



## Review Article

# Dominance and Leadership: Useful Concepts in Human–Horse Interactions?



Elke Hartmann<sup>a,\*</sup>, Janne W. Christensen<sup>b</sup>, Paul D. McGreevy<sup>c</sup>

<sup>a</sup> Department of Animal Environment and Health, Swedish University of Agricultural Sciences, Uppsala, Sweden

<sup>b</sup> Department of Animal Science, Aarhus University, Tjele, Denmark

<sup>c</sup> Faculty of Veterinary Science (B19), University of Sydney, NSW, Australia

## ARTICLE INFO

### Article history:

Received 5 January 2017

Accepted 24 January 2017

Available online 6 February 2017

### Keywords:

Horse

Social order

Dominance hierarchy

Aggression

Injury

Learning

Training

## ABSTRACT

Dominance hierarchies in horses primarily influence priority access to limited resources of any kind, resulting in predictable contest outcomes that potentially minimize aggressive encounters and associated risk of injury. Levels of aggression in group-kept horses under domestic conditions have been reported to be higher than in their feral counterparts but can often be attributed to suboptimal management. Horse owners often express concerns about the risk of injuries occurring in group-kept horses, but these concerns have not been substantiated by empirical investigations. What has not yet been sufficiently addressed are human safety aspects related to approaching and handling group-kept horses. Given horse's natural tendency to synchronize activity to promote group cohesion, questions remain about how group dynamics influence human–horse interactions. Group dynamics influence a variety of management scenarios, ranging from taking a horse out of its social group to the prospect of humans mimicking the horse's social system by taking a putative leadership role and seeking after an alpha position in the dominance hierarchy to achieve compliance. Yet, there is considerable debate about whether the roles horses attain in their social group are of any relevance in their reactions to humans. This article reviews the empirical data on social dynamics in horses, focusing on dominance and leadership theories and the merits of incorporating those concepts into the human–horse context. This will provide a constructive framework for informed debate and valuable guidance for owners managing group-kept horses and for optimizing human–horse interactions.

© 2017 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Introduction

There is abundant evidence for the benefits of keeping horses in groups. Keeping horses in groups best fulfills their need for social contact with conspecifics [1], benefits the development of social skills in young horses [2,3],

especially if they are kept together with experienced adult horses [4], and encourages movement that is linked to enhanced gastrointestinal health [5] and musculoskeletal development [6]. Moreover, group-kept horses are generally easier and safer to handle than singly kept horses. For example, there is evidence that adult group-kept horses are more compliant during halter fitting and routine examination [7] and that young horses show less unwanted behavior toward the trainer during foundation training [8]. Likewise, it has been suggested that lower reactivity levels in group-kept adult horses can promote human safety in a training context [9]. When given the choice, horses are highly motivated to achieve social contact as revealed in

Invited speaker paper: Equine Science Society Symposium (Minnesota, USA, 2017).

\* Corresponding author at: Elke Hartmann, Department of Animal Environment and Health, Swedish University of Agricultural Sciences, PO Box 7068, 750 07 Uppsala, Sweden.

E-mail address: [elke.hartmann@slu.se](mailto:elke.hartmann@slu.se) (E. Hartmann).

operant conditioning tasks [10], and they chose to remain longer in the paddock with other horses present than being alone in it [11].

It is widely recognized that social isolation, both short term and long term, that often coincides with confinement is aversive for horses. For example, there is sufficient empirical evidence showing that the development of stereotypic behaviors correlates with the transition from group housing to isolation [12], that stress responses to isolation are reflected in higher fecal cortisol concentrations [7], and that, after being deprived of social contact, horses are aggressive when reunited with conspecifics [3]. The overall benefits of keeping horses in groups should outweigh some of the concerns associated with group housing as the risk factors are clearly attributable to inappropriate management [13]. Management conditions where available resources such as food are restricted, small enclosure sizes, and/or high density of horses and unstable group membership are usually associated with higher aggression levels and thus higher injury risk than reported from feral horse groups [13]. However, given appropriate management, the incidence of severe injuries as one of the main concerns against group housing was not supported by quantitative data [14,15].

The social housing of horses is mandated by horse welfare guidelines and legislations in some European countries which may be reflected by the relatively high number of group-kept horses in those countries. In the Nordic countries (Denmark, Norway, Sweden, and Finland), survey data indicated that 47% of horses were grouped for the entire 24-hour period and 45% were stabled singly but grouped during turn-out [16]. Results from a UK survey are aligned, showing that 91% of horses were together with conspecifics during turn-out [17]. Hence, questions around the safe handling of horses at a group level are pivotal. These questions have not been sufficiently addressed in contrast to recent advances in equitation science and the application of scientifically sound learning principles to horse training that are suggested to be contributing to safer rider–horse interactions [18] but can also benefit the handling of horses at group level. Such questions relate to scenarios such as approaching, catching, and leading a horse away from its group. Interactions with horses at group level can become a challenge if group dynamics lead to conspecifics attempting to follow the horse that is being taken out.

Synchronization of behavior to achieve group cohesion is an important facet of group life [19]. This is clear from observations of free-ranging horse groups and also applies to managed groups of horses in the domestic environment because species-typical social behavioral patterns have remained relatively unaffected by domestication [20]. The provision of food to group-kept horses represents another scenario in which human safety may be jeopardized due to unexpected horse behavior and aggressive horse–horse interactions [21]. Heightened arousal and lower threshold for agonistic responses in horses typically accompany the delivery of food by humans [22] and can increase the risk to humans if they accidentally get in the way or are approached in a threatening manner. Crowding of horses near gateways represents another potentially hazardous situation for

humans. Besides injuries caused by falling off horses, accidents also arise when horses are being handled from the ground and may kick, stamp, or run into humans [23].

The observation that horses establish predictable social relationships with group members may have led to the assumption that dominance theory can be incorporated into the human–horse interface to ease handling and promote compliance during training. The logical extension of this approach would be that humans might benefit from mimicking horse–horse interactions so that they can occupy an alpha position in the dominance hierarchy to achieve compliance in-hand and under saddle and become the horse's leader. It has been emphasized that many of the interactions we make with horses do not align with the equid social ethogram [24]. Nevertheless, the notion persists that horses' social roles can be transferred to human–horse interactions simply because horses are expected to respond to humans as they would to other horses. Furthermore, under this framework, unwelcome behaviors such as biting or rearing may be readily labeled as dominant, that is, the horse acting deliberately and striving for higher rank. In these constructs, the use of coercion and punishment may gain justification to prevent and correct such responses. However, this beguiling but simplistic approach denies the complexity of horse–horse interactions and their context specificity. Moreover, there is no evidence that horses perceive humans as part of their social system [24]. Furthermore, the use of punishment in horse training is both unethical and has a number of undesired side effects, such as deleterious emotional changes and negative associations with the punisher [25,26]. Scientific studies investigating links between dominance and leadership in horses are scarce and only just emerging compared to other nonhuman animal groups.

The handling and training of horses are driven along very traditional lines, and much of what is done with horses is based on opinions and subjective personal endorsement rather than evidence-based practice. This is possibly one of the reasons why concepts such as the human dominion over horses are historically embedded into handling and training. The current review aims to provide a constructive framework for discussions around and empirical investigations of the relevance of dominance and leadership theory at the human–horse interface to encourage a shift from opinion driven to evidence-based practice.

## 2. Dominance and Leadership Theories

The concept of dominance was introduced by Schjelderup–Ebbe [27] and was originally labeled as “pecking order” based on empirical observations of domestic fowl. Since then, a variety of concepts and definitions have emerged, all striving to explain the social structure of nonhuman animals. Drews ([28]; p 283, p 308) summarized the concept of dominance as follows: “Dominance is an attribute of the pattern of repeated, agonistic interactions between two individuals, characterized by a consistent outcome in favor of the same dyad member and a default yielding response of its opponent rather than escalation. The status of the consistent winner is dominant

and that of the looser subordinate. Dominance status refers to dyads, while dominance rank, high or low, refers to the position in a hierarchy and, thus, depends on group composition. Dominance is a relative measure and not an absolute property of an individual.”

Individual recognition of the protagonist and memory of the contest outcome is possibly important in stable social groups but not necessary if participants in an agonistic interaction are unfamiliar with one another. Thus, in the absence of previous experiences, they may base their assessment of their opponent on morphological features or displays that correlate to competitive ability [28].

A general feature of dominance definitions accounts for the links between conflict resolution and priority access to resources of any kind. However, rank alone is not an absolute predictor of contest outcome as it depends on the value of the resource, that is, the motivation to acquire it and the cost associated with acquiring it, i.e. fighting [28]. Furthermore, even though dominance usually refers to agonistic behavior per definition, that is, aggression and avoidance, dominance is more about the patterning of interactions. Thus, aggressive behavior may not be observed once dominance relationships are established, but status may be reflected in spontaneous avoidances by subordinates [29,30].

Rank order in horses has been suggested to be linear, that is, A dominates B, C and D; B dominates C and D, and C dominates D, but triangles can also occur [29,31]. Horses can form strong and long-lasting social bonds where individuals can interfere in dyadic interactions in an attempt to safeguard existing relationships [32–34]. Thus, the outcome of an encounter may also depend upon the presence of a third individual.

The determination of rank relative to body weight or height, age, or sex is not easily predicted as revealed by contradicting results from different studies. Body weight, for example, has only recently been correlated with high rank [35] and was also found to affect position in the hierarchy in captive herds studied by Houpt et al [31] but not in a study by Van Dierendonck et al [29]. Most results suggest a correlation of age with rank [36,37] which seems appropriate because older horses usually have more experience than younger animals (e.g., in exploiting resources) [38]. Duration of residency in the group may also be an indicator of rank as reported by Van Dierendonck et al [29]. Stallion's rank is context specific, and stallions are not necessarily higher in rank than mares not least because outside of sexual contexts, they have less contact with the group than mares do [37,39]. Harem stallions often remain at the boundaries of the natal band, patrolling, or herding mares back to the group to maintain group cohesion which has been suggested to be a unique characteristic of high ranking males [40]. The popular belief that a harem group is exclusively led by a dominant mare [41] has been recently questioned likewise has the assumption of the leader role of the stallion [42]. These new constructs have emerged due to recent advances in the study of horse behavior, specifically studies of leadership in the context of group movements and research focusing on more complex patterns of cooperation and conflict resolution in nonhuman animal groups.

For social animals, including horses, group cohesion has adaptive advantage and maximizes the benefits of group life, that is, mainly decreased predation risk and increased foraging efficiency. Therefore, coordinating activities to remain cohesive in a single unit regardless of discrepancies in individuals' motivations or physiological needs is a priority [43–45]. Thus, some form of leadership is inevitable for coordination of behavior at group level. Leadership describes the process of social influence in which specific leaders appear to guide the actions of group members such as changes in activity or location [46]. Accordingly, a follower is any individual who follows or joins the leader for a certain activity, whereas “initiators” have the propensity to be followed [46,47]. In the behavioral literature, the leader can be referred to as the individual moving in front of the group, as the first departing animal, or any individual managing to recruit followers [48]. Based on these characteristics of leadership as well as differences in group compositions (i.e., free-ranging harem groups vs. single sex or mixed sex groups with geldings), discrepancies in results may appear in the literature. So, it remains unclear what constitutes sufficient evidence for an individual to be called a leader. For example, is leadership evident from a single movement or only across repeated movement initiations? Equally, are individuals that often depart first but rarely travel in front position leaders as recently questioned by Bourjade et al [49].

Leadership and its attributes have been extensively studied across mammalian species (for reviews, see King et al [45] and Smith et al [46]) and also in fish [50,51]. Decision-making processes about where to go and what to do have also recently been empirically assessed in horses. Here, the focus has been on studying group movements, usually in the context of maintenance behavior (moving between foraging places or to shelters) without making comparisons between functional contexts, including intergroup encounters, predator defense, or exploration. The central questions in these reports relate to whether certain horses can be assigned consistent leadership roles [49,52], what effect rank has on eliciting followers [53], what behaviors are displayed before departure and are indicative of subsequent leadership [49,54], and what effect personality and social bonding have on initiating movement [52,55]. Results across these studies indicate that leadership, in contrast to the traditional dogma, is not unique to the highest-ranked or oldest horse but that any horse of the group can act as leader. Bourjade et al [49,54] found shared leadership in groups of Przewalski horses where several individuals could depart from the group simultaneously. These authors concluded that the decision-making process prior to movement was partially shared and was largely based on predeparture behavior displayed by several horses (e.g., moving away without foraging, staying at the periphery of the group, following an individual, i.e., moving away, and joining a peripheral individual).

Results from Andrieu et al [53] and Krüger et al [52] indicate that high-ranked horses were followed significantly more often than subordinates, but this was not supported by Briard et al [55], who posited the idea that collective movements depend more on the motivations of

the followers than the characteristics of the one individual acting as leader, that is, that the latter acts as the trigger but that the collective decision has already been taken by group members beforehand (see also Petit and Bon [48]). Nevertheless, Briard et al [55] found that bolder horses made more start attempts than shy horses as they seemed to be more explorative and less fearful as well as more independent. Boldness in this context was assessed subjectively via survey questions completed by the two observers at the end of the study period and via recordings of dyadic social interactions as a measure of gregariousness or sociability, that is, the propensity to stay close to conspecifics or lower sensitivity to isolation-induced fear. Furthermore, horses that were socially bonded, as evaluated by nearest-neighbor recordings, were more likely to move together [39,55]. In contrast, Krüger et al [52] assessed social bonds through an analysis of agonistic and affiliative interactions but found no such correlation.

In a study of sheep flocking dynamics, Pillot et al [56] proposed that a quick movement by a single individual moving away from the group may be enough to trigger a following response by observing group members. In their study, one member of the flock was trained to respond to a sound cue and move toward a panel, whereas remaining group members were naïve. The sound could be heard by the whole group, leading to synchronization of attentional states which may have facilitated a collective movement. Notably, trained sheep were not observed to actively recruit group members by looking back at conspecifics, vocalizing, or herding. Thus, maybe leadership also includes responses to alerts from conspecifics and leaders may be specifically attended to when safety is threatened. Christensen (unpublished data), for example, exposed groups of four horses to a frightening stimulus (opening of umbrella) in which one of the horses in each group was habituated to the umbrella, whereas the other three horses were naïve. In groups of only young horses (2 years old), the three frightened group members caused the trained demonstrator to flee, whereas in groups with one old horse (more than 5 years old), the older demonstrator caused reduced fear in the young horses. As also shown in elephants by McComb et al [57], individuals within a group may benefit from the influence of an older leader because of their enhanced ability to make decisions about potential threats. A similar experimental approach to Pillot et al [56] was used by Andrieu et al [53] studying groups of horses in which some individuals were informed of the location of food. Informed horses generally walked toward the food source more steadily and actively than naïve horses, and followed horses were using more direct paths than non-followed horses. The absence of active recruitment behavior such as coercive behavior, vocalizations, or body postures is suggestive of a passive recruitment process which aligns with other results [49,52,54]. Bourjade et al [54] discussed the concept of social facilitation underlying a group consensus during departure where simply the movement of one or more animals away from the group increases the probability of conspecifics following.

In biological sciences, studies of leadership are mainly concerned with group cohesion and decision-making in the context of collective movements. By contrast, in social

sciences, leadership has been extensively studied in a wide range of contexts including political, commercial, educational, ethical, or moral leadership constructs (for example [58,59]). In social sciences, leadership is generally described as an interpersonal process in which a leader influences followers and is characterized by an intentional influence by one person over others [60]. More recently, the focus has shifted from studying why leaders are influential (e.g., personality traits, behaviors, attitudes, and perceptions) and can act as drivers for organizational success, whereby followers are treated as passive recipients to studying the behavior of followers, that is, why they are willing to be influenced by leaders and how followers construe leadership by assigning them a more active role in the relationship [58,60].

### 3. Intraspecies and Interspecies Communication and Human–Horse Interactions

Horses communicate with each other via visual, auditory, olfactory, and tactile signals. The breadth of intraspecific communication is mirrored in a comprehensive equid ethogram summarized by McDonnell [61]. In contrast, communication between humans is primarily based on auditory signals via well-developed linguistic skills. Thus, much emphasis is put on auditory signals in human–horse interactions with the underlying assumption that horses have an inherent understanding of harsh voice cues (used as reprimands) versus soothing voice cues (used as a reward or to calm the horse down). However, recent research shows that soothing vocal cues did not enhance the horse's ability to perform a novel, potentially frightening task [62]. Horses' reactions to vocal cues could be explained simply by classical conditioning that reliably pairs cues with a pleasant or unpleasant outcome and has no reliance on higher cognitive abilities. Moreover, it is important for horses to recognize individual social partners in their group to develop and sustain social relationships. Horses appear to possess a cross-modal representation of known conspecifics based on unique auditory signals, including visual and olfactory information [63]. This ability to recognize familiar conspecifics also transfers to the recognition of familiar human faces based on playbacks of familiar human voices [64,65].

The ability of horses to respond to manifestations of human affective states and to determine the focus of human attention has also been studied experimentally. Humans facing and looking at horses were more likely to be approached by horses than in-attentive humans with closed eyes and a body orientated away from a food source [63]. Furthermore, horse's response to a vocal cue to stand still was affected by the attentional state of an unfamiliar person giving the cue, that is, the response duration was increased when the person was paying attention to the horse compared to when that same person turned their back toward the horse. In contrast, the attentional state of a familiar person did not affect response duration [66]. Horses can also learn to use human pointing gestures as a communicative cue often in connection with the human indicating the location of food [67,68]. Although the horses readily learned to use pointing gestures that were given

close to the food bucket as well as sustained distal pointing gestures, they were less able to use momentary distal cues (i.e., when the cue was only brief and distant from the food bucket). The researchers suggested that distal momentary pointing may be more cognitively demanding than other pointing styles [67]. Thus, horses may rely on stimulus or local enhancement in human-guided choice tasks rather than on a referential understanding of the actual gestures [68,69]. Proops et al [70] suggested that horses may develop the skill of following human gestures as they age and that lifetime experience plays an important role in this development.

Taken together, the results from the horse studies do not support the theory that horses are innately predisposed to be particularly skilled at interpreting human vocal cues and gestures. Their ability to use human visual cues in object choice tasks (such as choosing between food buckets as in the studies cited previously) is likely to reflect a more general learning ability related to stimulus or local enhancement rather than a specific “human-reading” skill [70,71]. Furthermore, other lifetime factors, such as training method could enhance the responsiveness of horses toward human gestures. For example, a small-scale study by Dorey et al [72] showed that horses trained with natural horsemanship techniques learned to follow a momentary distal pointing cue to locate hidden food with significantly more success than traditionally trained horses. Natural horsemanship often uses human visual gestures during training from the ground, whereas traditional riding tends to rely more on tactile cues.

In addition to the intentional cues that humans use to communicate with horses, humans also communicate with horses unintentionally. Some studies have found that an increase in heart rate in riders or handlers due to the expectation of a negative event was reflected in a similar increase in heart rate in their horses [73,74]. For prey species, it is clearly adaptive to respond to arousal cues in other species because such cues could signal danger. This may be supported by results from Birke et al [75], showing that when experienced adult riding horses were approached individually in a vigorous style, with a gently swinging rope and direct eye contact, their flight distance was greater than during an indirect approach consisting of a relaxed body posture, no swinging rope, and no eye contact. In contrast, direction of approach, that is, the person moving toward the front or back of the horse, shoulder, middle, or quarter from each side did not affect flight distance presumably because of the horse's wide field of vision [75]. In the same study, when naïve, feral ponies were approached, they were more likely to trot away from the person and traveled further when approached fast and directly (with a tense, upright stance, and gaze directed toward horses) compared with a slow, indirect approach with relaxed body posture. Thus, approaching horses vigorously compared with a relaxed approach can trigger a flight response, whereas, contrary common belief, body posture (tense vs. relaxed) per se did not seem relevant [75]. Furthermore, eye contact may not be relevant in a situation where horses are approached by humans at pasture as was reported by Verrill and McDonnell [76] although it may be difficult to separate eye contact from other cues and human body

postures that may be more salient than eye contact alone. Hartmann et al [77] and Jørgensen et al [78] studied the ease with which group-kept horses could be caught at pasture. Horses were approached calmly with a normal body posture. Catching a horse from its social group was generally unproblematic in both studies as well as in a recent study published by Keeling et al [14]. Consequently, the ease of approaching and catching horses on pasture may also be influenced by prior experience with humans and subsequent interactions rather than approach style alone, that is, horses that have pleasant experiences with humans are easier to catch. Furthermore, catching success may also depend upon the level of handling which explains why young horses may be initially more difficult to catch than experienced adult horses [14,76].

Indeed, an important element influencing how horses react to humans is the relationship they have established with humans [79,80] which can have a positive (e.g., appropriate training and use of positive reinforcement) or negative valence (e.g., exposing the horse to harsh training procedures or punishment) or a mixture of both. The relationships horses establish with humans may be context specific, for example, if they are taken into a particular area for veterinary treatments that may be aversive they may become wary of all humans (even those who, elsewhere, reliably bring food) in that area. A relationship may be defined as a succession of interactions that occur over time between two or more individuals: these individuals will have expectations of the next interaction on the basis of the previous ones [79,81]. Research suggests that horses can recognize and remember individual handlers and trainers and whether past interactions with those individuals had been pleasant or unpleasant through the process of classical conditioning. Specifically, Sankey et al [82] addressed the effect of using positive reinforcement (food rewards) during training on the quality of the human–horse relationship. Horses receiving food rewards spent more time close to the trainer than horses trained without food which was interpreted as a sign of horses having a “positive memory” of the trainer [82]. Thus, the reactions of horses toward humans can often be explained (or predicted) from previous interactions. Good training aims to decrease fearful reactions in horses toward humans to facilitate learning [83] and the quality of the human–horse relationship may determine whether fear could be further reduced [84].

#### 4. Dominance and Leadership: Useful Concepts in Human–Horse Interactions?

The application of dominance theory in the human–horse context would imply that unwelcome responses are easily explained by the horse trying to dominate the human and achieve higher social status. Thus, according to this doctrine, the human should strive for attaining superior high rank and take a leadership role to prevent and correct problem behavior and achieve compliance. This idea is specifically advocated by natural horsemanship trainers but also by other practitioners (for reviews, see Henshall and McGreevy [85] and Rickards [86]) and falls into the “conspecific model” [87]. This model implies that horses



would innately respond to human interventions in the same way as they would when receiving analogous signals from conspecifics. Most of the natural horsemanship approaches are based on a system of human body language and auditory cues to communicate with the horse such as that described by Roberts [88] as the language of “Equus.”

The principal context in which mimicking “natural” horse behavior is advocated is the so-called round-pen training which typically takes place in a circular pen of sufficient height to prevent the horse from escaping [85]. At first, the horse is usually moved away via aversive postural and auditory cues that elicit a flight response in the horse. By doing so, the human aims to establish a dominance–subordinate relationship. By stepping into the path of the horse, the trainer can then force it to change direction, thus, putatively demonstrating human dominance. The removal of aversive cues then allows the horse to stop running and moving toward the trainer. A following response by the horse is then interpreted as the horse accepting the leadership role of the human similar to the assumed role of the herd leader or alpha mare.

Several empirical studies have documented the training outcomes based on the round-pen technique (for review, see Henshall and McGreevy [85]). It has been suggested that horses certainly learned to follow the trainer over a series of trials (via negative reinforcement) and that following behavior was context specific, that is, only occurred in the round-pen and not when horses were tested on pasture or small paddocks in their social group, in pairs or alone [89]. The ethological interpretation of responses in round-pen training as elements of horse–horse interactions could not be supported by Koster et al [90] and Warren-Smith and McGreevy [91]. In these two studies, dyads of unrelated, unfamiliar mares and young horses were placed in a round-pen and subsequent interactions were recorded. Contrary to normal round-pen training sessions, hardly any chasing by mares was recorded, aggressive interactions were seldom observed, and young horses frequently avoided the mares. Given the complex social organization of horses and the many factors determining social order within a band or group hierarchy, the relevance of dominance theory applied at the human–horse interface is likely to be low. This is also emphasized when one recalls that horses’ hierarchies become evident during the competition for resources which are usually absent in a training context. The significant morphological differences between horses and humans furthermore decrease the likelihood that horses would innately respond to human attempts to mimic horse behavior as discussed by Henshall and McGreevy [85]. Moreover, as recent results have shown, roles of leaders in groups of horses vary and those individuals acting as leaders may not necessarily occupy the highest rank in disputes of food. Horses, like other species, learn as a result of the reinforcement that follows a behavior and not because they sense the social rank of the human nor her/his strong leadership skills. Therefore, becoming the quasi-dominant leader of a horse may have little ethological relevance from the horse’s perspective, and it is questionable whether horses do include humans in their social hierarchy. Perhaps, one explanation for such beliefs is anthropomorphism, the

tendency to transfer human characteristics, such as respect and authority, onto the horse. A relationship based on trust, mutuality, and cooperation are what many horse owners are hoping for [92]. Yet, during most work and handling from the ground, horses have negligible autonomy as humans assert control simply because of safety reasons [26]. Attempts to dominate the horse to achieve control often encourages and justifies the application of harsh training methods and punishment. As a consequence, the predominant reaction of most horses would be to avoid the trainer, show flight responses or defensive behavior which are all undesirable in a training situation and jeopardize horse welfare and human safety.

Similar to horse training, traditional dog training relied on dominance theory for many decades, as it was assumed that dogs misbehave primarily because they are striving for high rank [93]. This approach has been largely replaced by explaining undesirable behavior from scientifically sound learning principles and emerged after leading canine ethologists reevaluated studies on captive and free-ranging wolves and dogs, showing that individuals were not always fighting to gain high rank [94]. Most undesirable behaviors in dogs (e.g., aggression or excessive barking) are not concerned with access to valued resources but are likely to be a consequence of inadvertently rewarding those behaviors without training alternative, appropriate responses.

Food-related aggression toward people in horses can occur, mainly in stabled horses but also in group-kept horses that receive restricted food [22]. Hence, rather than labeling it as dominant behavior based on resource guarding, an alternative explanation would be that the aggressive behavior was inadvertently reinforced by the human walking away after food provision or the horse learned (unintentionally via operant conditioning) the association between its behavior and the arrival of food. Using physical punishment runs the risk of intensifying the agonistic behavior and is correlated to an array of other associated problems [26]. Aggressive responses around food that are associated with apparent displacement of the human (as they leave to go about their business) can certainly be modified. In groups of horses that have learned to associate humans with the arrival of food, the safety of any person moving through the herd may be jeopardized. At a group level, granting all horses free access to roughage has the best potential to reduce both this risk and agonistic interactions between horses [21] as well as reducing the risk for gastric ulcers [95]. Automatic feeding stations where individuals are recognized via transponders are another practical solution that can reduce competition among horses and keep human interference at a minimum.

The debate to applying dominance theory at the human–horse interface has made room for the concept of humans as leaders, a notion that is also widespread in dog-training circles. The position statement of the American Veterinary Society of Animal Behavior [96] explicitly encourages pet owners to establish a leadership role which should be obtained by positive means of interactions (e.g., immediately rewarding desired behavior) and by consistently setting clear limits to influence pets to perform behaviors willingly. Furthermore, the use of scientifically sound learning principles to modify behavior is

emphasized. However, given the complexity and various definitions of leadership in social sciences, using the term “leader” if not clearly defined can become blurred in a training context. Furthermore, followers are usually assigned a more active role in the leadership process [58]. Thus, the question emerges whether horses be assigned a more active role during training or are they merely followers with little autonomy if concepts such as leadership are applied in a training context? If horses could decide themselves whether to participate in training, perhaps the presence of peers would be more important than human company. Unless horses have been hand reared or excessively handled, they typically find conspecifics more salient than humans which is mirrored in the separation anxiety-related responses that are seen in horses when removed from herd-mates and their strong motivation to return to the herd [78,97]. This implies that they are not following humans to aversive places away from conspecifics just because they have bonded with the human and regard the human as a trustful leader. Instead, they are responding to operant cues, and in the absence of such cues (e.g., when a rider falls off), they most often return to the herd rather than remaining with their humans. Furthermore, if leadership concepts from social sciences are applied at the human–horse interface, then there is the risk of overestimating horses’ cognitive abilities. Because leadership among humans reflects shared expectations and implies that the leader is acting intentionally [60], then the question arises whether horses are capable of understanding human intentions during a given task. Accepting this notion, then blaming horses for knowing what they have done wrong or that they misbehave deliberately puts an anthropomorphic label on and runs the risk of abuse [98].

An array of questions arise within the concept of humans as leaders for horses: What, if the horse, for example, does not follow the human into the trailer? Does that speak of lack of trust in the human and failure of the human acting as leader? And, following up, what particular aspects of leadership qualities are lacking? Another scenario is that of catching horses on pasture. If horses see certain humans genuinely as leaders, would we not expect them to approach and follow easily, leaving conspecifics behind? However, as discussed earlier, there is insufficient evidence that horses approach humans of other reasons than merely curiosity or because they have been trained to do so.

## 5. Conclusions

It is unlikely that horse–horse social status translates to analogues of human–horse interactions, and the concept of leadership as advocated in many training manuals proves to be unreliable in the horse as evidenced by several studies. Thus, horses’ responses to training are more likely a result of reinforcement during which correct responses were clearly and consistently rewarded rather than a result of humans attaining high social status and a leadership role. Knowledge of horses’ natural behavior and learning capacities are more reliable in explaining training outcomes than anthropomorphic explanations and the

application of dominance and leadership concepts that can jeopardize horse welfare and human safety.

## Acknowledgments

This work was supported by the Swedish Research Council Formas (grant number 942-2015-1430).

Conflict of interest statement: None of the authors of this paper has a financial or personal relationship with other people or organizations that could inappropriately influence or bias the content of this review paper.

## References

- [1] Hartmann E, Søndergaard E, Keeling LJ. Keeping horses in groups: a review. *Appl Anim Behav Sci* 2012;136:77–87.
- [2] Ladewig J, Søndergaard E, Christensen JW. Ontogeny: preparing the young horse for its adult life. In: Mills DS, McDonnell S, editors. *The domestic horse: the evolution, development and management of its behaviour*. Cambridge: Cambridge University Press; 2005. p. 139–49.
- [3] Christensen JW, Ladewig J, Søndergaard E, Malmkvist J. Effects of individual versus group stabling on social behaviour in domestic stallions. *Appl Anim Behav Sci* 2002;75:233–48.
- [4] Bourjade M, Moulinot M, Henry S, Richard-Yris MA, Hausberger M. Could adults be used to improve social skills of young horses, *Equus caballus*? *Dev Psychobiol* 2008;50:408–17.
- [5] McGreevy PD. *Equine behavior—a guide for veterinarians and equine scientists*. London: W.B. Saunders; 2012.
- [6] Firth EC. The response of bone, articular cartilage and tendon to exercise in the horse. *J Anat* 2006;208:513–26.
- [7] Yarnell K, Hall C, Royle C, Walker SL. Domesticated horses differ in their behavioural and physiological responses to isolated and group housing. *Physiol Behav* 2015;143:51–7.
- [8] Søndergaard E, Ladewig J. Group housing exerts a positive effect on the behaviour of young horses during training. *Appl Anim Behav Sci* 2004;87:105–18.
- [9] Lesimple C, Fureix C, LeScolan N, Richard-Yris MA, Hausberger M. Housing conditions and breed are associated with emotionality and cognitive abilities in riding school horses. *Appl Anim Behav Sci* 2011;129:92–9.
- [10] Søndergaard E, Jensen MB, Nicol CJ. Motivation for social contact in horses measured by operant conditioning. *Appl Anim Behav Sci* 2011;132:131–7.
- [11] Lee J, Floyd T, Erb H, Houtp K. Preference and demand for exercise in stabled horses. *Appl Anim Behav Sci* 2011;130:91–100.
- [12] Visser EK, Ellis AD, Van Reenen CG. The effect of two different housing conditions on the welfare of young horses stabled for the first time. *Appl Anim Behav Sci* 2008;114:521–33.
- [13] Fureix C, Bourjade M, Henry S, Sankey C, Hausberger M. Exploring aggression regulation in managed groups of horses *Equus caballus*. *Appl Anim Behav Sci* 2012;138:216–28.
- [14] Keeling LJ, Bøe KE, Christensen JW, Hyyppä S, Jansson H, Jørgensen GHM, et al. Injury incidence, reactivity and ease of handling of horses kept in groups: a matched case control study in four nordic countries. *Appl Anim Behav Sci* 2016;185:59–65.
- [15] Jørgensen GHM, Borsheim L, Mejdell CM, Søndergaard E, Bøe KE. Grouping horses according to gender: effects on aggression, spacing and injuries. *Appl Anim Behav Sci* 2009;120:94–9.
- [16] Hartmann E, Bøe KE, Christensen JW, Hyyppä S, Jansson H, Jørgensen GHM, et al. A Nordic survey of management practices and owners’ attitudes towards keeping horses in groups. *J Anim Sci* 2015;93:4564–74.
- [17] Hockenhuill J, Creighton E. The day-to-day management of UK leisure horses and the prevalence of owner-reported stable-related and handling behaviour problems. *Anim Welf* 2015;24:29–36.
- [18] Starling M, McLean AN, McGreevy PD. The contribution of equitation science to minimising horse-related risks to humans. *Animals* 2016;6:15.
- [19] Nicol CJ. The social transmission of information and behaviour. *Appl Anim Behav Sci* 1995;44:79–98.
- [20] Christensen JW, Zharkikh T, Ladewig J, Yasinetskaya N. Social behaviour in stallion groups (*Equus przewalskii* and *Equus caballus*) kept under natural and domestic conditions. *Appl Anim Behav Sci* 2002;76:11–20.

- [21] Burla JB, Ostertag A, Patt A, Bachmann I, Hillmann E. Effects of feeding management and group composition on agonistic behaviour of group-housed horses. *Appl Anim Behav Sci* 2016; 176:32–42.
- [22] Hockenhuil J, Creighton E. Pre-feeding behaviour in UK leisure horses and associated feeding routine risk factors. *Anim Welf* 2014; 23:297–308.
- [23] Hawson LA, McLean AN, McGreevy PD. The roles of equine ethology and applied learning theory in horse-related human injuries. *J Vet Behav* 2010;5:324–38.
- [24] McGreevy PD, Oddie C, Burton FL, McLean AN. The horse–human dyad: can we align horse training and handling activities with the equid social ethogram? *Vet J* 2009;181:12–8.
- [25] McLean AN, Christensen JW. The application of learning theory in horse training. *Appl Anim Behav Sci* 2017. in press.
- [26] McGreevy PD, McLean AN. Punishment in horse-training and the concept of ethical equitation. *J Vet Behav* 2009;4:193–7.
- [27] Schjelderup-Ebbe T. Beiträge zur Sozialpsychologie des Haushuhns. *Zeitsch Psychol* 1922;88:225–52.
- [28] Drews C. The concept and definition of dominance in animal behaviour. *Behaviour* 1993;125:283–313.
- [29] Van Dierendonck MC, De Vries H, Schilder MBH. An analysis of dominance, its behavioural parameters and possible determinants in a herd of Icelandic horses in captivity. *Neth J Zool* 1994;45: 362–85.
- [30] Heitor F, do Mar Oom M, Vicente L. Social relationships in a herd of Sorraia horses: Part I. Correlates of social dominance and contexts of aggression. *Behav Processes* 2006;73:170–7.
- [31] Houpt KA, Law K, Martinisi V. Dominance hierarchies in domestic horses. *Appl Anim Ethol* 1978;4:273–83.
- [32] Van Dierendonck MC, de Vries H, Schilder MBH, Colenbrander B, Porhallsdóttir AG, Sigurjónsdóttir H. Interventions in social behaviour in a herd of mares and geldings. *Appl Anim Behav Sci* 2009; 116:67–73.
- [33] Hartmann E, Keeling LJ, Rundgren M. Comparison of 3 methods for mixing unfamiliar horses (*Equus caballus*). *J Vet Behav* 2011;6:39–49.
- [34] Schneider G, Krüger K. Third-party interventions keep social partners from exchanging affiliative interactions with others. *Anim Behav* 2012;83:377–87.
- [35] Giles SL, Nicol CJ, Harris PA, Rands SA. Dominance rank is associated with body condition in outdoor-living domestic horses (*Equus caballus*). *Appl Anim Behav Sci* 2015;166:71–9.
- [36] Feh C. Social-behavior and relationships of Przewalski horses in Dutch semi-reserves. *Appl Anim Behav Sci* 1988;21:71–7.
- [37] Keiper RR, Sambras HH. The stability of equine dominance hierarchies and the effects of kinship, proximity and foaling status on hierarchy rank. *Appl Anim Behav Sci* 1986;16:121–30.
- [38] Keiper R, Receveur H. Social interactions of free-ranging Przewalski horses in semi-reserves in The Netherlands. *Appl Anim Behav Sci* 1992;33:303–18.
- [39] Wells SM, von Goldschmidt-Rothschild B. Social behaviour and relationships in a herd of Camargue horses. *Z Tierpsychol* 1997;49: 363–80.
- [40] Berger J. Organizational systems and dominance in feral horses in the Grand Canyon. *Behav Ecol Sociobiol* 1977;2:131–46.
- [41] Miller RM. The dominance hierarchy. *J Equine Vet Sci* 1995;15: 467–8.
- [42] Feist JD, McCullough DR. Behavior patterns and communication in feral horses. *Z Tierpsychol* 1976;41:337–71.
- [43] Conradt L, Roper TJ. Deciding group movements: where and when to go. *Behav Processes* 2010;84:675–7.
- [44] Jacobs A. Group cohesiveness during collective movements: travelling apart together. *Behav Processes* 2010;84:678–80.
- [45] King AJ, Johnson DDP, Van Vugt M. The origins and evolution of leadership. *Curr Biol* 2009;19:911–6.
- [46] Smith JE, Gavrillets S, Mulder MB, Hooper PL, El Mouden C, Nettle D, Hauert C, Hill K, Perry S, Pusey AE, van Vugt M, Smith EA. Leadership in mammalian societies: emergence, distribution, power, and payoff. *Trends Ecol Evol* 2016;31:54–6.
- [47] Pyritz LW, King AJ, Sueur C, Fichtel C. Reaching a consensus: terminology and concepts used in coordination and decision-making research. *Int J Primatol* 2011;32:1268–78.
- [48] Petit O, Bon R. Decision-making processes: the case of collective movements. *Behav Processes* 2010;84:635–47.
- [49] Bourjade M, Thierry B, Hausberger M, Petit O. Is leadership a reliable concept in animals? An empirical study in the horse. *PLoS One* 2015;10:14.
- [50] Nakayama S, Harcourt JL, Johnstone RA, Manica A. Initiative, personality and leadership in pairs of foraging fish. *PLoS One* 2012;7: e36606.
- [51] Harcourt JL, Ang TZ, Sweetman G, Johnstone RA, Manica A. Social feedback and the emergence of leaders and followers. *Curr Biol* 2009;19:248–52.
- [52] Krüger K, Flauger B, Farmer K, Hemelrijk C. Movement initiation in groups of feral horses. *Behav Processes* 2014;103:91–101.
- [53] Andrieu J, Henry S, Hausberger M, Thierry B. Informed horses are influential in group movements, but they may avoid leading. *Anim Cogn* 2015;19:451–8.
- [54] Bourjade M, Thierry B, Maumy M, Petit O. Decision-making in Przewalski horses (*Equus ferus przewalskii*) is driven by the ecological contexts of collective movements. *Ethology* 2009;115: 321–30.
- [55] Briard L, Dorn C, Petit O. Personality and affinities play a key role in the organisation of collective movements in a group of domestic horses. *Ethol* 2015;121:888–902.
- [56] Pillot MH, Gautrais J, Gouello J, Michelenia P, Sibbald A, Bon R. Moving together: incidental leaders and naïve followers. *Behav Processes* 2010;83:235–41.
- [57] McComb K, Shannon G, Durant SM, Sayialel K, Slotow G, Poole J, Moss C. Leadership in elephants: the adaptive value of age. *Proc Biol Soc* 2011;278:3270–6.
- [58] Oc B, Bashshur MR. Followership, leadership and social influence. *Leadersh Quart* 2013;24:919–34.
- [59] Brown ME, Treviño LK. Ethical leadership: a review and future directions. *Leadership Quart* 2006;17:595–616.
- [60] Dansereau F, Seitz SR, Chiu CY, Shaughnessy B, Yammarino FJ. What makes leadership, leadership? Using self-expansion theory to integrate traditional and contemporary approaches. *Leadership Quart* 2013;24:798–821.
- [61] McDonnell SM. The equid ethogram: a practical field guide to horse behavior. Lexington, Kentucky: Eclipse Press; 2003.
- [62] Heleski C, Wickens C, Miner M, DallaCosta E, Wu C, Czeszak E. Von Borstel. Do soothing vocal cues enhance horses' ability to learn a frightening task? *J Vet Behav* 2015;10:41–7.
- [63] Proops L, McComb K. Attributing attention: the use of human-given cues by domestic horses (*Equus caballus*). *Anim Cogn* 2010;13:197–205.
- [64] Proops L, McComb K. Cross-modal individual recognition in domestic horses (*Equus caballus*) extends to familiar humans. *Proc Biol Sci* 2012;279:3131–8.
- [65] Lampe J, Andre J. Cross-modal recognition of human individuals in domestic horses (*Equus caballus*). *Anim Cogn* 2012;15:623–30.
- [66] Sankey C, Henry S, André N, Richard-Yris MA, Hausberger M. Do horses have a concept of person? *PLoS One* 2011;6:e18331.
- [67] Maros K, Gácsi M, Miklósi Á. Comprehension of human pointing gestures in horses (*Equus caballus*). *Anim Cogn* 2008;1:457–66.
- [68] Proops L, Walton M, McComb K. The use of human-given cues by domestic horses, *Equus caballus*, during an object choice task. *Anim Behav* 2010;79:1205–9.
- [69] Lovrovich P, Sighieri C, Baragli P. Following human-given cues or not? Horses (*Equus caballus*) get smarter and change strategy in a delayed three choice task. *Appl Anim Behav Sci* 2015;166:80–8.
- [70] Proops L, Rayner J, Taylor AM, McComb K. The responses of young domestic horses to human-given cues. *PLoS One* 2013;8:e67000.
- [71] Krüger K, Flauger B, Farmer K, Maros K. Horses (*Equus caballus*) use human local enhancement cues and adjust to human attention. *Anim Cogn* 2010;14:187–201.
- [72] Dorey NR, Conover AM, Udell MAR. Interspecific communication from people to horses (*Equus ferus caballus*) is influenced by different horsemanship training styles. *J Comp Psychol* 2014;128: 337–42.
- [73] Von Borstel UU, Duncan IJH, Shoveller AK, Millman ST, Keeling LJ. Transfer of nervousness from competition rider to the horse. In: Proceedings of the 3rd Symposium of the International Society for equitation science, Michigan, U.S.A., 13–14 August, 2007. International Society for Equitation Science; 2007. p. 17.
- [74] Keeling LJ, Jonare L, Lanneborn L. Investigating horse-human interactions: the effect of a nervous human. *Vet J* 2009;181:70–1.
- [75] Birke L, Hockenhuil J, Creighton E, Pinno L, Mee J, Mills D. Horses' responses to variation in human approach. *Appl Anim Behav Sci* 2011;134:56–63.
- [76] Verrill S, McDonnell S. Equal outcomes with and without human-to-horse eye contact when catching horses and ponies in an open pasture. *J Equine Vet Sci* 2008;28:309–12.



- [77] Hartmann E, Søndergaard E, Keeling LJ. Identifying potential risk situations for humans when removing horses from groups. *Appl Anim Behav Sci* 2012;136:37–43.
- [78] Jørgensen GHM, Fremstad KE, Mejdell CM, Boe KE. Separating a horse from the social group for riding or training purposes: a descriptive study of human-horse interactions. *Anim Welf* 2011;20:271–9.
- [79] Hausberger M, Roche H, Henry S, Visser EK. A review of the human–horse relationship. *Appl Anim Behav Sci* 2008;109:1–24.
- [80] Hausberger M, Muller C. A brief note on some possible factors involved in the reactions of horses to humans. *Appl Anim Behav Sci* 2002;76:339–44.
- [81] Hinde R. Towards understanding relationships. Londres: Academic Press; 1979.
- [82] Sankey C, Richard-Yris MA, Leroy H, Henry S, Hausberger M. Positive interactions lead to lasting positive memories in horses, *Equus caballus*. *Anim Behav* 2010;79:869–75.
- [83] Payne E, DeAraugo J, Bennett P, McGreevy PD. Exploring the existence and potential underpinnings of dog-human and horse-human attachment bonds. *Behav Processes* 2016;125:114–21.
- [84] McGreevy PD, Henshall C, Starling MJ, McLean AN, Boakes RA. The importance of safety signals in animal handling and training. *J Vet Behav* 2014;6:382–7.
- [85] Henshall C, McGreevy PD. The role of ethology in round pen horse training—a review. *Appl Anim Behav Sci* 2014;155:1–11.
- [86] Rickards T. Trust-based leadership: creative lessons from intelligent horsemanship. *Creat Innov Manag* 2000;9:259–66.
- [87] DeAraugo J, McLean AN, McLaren S, Caspar G, McLean M, McGreevy PD. Training methodologies differ with the attachment of humans to horses. *J Vet Behav* 2014;9:235–41.
- [88] Roberts M. The Man who listens to horses. London, UK: Arrow Books; 1997.
- [89] Krüger K. Behaviour of horses in the “round pen technique”. *Appl Anim Behav Sci* 2007;104:162–70.
- [90] Koster D, Wegert AC, Bronicki BB, Warren-Smith A. 2009. Further investigations into the ethological relevance of round-yard training of horses. In: Proceedings of the 5th Conference of the International Society for equitation science, Sydney, Australia, 12–14 July, 2009. International Society for Equitation Science; 2009. p. 35.
- [91] Warren-Smith AK, McGreevy PD. Preliminary investigations into the ethological relevance of round-pen (round-yard) training of horses. *J Appl Anim Welf Sci* 2008;11:285–98.
- [92] Birke L, Hockenhull J. Journeys together: horses and humans in partnership. *Soc Anim* 2015;23:81–100.
- [93] McGreevy PD. A modern dog’s life. Sydney, Australia: UNSW Press; 2009.
- [94] Bradshaw JWS, Blackwell E, Casey RA. Dominance in domestic dogs—useful construct or bad habit? *J Vet Behav* 2009;4:135–44.
- [95] Richardson K, Murray JAMD. Fiber for performance horses: a review. *J Equine Vet Sci* 2016;46:31–9.
- [96] American Veterinary Society of Animal Behavior (AVSAB). Position statement on the use of dominance theory in behavior modification of animals. <https://avsab.org/resources/position-statements/>; [accessed 14.12.2016].
- [97] Hartmann E, Christensen JW, Keeling LJ. Training young horses to social separation: effect of a companion horse on training efficiency. *Equine Vet J* 2011;43:580–4.
- [98] McLean AN, McGreevy PD. Ethical equitation: capping the price horses pay for human glory. *J Vet Behav* 2010;5:203–9.