective and humane training *always* takes account of the animal's ethology, so there seems little need for the development of a distinct subclass of training.

It is time to set out the correct meaning of these terms and also to identify human–horse interactions that are especially reflective of ethological principles. This article explores the ethological challenges encountered by working horses and considers the merits and limitations of solutions that bypass associative and non-associative learning.

Discussions of horse–human interactions acknowledge the use of ethological techniques to some extent but have focused largely on cognitive and learning abilities. This is because purely ethological solutions are limited (McGreevy and McLean, 2006) because they are confined to the innate predispositions of the animal that humans can capitalize on to modify behavior (allelomimetic behavior, social facilitation, stimulus enhancement, and so on). By way of contrast, learning theory provides far greater possibilities to alter behavior through the non-associative processes of habituation and sensitization and associative modalities such as operant and Pavlovian conditioning. With a focus on dressage (from the French: *dresser*, to train), this article explains how equitation science may allow us to re-appraise the way all horses are trained.

Successful horse training over the millennia reflects the effective use of learning theory. Importantly, it is also likely that various training methodologies over the millennia more or less *approximated* optimal learning conditions but probably achieved viable outcomes chiefly because of the horse's abilities in stimulus generalization. This variation in efficiency is an important consideration that would explain the current high rates of wastage among domestic horses attributed to behavior problems (Ödberg and Bouissou, 1999; Von Butler and Armbruster, 1984). Therefore it makes sense to explore the horse's ethology, cognition, and learning abilities to inform the development of a set of principles of correct training. From this vantage point it should then be possible to identify behavioral disorders in any equestrian discipline that result from the abrogation of at least one of these principles.

Learning theory emerged from psychology to explain changes in behavior, beyond hard-wired physiologic and non-associative learning modalities, that are a product of reinforcement (McGreevy and Boakes, 2007). Reinforcement can be defined as that process in which a reinforcer follows a particular behavior so that the frequency (or probability) of that behavior increases (McGreevy, 2004; McGreevy et al., 2005).

Learning theory maintains that stimuli that meet the behavioral needs of animals (such as food, water, comfort, sex, and companionship) are primary reinforcers. In equitation, the horse strives to meet his behavioral need for comfort, learning all of his basic locomotory responses (including go forward, turn, go sideways, and stop/slow/go backward) through negative reinforcement (NR) (McGreevy and McLean, 2005). The same holds true for the horse's basic locomotory responses in-hand with the action of the lead rein (lead line) on his headcollar or halter.

Equitation presents a number of stimulus discrimination problems for the horse. Aside from conditioning, there are several training principles that help to enhance discrimination. These include using specific loci on the horse's body for achieving stimulus control. This goal demands correct and consistent riding posture and technique. The training principles also include the importance of conditioning or eliciting one response at a time, as well as training consistent attributes for all learned responses including the timeframe and structure of transitions. In equitation, transitions can be either inter-gait (changes from one gait, such as walk, to another, such as trot) or intra-gait (changes in speed and stride length within a gait). Both inter-gait and intra-gait transitions can be either upward or downward (e.g., from walk-to-trot or trot-to-walk), from shorter-to-longer strides or longer-to-shorter strides, or from faster-to-slower steps or slower-to-faster steps. To maintain optimum responding it is also important to train persistence of trained responses. The change is maintained until the horse is cued to offer another response. For example, in the case of a horse that has been prompted to make a transition from slower-to-faster steps, the faster steps should persist until the rider signals for the next transition. This applies to the qualities of the horse's locomotory responses such as rhythm, tempo, line, direction, straightness, and head/neck posture. In dressage, the persistence of these features is known as self-carriage: the self-maintenance of rhythm, tempo, direction, straightness, and outline (McGreevy et al., 2005). A final principle focuses on the avoidance of fearful behaviors because of their interference with learning and their tendency to show spontaneous recovery (McGreevy and McLean, 2006).

This article sets out to identify and establish a set of training principles essential for optimal learning in horses during training. It follows that these principles should diminish negative welfare outcomes associated with some current horse training practices (including inappropriate punishment, simultaneous bit and flank pressure, failure to reward appropriate responses) (McGreevy and McLean,

Table 1 Examples of regular equitation that represent environmental challenges to horses by running counter to their ethology

In-hand	Under-saddle	Comfort
• Leading/following handlers • Lunging • Entering small spaces, including trailers • Proximity to humans • Standing on moving platforms • Approaching erratically moving/sounding unfamiliar objects	• Walking, rather than running, through unfamiliar creek beds • Overhanging elements • Approaching erratically moving/sounding unfamiliar objects • Maintaining speed while travelling from light to dark areas or across uneven terrain or downhill (head is usually lowered to assist detection of the safest path) • Maintaining a fixed postural outline while changing gait • Advancing when familiar conspecifics are emitting fearful signals • Walking backward for more than a body length (i.e., entering any unfamiliar cul-de-sac that would require reversing)	• Not rolling when hot and standing in water • Walking on stony ground • Standing square for extended periods • The presence of a bit • Sweaty head covered with a bridle and back covered with a girth, saddle, and saddle cloth

2005) and allow horses to learn as efficiently as possible. Furthermore, these principles should assist in explaining the ontogeny of training difficulties and disorders, ranging from conflict behavior (responses characterized by hyper-reactivity that arise largely through confusion) to learned helplessness, especially those attributable to deficits in one or more of these principles.

Ethology

Ethology is primarily the study of animal behavior in a natural environment. It can help us understand how animals respond to environments in which they have not evolved (e.g., the human domain). More accurately, it is the study of animal behavior in the environment in which natural selection acted to shape that behavior. Given that all aspects of behavior are subject to natural selection, ethology is not merely the study of innate behaviors but also the study of how selection, both natural and artificial, has influenced learning strategies and capabilities. Natural selection will, for example, have influenced whether or not an animal learns well individually, or learns by observing conspecifics, or both. It will have influenced such variables as relative attention devoted to learning new food finding techniques versus scanning for predators.

Equine ethology describes not only communication but equine behavioral needs and preferences, learning, value systems, and motivation. It helps us to predict some of the ways horses out of their natural environment (i.e., in the domestic context) might react and cope with various challenges and how behaviorally flexible they may be. As such it underpins enlightened and effective training but is not a training system or philosophy per se.

Ethological challenges

Ethological challenges include interventions that cause horses both social and environmental distress. Examples of *social* challenges include leaving the social group, taking the lead in the company of established leaders, being close to aggressive conspecifics, walking abreast rather than trekking in a line, and ignoring displays by other horses. Enforced proximity to conspecifics can cause one horse to tread on another in ways that seldom occur in the free-ranging state. It can also be hazardous because it limits vision, such as when horses are clustered during steeple chasing. Furthermore, as jockeys well know, when galloping horses are too closely spaced, they may be prompted by their conspecifics to jump when they are not close enough to the obstacle to clear it safely.

Even when riding alone we may demand responses that naturally arise only in social contexts, contexts far removed from the manège. The collection and elevation required in higher levels of dressage, for instance, may be appropriate when horses greet one another but are ethologically discordant in isolation.

Examples of *environmental* challenges include leaving the home range, deviating from an obvious track and traversing, rather than avoiding, obstacles. Other examples of the ways in which equitation provides environmental challenges to horses that run counter to their ethology appear in Table 1.

Riding brings both social and environmental challenges and is a useful example of the way we overcome horses' innate responses and thus ignore their preferences. For example, free-ranging horses rarely maintain a fixed postural outline while changing gait. The current debate surrounding hyperflexion (Rollkür) has helped to highlight the extent to which riders can enforce a sustained, abnormal manipulation of a horse's posture and sometimes gain a competitive advantage as a result (van Breda, 2006).

Responses to physical discomfort under saddle generally have more to do with physiology than ethology. The most obvious sources of *physical* discomfort are the bit, the rider's leg/spur, the whip, the 'carrot-stick,' and the girth. This is important because there seems to be an implied

assumption that the relationship a human has with a horse on the ground is identical to the relationship when he is mounted. It is by no means certain that horses connect pressure in the mouth with the rider. They have not evolved to expect that another animal can apply pressure to the inside of the buccal cavity via a piece of metal. This cognitive aspect may account for the apparent tolerance horses show when allowing heavy-handed riders to mount them time after time. It is therefore unnecessary and inappropriate to complicate a rider's interventions by giving them anthropomorphic labels such as *asking* (e.g., asking the horse to lower his head), *encouraging* (e.g., using the inside leg to encourage forward movement), and *supporting* (e.g., outside rein to support the impulsion). It may be the intention to use words that are common in every day usage and convey an attitude of cooperation rather than supremacy but the abiding problem with the use of an anthropomorphic framework to explain rider–horse interactions is that it can disguise and justify abuse of horses that offer undesirable responses. Most horses benefit when science provides mechanistic explanations of equitation, even though some horse-lovers argue that this is undermining the bond they share with their horses (McGreevy, 2007).

Communicating ethologically

There is an appealing notion that we can apply equine social strategies to human–horse interactions, although data and scientific rigor are lacking in this domain. In the midst of social conflict among horses, it is often appeasement signals that switch off aggression (McGreevy, 2004) and thus determine the outcome. These signals may be very subtle: indeed so subtle that they are the subject of considerable debate among equine ethologists (Goodwin, 1999). Horses have rod-dominant dichromatic photoreceptors arranged in a visual streak, giving tremendous peripheral vision that contrasts with the cone-dominant trichromatic *area centralis* of humans (Evans and McGreevy, 2006). They are able to detect minute cues from animals (and not just horses) around them. It seems likely that most human signals are not necessarily interpreted as homologues of equine signals (Roberts and Browning, 1998). How crude are the signals from a human to an equine observer? With no tail, fixed ears, a short, inflexible neck and only 2 legs we can hardly expect horses to regard us as equine. The chance that we can mimic equine signaling with any subtlety seems remote. Perhaps this is partly why humans rarely claim an ability to issue appeasement signals to horses and why agonistic advances (that may facilitate putative domination) prevail. Humans who fall into the trap of assuming that they can speak the language of horses with eloquence may fail to recognize the averseness of some of their behavior and so put horses under inappropriate pressure. Ultimately, however, any search for equine analogues of human interactions with a horse becomes virtually irrelevant when a human gets on the horse's back. This point is based simply on the observation that horses mount conspecifics far more occasionally and far more briefly, in play and sexual congress.

Relating ethologically

If, when handling horses on the ground, we are to correctly exploit the social organization of Equidae in training and handling them, the distinction between so-called dominance characteristics and leadership is critical. It is important to recognize that in the equestrian context, the imposition of so-called dominance manifests as the application and withdrawal of aversive stimuli and therefore cannot be considered outside the framework of learning theory (McGreevy, 2007). There is growing distaste for the term 'alpha' because this implies domination and permanency. This trend is also found in dog-training circles, and has led to a preference for the notion of leadership. This concept of humans as leaders of horses has subsequently gained currency in equestrian contexts but brings its own set of problems. It implies that all horses that 'respect' a human as leader and have subsequently bonded to him or her will follow that human even when conspecifics are present. Leadership implies also that such bonded horses will follow humans to aversive places away from the sanctuary of conspecifics. There is no evidence in the scientific literature of these phenomena occurring. Furthermore, those who subscribe to the notion of leadership do not explain how leadership qualities can be developed. Rather, they describe operant techniques that condition some useful responses. Perhaps this area of debate would move forward if there was more intraspecific evidence of the role of learning in the acquisition of equine leadership and following styles.

Unless they have been hand-reared or subjected to excessive early handling, horses will always find conspecifics more salient than humans as leaders. Analogues drawn between human–horse interactions and elements of the equine ethogram can be tenuous. For example, it is suggested that simply being behind a horse and driving it forward (as in long-reining) is directly analogous to the herding behavior of stallions (Zeitler-Feicht, 2004). This assumption is very difficult to test but convincing evidence would include behavioral analogues in horses driven by humans of the responses herd members typically make when driven by a familiar stallion. Perhaps we should simply accept that we are, at best, caregivers and companions, and when we are not giving care and companionship, we are trainers. Conspecifics, including dams, can condition members of their social group and this activity may facilitate some later function but whether training is their intention is debatable. Although there is clearly some overlap between care-giving, companionship, and training, there seems sense in compartmentalizing them. To do so helps us approach each set of activities with clear expectations.

It has been suggested that humans can enter the social 'hierarchy' of groups of horses by mimicking their behavior, most notably through their signals (Roberts, 1997; Sighieri et al., 2003). Based on the debatable premise that a herd

is organized according to a social status established by means of ritualized conflict, this approach has grown in popularity but embodies some muddy thinking.

Consider round-pen training as an example. The merits of this type of hands-off training are purported to be that it is humane and carries with it little risk of learned helplessness. The chief appeal of this approach lies in the notion that it is possible to manage unhandled horses without coercion by mimicking behaviors from the equid social ethogram. But round-pen training does involve coercion. For unhandled horses, being approached and touched seem to lie on the same continuum of aversive interactions as being whipped, they are all interactions worth avoiding (McGreevy, 2004). Round-pen training can be ineffective insofar as achieving anything useful in human-horse interactions. Indeed, it has been proposed that horses might simply learn how to avoid being chased (Krueger, 2007), in other words, negative reinforcement. In some circumstances (with fearful horses, for example), round-pen training can be inhumane. It can precipitate chronic stress if used to condition horses into constant states of hyper-reactivity and therefore may increase behavioral wastage in the form of loss of usefulness and commercial value, a trend that can lead to euthanasia. Furthermore, rewards in round-pens often take the form of rubbing, typically on the forehead. Although this intervention may indeed be effective, it lacks ethological salience, given that allogrooming of the forehead by conspecifics is unlikely to occur compared with wither-scratching, which has been shown to lower the heart-rate (Feh and de Mazières, 1993; McBride et al., 2004). Interestingly, a recent report of responses to round-pen training states that grooming seemed to have no significant effect on the horses' tendency to follow trainers in the round-pen itself (Krueger, 2007).

A raft of questions is launched by the philosophy of human-as-leader. What if, despite embracing the notion wholeheartedly, handlers cannot persuade their horses to comply? Does it mean that the *horse* has better and more consistent leadership characteristics? If the horse fails to follow the handler into a trailer, does that simply mean the human was perceived as a poor leader? What particular aspect of the human's leadership was lacking? How can this be studied scientifically? Are there negative welfare implications for the horse that doesn't recognize any human as leader? If a third party leads the horse using negative reinforcement is he/she showing subliminal leadership?

One would expect horses that have bonded in this way and genuinely regard certain humans as leaders to seek out the company of the human leaders and forsake their conspecific affiliates. However, there is currently insufficient evidence that horses in a paddock approach humans for reasons other than mere curiosity or because they have been conditioned to do so. Indeed, it is worth noting that after 'successful' round-pen training, horses show no increase in their tendency to follow trainers (Krueger, 2007), leading us to question the use of such a potentially detrimental technique.

Ethological solutions

It has been suggested that a trainer's interactions with horses should be based on 3 elements fundamental to the equilibrium of the herd: flight, herd instinct, and 'hierarchy' (Sighieri et al., 2003). However, this approach overlooks the importance of foraging, coalitions, kinship and affiliation as well as the reality of the effects of conditioning on all innate responses. Ethologically sound solutions should not depend on a notion of the horse's benevolence—that the horse is 'wanting to be with' or 'wanting to please' the trainer. This is an ideologically unsound mindset owing to its anthropocentricity.

The importance of habituation, sensitization, operant and Pavlovian conditioning should never be underestimated because they facilitate efficient learning and underpin training techniques. They are informed by learning theory, and supported by ethology. Although most training systems use a blend of all 4 of these processes, there are fundamental gaps in the understanding and acceptance of their place in equestrian coaching (Warren-Smith and McGreevy, 2006). Studying equine ethology demands consideration of how natural selection shaped horse behavior and horse learning capacity. Training philosophies that embrace learning theory can be ethological in the sense that they might take into account the types of stimuli horses are most likely to respond to and the types of reinforcer that are most rewarding (from knowledge of ethology).

Instinctive responses predicted by ethology can facilitate horse handling without the need for deliberate training. For example, allelomimetic behavior, mimicry, stimulus enhancement, and social facilitation (McGreevy et al., 2005) are all mechanisms for changing behavior without associative conditioning. However, these are adaptive mechanisms that evolved for group cohesion and they can and do act on behaviors that may have been subject to conditioning themselves.

Ethologically-based training solutions can capitalize on 'leadership' by conspecifics and possibly even the effects of psychopharmaceuticals (including pheromones) (Falewee et al., 2006). Dressing up training systems as being forms of ethology denies the importance of learning theory and implies that we must speak the language of horse. This may be beguiling but it is an illusion ultimately.

The illusions of horse owners are generally harmless as long as they do not create unrealistic expectations. Learning theory can and should be used to explain all training techniques no matter how elaborately they are camouflaged. For example, advance-and-retreat (Blackshaw et al., 1983) is as much based on negative reinforcement as the physical pressure-release systems used in the ridden horse (McLean and McGreevy, 2004). Equitation science uses learning theory to demystify and simplify training and, although still in its infancy, it is already

Table 2 Phase 1 of training

Stimulus	Locomotory Response of Horse
Under-saddle: both reins via the bit	Inter-gait and intra-gait downward transitions
Under-saddle: both reins via the 'bitless' bridle	Inter-gait and intra-gait downward transitions
Under-saddle: single rein	Turn
Under-saddle: rider's 2 legs	Inter-gait and intra-gait upward transitions
Under-saddle: rider's single leg	Sideways
Under-saddle: both spurs	Inter-gait and intra-gait upward transitions
Under-saddle: single spur	Sideways
Under-saddle/In-hand: whip, 'carrot-stick'	Inter-gait and intra-gait upward transitions
In-hand: anterior direction pressure of the lead-rein	Inter-gait and intra-gait upward transitions
In-hand: posterior direction pressure of the lead-rein	Inter-gait and intra-gait downward transitions

beginning to show how behavioral wastage can be reduced and welfare enhanced (McGreevy, 2007).

Use learning theory appropriately

Successful equitation implicitly relies on non-associative and associative learning modalities. Habituation is an important learning modality in equitation. In the young horse, habituation defines the process whereby the horse learns to tolerate its habitat and surroundings including the people and animals within it, along with various paraphernalia used in equitation including saddlery, horse boots, blankets, and covers. The horse also habituates to the presence of a human on its back. For example, in some methodologies of foundation training, the rider might first lay on the horse's back (providing the horse remains calm), then move one leg over, then gradually sit upright (McLean, 2006).

All forms of horsemanship involve the use of the rider's legs and the reins for control of acceleration and deceleration, changing direction, and moving sideways (McLean and McGreevy, 2004). In-hand, the lead rein (lead line) and, by classical conditioning, the voice control the horse's locomotory responses. In early foundation training, control is established via NR, commonly known as 'pressure-release.' In NR, the increasing pressure (including increases in frequency of whip taps) motivates the animal to trial various responses and the removal of the pressure reinforces the desired response. The timing of the release of pressure is critical to reinforcing the correct response. Poor timing of release accounts for many behavioral problems in the ridden and led horse (McGreevy and McLean, 2005) that can manifest as conflict behaviors and may escalate into learned helplessness (McLean and McGreevy, 2004). The use of NR provides an efficient mechanism for rapidly achieving control of the horse's locomotory responses because it motivates the animal to trial a response. The use of NR can therefore be termed *Phase 1* in the training process in-hand and under-saddle.

Despite its significance and ubiquity in horse training, the meaning and use of NR is mostly misunderstood by qualified Australian riding coaches (Warren-Smith and McGreevy, 2006). There is no reason to expect that the situation would be different in other countries. The Parelli system of horse training, Horse-Man-Ship, is perhaps the most extensively marketed horse training system in the world today, and also incorrectly defines NR (Parelli, 1995). Furthermore, the full importance of NR has been overlooked in dressage texts throughout the centuries. For example, even though the expected effect of the reins on the horse is deceleration, a response that is undoubtedly trained by NR, the rein effect is described without mention of pressure or release as 'contact,' a response that is said to evolve during training. Contact in this context is defined currently as the connection of the rider's hands to the horse's mouth, of the legs to the horse's sides, and of the seat to the horse's back via the saddle (McGreevy et al., 2005). The topic of contact with both hand and leg generates considerable confusion related to the pressure that the horse should endure if the contact is deemed to be correct. That said, pressure-release effects specific to the rider's legs are more appropriately acknowledged by the contemporary and classical texts of equitation. Owing to the sensitivity of the horse's mouth, it is likely that inappropriate training of the decelerating effects of the reins can lead to conflict behaviors, stress, and wastage. Examples of conflict behaviors include bucking, shying, rearing, swerving, leaping, and bolting (Table 2).

In correct equitation, the pressures provided by the reins and rider's legs begin with the lightest pressures and smoothly but rapidly increase to a threshold that prompts a response. The initial light pressure acts as a discriminative stimulus heralding the onset of stronger pressures that approach this threshold. The subsequent release of pressure reinforces the correct response and then, through classical conditioning, the discriminative stimulus (the light aid) becomes the trigger that alters the horse's locomotion. We propose this transformation be termed *Phase 2* of training. Ultimately, stimulus control of all locomotory responses, both in-hand and under-saddle, should be achieved via these light aids: the diminutive version of the original rein or leg pressures (Table 3).

Further discriminative stimuli, such as the seat, posture, and voice, can achieve stimulus control. Again, these are

Table 3 Phase 2 of training

Discriminative Stimulus	Locomotory Response of Horse
Under-saddle: light reins (both) via the bit	Inter-gait and intra-gait downward transitions
Under-saddle: light reins (both) via the 'bitless' bridle	Inter-gait and intra-gait downward transitions
Under-saddle: light single rein	Turn
Under-saddle: light legs (both)	Inter-gait and intra-gait upward transitions
Under-saddle: rider's single leg	Sideways
Under-saddle: light spur (both)	Inter-gait and intra-gait upward transitions
Under-saddle: light single spur	Sideways
In-hand: anterior direction light signal of the lead-rein	Inter-gait and intra-gait upward transitions
In-hand: posterior direction light signal of the lead-rein	Inter-gait and intra-gait downward transitions

acquired through the process of classical conditioning. Because the stimuli in this case are not related directly to the diminutive versions of the original pressures, we propose their emergence as discriminative stimuli be termed *Phase 3* of training (Table 4).

It is important to recognize the characteristics of the 3 phases of training and the different mechanisms of learning (NR and classical conditioning) they use. Although desirable responses can be classically conditioned, many undesirable responses can also emerge if the basics are not established unequivocally at Phase 1.

The 3 phases of training can be summarized as follows:

- Phase 1 – Trial-and-error (operant) learning where the horse learns the correct response to the pressure stimulus;
- Phase 2 – Shrinking the pressures used in pressure-release training so that they become light versions of the same stimuli; responses are now under stimulus control; and
- Phase 3 – Classical conditioning of light signals to other unrelated cues; this is the phase where new cues achieve stimulus control.

All equestrian disciplines involve progressive improvements in responses deemed correct and desirable by trainers. These improvements are the result of the process of *shaping*. Shaping can be defined as the successive approximation of a behavior toward a targeted desirable behavior through the consecutive training of one single quality of a response followed by the next (McGreevy et al., 2005). In European and traditional 'English' equitation, shaping involves the gradual refinement of responses culminating in a ridden horse that gives the impression of a free, rhythmically moving horse with a 'rounded' outline that follows the rider's line and cues with precision and without tension or resistance. These characteristics involve the progressive shaping of the following qualities:

1. Reinforcing the correct locomotory responses through trial and error learning (principally NR);
2. Placing the locomotory responses under the stimulus control of the discriminative stimuli of the appropriate light signals of the rein(s), lead, or rider's leg(s);
3. Achieving desired responses within a distinct time-frame and locomotory structure;
4. Achieving persistence of rhythm and tempo of locomotory responses;
5. Achieving persistence of line and directional locomotory responses;
6. Achieving persistence of the horse's head, neck, and body postures; and
7. Achieving all of the above qualities in different environments ensuring that the horse is consistently under the rider's or handler's stimulus control in the face of other aversive and potentially controlling or overwhelming stimuli.

For optimal learning, unrealistically large incremental improvements must not be expected and shaping must use consecutive steps so that the horse is not overwhelmed by inappropriate demands that can contribute to stress and possibly learned helplessness.

Table 4 Phase 3 of training

Classically Conditioned Stimulus	Locomotory Response of Horse
Under-saddle: 'bracing' seat	Inter-gait and intra-gait downward transitions
Under-saddle: body position left or right	Turn
Under-saddle: 'sweeping' seat	Inter-gait and intra-gait upward transitions
Under-saddle: 'following' seat	Maintenance of gait, rhythm, and required movement
Under-saddle: seat and leg position	Sideways
In-hand: voice cue, hand signals, equipment signals (e.g., lead-rope moving)	Inter-gait and intra-gait transitions
In-hand: human postural ('body language') cue (e.g., human walking)	Maintenance of gait, rhythm, and required movement

Train easy-to-discriminate signals

Numerous signals from the rider are used to elicit the responses of go, stop, turn, and sideways and their subsets of quickening or slowing the steps, lengthening and shortening the steps, and changing the gait (walk, trot, canter, and gallop). In the competition dressage horse, the number of responses is further increased when other movements and postures are taken into account such as: rein-back, lateral bend, lateral flexion, altering the head and neck posture, collection, straightening the horse, lowering the hind quarters, as well as the movements of turn on the forehand (walk), pirouette (walk and canter), shoulder-in (trot), travers (trot), half-pass (trot and canter), piaffe, and passage. We do not include High School movements (Haute Ecole) as these are practiced rarely outside historic riding academies such as the Spanish Riding School in Vienna.

Despite the increased number of responses, the limitations of the rider's position on the horse's body mean that there cannot be a concomitant increase in the loci on the horse's body in which to apply pressure and thus condition these responses. For example, the rider sits on the saddle at approximately the centre of the thoracic segment of the vertebral column. The rider's legs can exert pressure in an arc stretching perhaps 20 cm, whereas the reins can exert pressure on the mouth equilaterally or bilaterally, and the reins can also exert lateral pressure on the horse's neck (neck-reining). Finally, the seat can exert pressure on the horse's dorsal musculature equilaterally or bilaterally and the rider can also alter the range of seat movement within a stride or accentuate pressure at either end of the seat arc (traditionally to cue deceleration and acceleration). The rider is also able to use spurs in isolation or in combination with the stimuli above to stimulate a particular locus on the horse's side. These considerations emphasize the importance of rider position in effectively achieving consistent responses in the horse. In addition, although the use of the voice is forbidden in the sport of dressage (Federation Equestre Internationale, 2003), verbal cues and auditory secondary reinforcers (e.g., clickers) are sometimes used in equitation.

It follows that the discrepancy between the number of responses required of a trained dressage horse and the limited number of signal loci means that some signals must elicit more than one response, or that some responses must be elicited by more than one signal, or that some responses must be elicited by a cascading series of particular signals. It is clear that the potential for confusion is high. When a single signal gives rise to multiple responses, it can induce conflict behavior (McLean and McGreevy, 2004).

The problem of there being too few signal loci for the number of responses required are typically solved in 3 ways in training:

1. Directional line and straightness of the body as well as the maintenance of the horse's head carriage are qualities that are usually trained using the legs and reins. For this reason, instead of training them as if they were separate from the basic locomotory responses that are trained using the same signals, they should be shaped during the training of the basic locomotory responses of go, stop, turn and sideways; the basic responses under the stimulus control of the reins and legs.
2. Combining discrete characteristics of rider posture and weight in association with basic locomotory signals for responses such as bend and collection.
3. Beyond stop, go, turn and sideways, more complex movements (i.e., in the sport of dressage: shoulder-in, travers, half-pass, pirouette, piaffe and passage) can be seen as combinations of these basic responses. For example, in dressage the movement of shoulder-in is a consecutive combination of turn (one step of the forelegs) followed by the go signal of the rider's inside leg that also serves to 'bend' the horse. The important criterion for all equitation disciplines is that any combination of maneuvers must be elicited consecutively (Decarpentry, 1949) although as close together as possible.

Train and subsequently elicit responses singularly

When the separate functions of the reins and rider's legs are considered in the light of their fundamental decelerating and accelerating actions, it must be confusing to the horse if both are trained or elicited simultaneously. Hull (1943) defined the simultaneous eliciting of 2 or more responses as 'overshadowing' or 'blocking,' depending on the strength of the different stimuli. He noted that the outcome was a reduction in responding. In the ridden horse this manifests as increasing heaviness in the reins and dullness to the rider's legs during locomotion and transitions. These days it is common for this important principle to be disregarded, for example the German National Equestrian Federation (1997) proposes that "Rein aids should only be given in conjunction with leg and weight aids." Yet Decarpentry (1949), one of the great masters of French equitation maintained the importance of separating rein and leg aids with the famous French maxim "hands without legs, legs without hands." Again, because of the anthropomorphic mindset in equitation, horses that become confused as a result of simultaneous application of reins and legs tend to be seen as uncooperative and heaviness to the aids and lowered responding is frequently expected during training by less knowledgeable trainers. It is therefore tempting for some riders to make the transition to the double bridle inappropriately in the quest for lightness. The result is a loss of self-carriage.

Train only one response per signal

A horse cannot be expected to know the intentions of its rider. It makes sense to recognize that confusion can also occur when one signal has more than one response attached to it. For example, during equitation the stimulus of the

single rein is the **most** basic (NR, *Phase 1*) signal for the turn response. When riders attempt to bend the horse's neck laterally using the single rein, the horse can easily become confused between the dual response of either turning (changing direction) or bending the neck: 2 responses from one signal. In addition the unthinking rider can become frustrated when the horse does not respond as expected. McLean (2003) suggested that such confusions account for a significant number of conflict behaviors in the ridden horse and possibly adding to wastage statistics.

Train all responses to be initiated and subsequently completed within a consistent structure

It is recognized in traditional horsemanship that the horse should initiate his response to the rider's aid immediately. However, the entire transition should not be completed abruptly. Contemporary dressage texts do not define the exact sequence of events surrounding transitions except to say that transitions should be within the rhythm of the strides (Herbermann, 1980; German National Equestrian Federation, 1997; Decarpentry, 1949). The use of such loose defining characteristics when describing the correct completion of transitions adds to the subjectivity of judging and coaching and moreover leads to losses of consistency and may confuse the horse. It is likely also to hinder the process of habit formation that Hebb (1949) described as a process of neural maturation. This suggests that the transitions should be consistently trained so that they become fixed. It follows that there are temporal/structural constraints in achieving consistent habits. Therefore, the training of the fundamental responses of stop, go, turn, and sideways include the training of the transitions that involve negative reinforcement of the correct response and the acquisition of the discriminative stimulus: the light aid. It is proposed that the sequence of events surrounding this process should also be consistent. This process involves 3 components: (1) a light aid followed by; (2) increasing pressure to motivate the response followed by; (3) immediate removal of the pressure when the desired (or improved) response emerges (McLean, 2003).

It is noted that in the execution of correct dressage at all levels, transitions occur within 3 beats of the rhythm of the strides (McLean, 2006). This 3-beat construction concurs with the sequence of negative reinforcement listed above. It is therefore proposed that dressage trainers should be mindful to train inter-gait and intra-gait transitions to occur within the framework of 3 beats of the forelegs of the horse for walk and trot transitions and 3 beats of the completed stride for canter and gallop (as these occur more rapidly). The 3 beats coincide with each of the 3 components as listed above and allows for the acquisition of the initiation and subsequent completion of responses within a defined timeframe. As the horse progresses in training over the years the transitions become more demanding in that they can occur to span greater ranges of speed. The second component is the period of stronger motivating pressure with the reins or the rider's legs that results in the transformation of the response occurring within 3 beats. For example if a cantering horse is stimulated to reduce his gait to the trot and it normally takes 5 beats of the canter stride to do so, then the rider will increase the rein pressure immediately after the light aid is applied and release this pressure when the horse trots. If the correct 'dose' of motivating pressure is used, this transforms the transition into the required 3 beats. This structure allows for a rhythmic flow, and is a feature of transitions when they are deemed to be in the correct timing in the sport of dressage. It avoids abruptness, allowing for the close temporal association between the discriminative stimulus (the light aid) and the release of pressure (reinforcement). Adherence to such a structure should hasten the acquisition of the transitions as learned responses.

Train persistence of current operantly conditioned responses

Because working and performance horses must respond to the rider's aids and sometimes continue responding for extended periods of time, it is important that they continue responding until signaled to switch to the next response. This principle is ubiquitous in horse training literature and is described as 'self-carriage' meaning that the horse must maintain his rhythm and tempo, line and straightness and head and neck outline without help from the reins and rider's legs. The 'great French master' Baucher described persistence of responding as a fundamental component of his training scale (Faverot de Kerbrech, 1891). In equitation, it is considered that this persistence is partially maintained by the action of the rider's seat that moves slightly differently in accordance with each gait's defining characteristics. The seat is also able to indicate to the horse that a shorter or longer stride is to be maintained because of the concomitant shorter or longer movements of the seat during those strides. In the absence of such classically conditioned signals, riders have to rely on continuously negatively reinforcing the correct response (as in *Phase 1* of training). If riders continually elicit a response by 'nagging' with their legs, habituation, and even learned helplessness may follow if continuous pain from spurs or bit is maintained. It is proposed that trainers and riders continuously test for self-carriage by completely releasing the reins or taking the legs away form the horse's sides for 2 steps in the walk and trot and 2 strides in the canter and gallop. In this short time-frame the horse should not lose gait, rhythm, tempo, line, straightness, or head carriage. We recommend the use of this technique (known as *Überstreichen*) as the test of self-carriage in all movements and gaits where possible both in training and in the execution of dressage tests. This would serve to lower wastage in those horses that are held in forced frames (where the rider maintains relentless and intolerable rein pressure) rather than exhibiting correct learned responses.

Avoid and disassociate flight responses

Le Doux (1994) showed that fear responses are less prone to extinction than other behaviors. This renders behaviors ranging from hyper-reactivity to anti-predator behaviors such as bolting, bucking, rearing, and shying as more persistent *if* given expression. Therefore, it is important for reasons of safety for both horse and rider that such behaviors are neither provoked nor maintained. It is likely that practicing such behaviors has negative welfare implications leading to chronic stress, learned helplessness, and wastage. Horses that are unclear in their acceleration and deceleration responses both in-hand and under-saddle show a positive correlation with hyper-reactive and conflict behaviors (McLean, 2005), suggesting that re-training of basic responses must form part of the rehabilitation process of such 'problem' horses. In retraining and prevention, riders should use downward transitions that slow the horse's legs to diminish fear responses during the expression of the hyper-reactivity, rather than simply ignore them or accelerate. Current practices such as roundpen techniques, lunging, driving or chasing horses for any reason whatsoever are detrimental if they induce fear and elicit a flight response. We recommend that they be dropped from the tool-box of enlightened trainers until there is statistic evidence that the potential benefits claimed for them outweigh the shown costs in behavioral wastage.

Conclusions

More rigor is needed in using the terms ethology and ethological in the equestrian domain. An understanding of equine ethology enhances effective horse handling but cannot explain the majority of the responses made by working horses. There is danger in confusing dominance and leadership with conditioning. Acknowledging the role of learning theory in human-horse interactions is the preferred means of avoiding over-interpretation of equine responses to humans.

If trainers across all disciplines of equitation adopt the principles described above, horses would maximize their abilities as work, sport, or leisure horses and learning rates could be accelerated. Furthermore if equestrian teaching manuals and institutions emphasized these as 'first principles,' lower behavioral wastage rates and increased safety for both riders and horses will follow.

Acknowledgments

We gratefully acknowledge 2 anonymous referees and several colleagues in the International Society for Equitation Science for their helpful comments on earlier drafts of this article.

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