Are we on the same page? A review of horse training approaches, terminology use and method reporting within the scientific literature

Ella Bartlett*[a], Emily J. Blackwell[a], Lorna J. Cameron[b] & Jo Hockenhull[a,c]

[a]Animal Welfare and Behaviour Group, Bristol Vet School, University of Bristol, Bristol, BS40 5DU, UK

[b]Hartpury University, Gloucester, GL19 3BE, UK

[c]The Donkey Sanctuary, Sidmouth, Devon, EX10 0NU, UK

Abstract

It is vital that the impact of different horse training approaches (TAs) is studied, to ensure the methods employed are effective, ethical and do not compromise equine welfare. Whilst a range of TAs are referred to within the scientific literature, no research has explored whether the way these are applied, described and reported is consistent across existing studies. This is problematic as differences in training application and method reporting may alter study outcomes, limit potential for inter-study comparison, and impede effective scientific communication. A systematic search of the published literature from three online databases (SCOPUS; Web of Science; PubMed) was used to identify studies that apply horse TAs within their methodology. A description of the training protocols was extracted from each paper and used to categorise the training approach(es) employed, identify their defining characteristics and assess consistency within TA description. A total of 75 studies published between 1992 and 2021 were reviewed using a mapping review method, within which ten distinct TA categories were identified. Six of these aligned directly with the principles of learning theory, however, distinct differences in their application were identified. The four remaining categories were less clearly defined with a wider range of terms used to describe them. Limited information provided within some methodologies would render accurate study replication impossible. This study highlights a need for more consistent and detailed reporting of horse TAs within the scientific literature and, subsequently, some initial recommendations to promote this have been made. This would facilitate communication between researchers and further enable comparisons to be made across studies, ultimately improving understanding of modern horse training practices and their welfare impact.

Keywords: Horse Training; Terminology; Equine Welfare, Science Communication

Ethical approval statement

The nature of this project meant that ethical approval was not required as it was a purely desk-based review of existing published work.

1.0 Introduction

Animal centred industries are continuously striving for the implementation of more 'welfare friendly' and socially acceptable management and training practices to help ensure their continuation by obtaining and maintaining 'legitimacy' in the public eye (Duncan et al., 2018; Hampton et al., 2020). This is particularly true of equestrian disciplines, where a series of 'bad press' incidents have prompted considerable public uproar surrounding the use of horses in modern sport (Holmes and Brown, 2022; Wolframm et al., 2023). One area that appears to be of greatest concern to both spectators (Graham and McManus, 2016; Williams et al., 2019) and industry stakeholders (Furtado et al., 2021; Horseman et al., 2016) is the continued use of training practices considered to be highly aversive, involving high levels of punishment or that conflict with the horse's learning capabilities. Consequently, there is a growing need for more ethical and socially acceptable horse training approaches to be utilised, whist still ensuring that the approaches are effective in meeting training aims and minimise the risks to safety associated with horse riding and handing activities (Havlik et al., 2010; Starling et al., 2016).

The term 'training' is typically used to mean *'the intentional modification of the frequency and/or intensity of specific behavioural responses'* (Goodwin et al., 2009), which can be achieved using a variety of different training approaches (TAs), applied together or independently. For example, desirable behaviours can be rewarded to increase their frequency, or undesirable behaviours reduced through the application of punishment. For horse training to be both effective and ethical it is vital that TAs are carefully selected to ensure they align with the underpinning cognitive principles of animal learning (Baragli et al., 2015; McGreevy & McLean, 2007; McLean & Christensen, 2017) with careful consideration given to their limitations and potential welfare implications. For this to be achieved, a comprehensive and unbiased understanding of different TAs must first be established. This relies on robust, well-reported and peer-reviewed research being conducted to compare different TAs, investigate their effect on the horse and assess their potential to influence welfare, to ultimately optimise horse training practices.

Over the last 30 years, the number of published studies that focus on horse training has rapidly increased as equitation science continues to be a growing area of research interest (McGreevy, 2007; Randle and Waran, 2019). Whilst this is a positive step towards improved understanding and subsequently more informed decision making in this area, the nature of equine research means that physical and financial constraints often limit the scale to which research can be conducted by a single research team (Pierard et al., 2015). Consequently, studies involving small and often heterogenous samples make up the body of work in this area which may contribute to reduced result credibility when studies are considered in isolation. Maximizing opportunities for inter-study comparison and method replication is therefore a vital step to increase confidence in the findings and subsequently facilitate their real-world implementation (Pierard et al., 2015; Randle and Waran, 2017, 2019). To achieve this, existing methods must be applied consistently across different research groups and the terminology used to describe them universally understood to facilitate clear communication both within the scientific community, and between researchers and individuals who are directly responsible for training horses (Randle, 2016; Thompson & Haigh, 2018). The need for this is particularly pressing given that poor understanding of horse training terminology is frequently highlighted as an area of concern within both horse-owner and practitioner populations (e.g. Brown and Connor, 2017; Guinnefollau et al., 2019; Luke et al., 2023; Warren-Smith and McGreevy, 2008) and may further hinder research interpretation and continued application at the industry level.

Whilst attempts to review the equitation science literature have been made (e.g. Dumbell et al., 2019; Pierard et al., 2015), none aim to identify which TAs are receiving the greatest research

focus and assess methodological and terminology consistency across existing work. A comprehensive review of existing TAs and their application is critical to informing the development of future study methodologies and facilitate consistent reporting of equine training protocols within the literature. This would further enable comparisons to be drawn across multiple studies, increasing confidence in their findings and ultimately improving understanding of modern horse training. Consequently, this study utilises a mapping review (Leenaars et al., 2021) approach to answer the following questions: (1) which horse training approaches have been applied within the published scientific literature? (2) Which terms are used to describe the TAs identified? (3) Are inconsistencies in terminology use or study reporting that may limit inter-study comparison present within existing work?

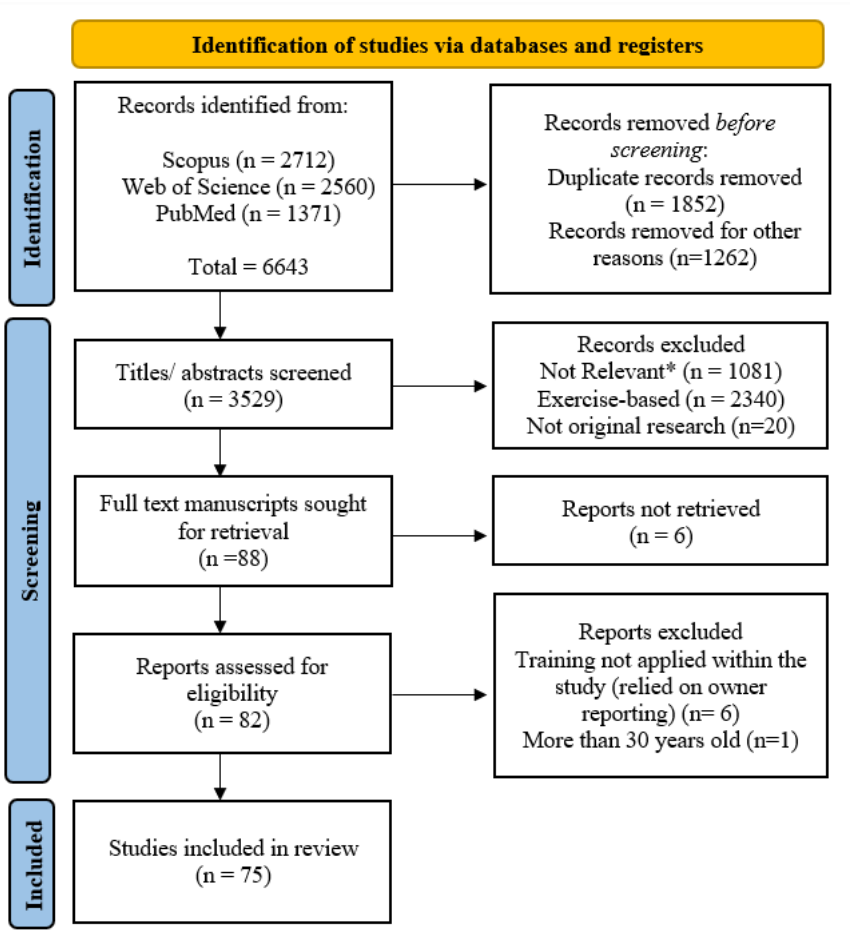
2.0 Method

2.1 Study identification and retrieval

In December 2021, a literature search for published research articles written in English was conducted using three online databases (SCOPUS, Web of Science and PubMed). Variations of the following search terms were applied:

(“*training method"* OR *"training"* OR *"punishment*” OR *"reinforcement"*) AND (“*horse"* OR *"pony"* OR *"equidae"* OR *"equine"*) AND NOT *"exercise"*

Search terms were intentionally broad to capture as widely as possible. The term ‘exercise’ was excluded to minimise the use of the term ‘training’ to mean physical conditioning, rather than a means of behaviour modification. Despite this, the search still yielded many studies that were unrelated to the topic of interest, leading to a considerable number being excluded *(fig. 1).* Literature were exported into Mendeley Desktop referencing software for sorting, and later to Microsoft Excel for data extraction. Titles and abstracts were initially screened by one author (EB) and were excluded from further review if they (1) did not refer to the species of interest, (2) did not describe the application of (non-physical) training method/s, (3) were not original primary research, or (4) were published more than 30 years ago. A decision was made to remove studies where the training method is not being directly applied (e.g. survey-based studies) as these methodologies typically rely on horse owners reporting on their own training approach and are therefore subject to a greater level of bias (Fenner et al., 2020) or may lack sufficient detail within their description to facilitate review. Studies that focused on other equids (e.g. donkeys) as the main training subject were also excluded, as it is generally recommended that horse training strategies are not directly applied to donkeys (McLean et al., 2019) given the differences in their behavioural response to threats and potential differences in spatial reasoning (Osthaus et al., 2013). Remaining articles were retained for full-text review.



**Titles/ abstracts were completely unrelated to the topic or about a different species (not Equidae)*

Figure 1 The number of articles included and excluded at each stage of the retrieval process. Adapted from the updated PRISMA reporting guidelines *(see* Page et al. (2021)).

2.2 Coding of studies and data extraction

A description of the training protocols applied within each study were extracted verbatim from their methodology section. These descriptions were then reviewed to identify the defining characteristics and learning theory principles that underpinned each of the techniques used to modify horse behaviour within these protocols. This information was then used to group the techniques into individual TA categories. As some studies involved applying more than one TA, the aim was not to categorise each article but rather each training approach described within an article. The descriptions of training and the terminology used were recorded and later assessed for consistency against other work that involved the same TA. To increase reliability of the assessment process, 15 of the studies (representing 20% of those included) were randomly selected and assessed by two authors (EB and EJB), with the latter blinded to all other study information. Inter-assessor agreement was assessed using IBM® SPSS® Statistics (V29) software, and any discrepancies between assessor coding were recorded and later discussed until a consensus was reached. Agreement between assessors across 20% of the sample was almost perfect (κ=0.952; P<0.001) (Sim and Wright, 2005) with only a minor difference seen in relation to 'habituation' and how this should be coded. These discrepancies were easily resovled during a follow-up discussion where consensus was reached.

The following additional information was also extracted from each study: (a) bibliographic information (e.g., authors, publication date and publishing journal); (b) sample size; (c) study aim and variables; (d) the reasons for applying training and (e) additional notes about the training (for example 'type of reinforcer' given, where appropriate). Any areas within the text that had potential to limit accurate study interpretation or replication were recorded for further discussion.

3.0 Results & Discussion

3.1 Overview of studies

A total of 75 studies were included within this review *(supplementary file 1)*. Only six studies were published before the year 2000 *(fig. 2)*, which may reflect the growing interest in equitation science over the last 20 years, perhaps in response to the growing recognition of animal welfare and sentience (Duncan, 2006; Proctor, 2012) resulting in greater consideration for the ethical nature of horse training (McLean & McGreevy, 2010; McLean & McGreevy, 2010). It may also have been driven by the formation of the International Society for Equitation Science in the early 2000s, who advocate for the inclusion of science within equitation (McGreevy, 2007).

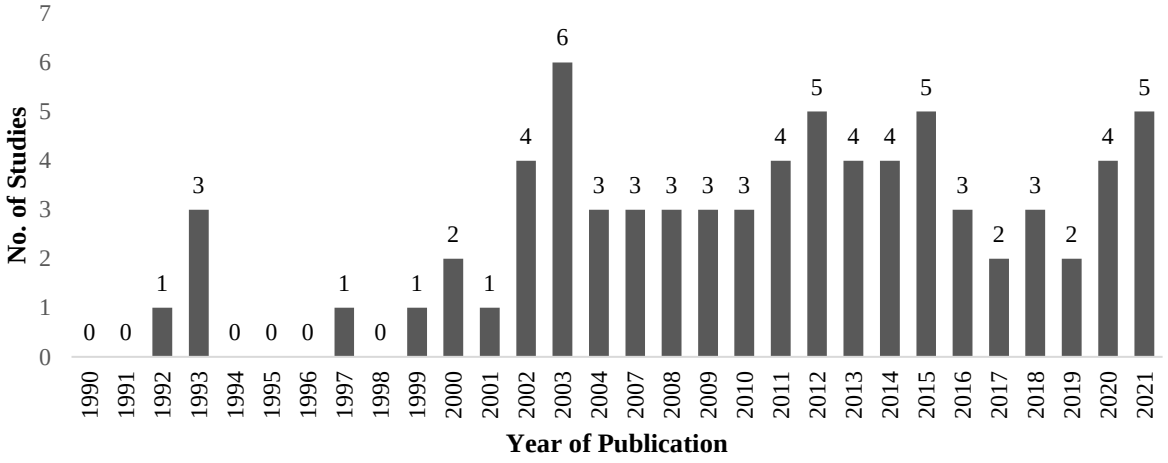


Figure 2 Studies included within this review (n=75) displayed by year of publication

Authors' reason for applying training within each study loosely fell into one of three categories: (1) 'training approach comparison', (2) 'training approach application' or (3) 'equine cognitive research'. 'Training approach comparison' studies involved applying more than one TA, and comparing the outcomes associated with each. 'Training approach application' studies applied one training approach and assessing their viability when applied to horses, or documenting the outcomes associated with the approach (without comparison to other approaches). 'Equine cognitive research' studies were considered to be those where the primary aim was to investigate factors associated with equine learning, memory or cognitive abilities. Any training applied within these studies was only used to facilitate data collection (for example, teaching horses to touch a specific shape to enable memory testing) and was not the focus of the research.

3.2 Training approach categorisation

Following review of the training protocols described within each study, ten unique TAs were identified by the assessors *(see Table 1).* Six of the TA categories ('positive reinforcement'; 'negative reinforcement'; 'combined reinforcement'; 'positive punishment'; 'combined positive punishment and negative reinforcement'; 'habituation') were considered to align directly with associative or non-associative learning principles (McLean and Christensen, 2017), whilst the remaining four TAs either involved utilising a combination of different learning theory principles, were underpinned by concepts that do not align with learning theory,

or were reported in a way that meant it was not possible to definitively identify the learning principles associated with them.

Table 1 Key characteristics of horse training approaches identified within the published scientific literature.

Training approach category identified within this review *(alternative terminology used within the scientific literature)*	**Number of studies that involve applying the training approach**	**Key characteristics of training approach**	**Overview of studies and additional comments**
Positive Reinforcement *('clicker training', 'differential-reinforcement-of-other-behaviour', 'food reinforcement', 'food reward', 'reinforcement', 'reward learning', 'reinforcement training')*	41	'Positive reinforcement' (PR) was defined as 'addition of a pleasant stimuli after a behaviour is performed to increase the likelihood that it is repeated'. If used in conjunction with NR, this was instead classified as 'combined reinforcement'.	• 11/41 (26.8%) studies referred to the learning process that underpinned this approach as only 'reinforcement', which does not differentiate it from negative reinforcement. • None of the studies mentioned 'negative punishment', even though both assessors considered it to be a key feature of the training applied in at least six of the PR studies. • 40/41 (97.6%) used food as the reinforcer (some also used tactile reinforcement alongside this too), whilst the remaining study used 'scratch' to train only foals. • A secondary reinforcer was used in 22/41 (52.7%) studies (there was some debate as to whether 'the sound of food landing in a bucket' constitutes a secondary reinforcer (e.g. (Kieson et al., 2020), although a decision was ultimately made to exclude this). Within these the most commonly used was a 'clicker (10/22), followed by the use of the word 'good' (7/22), a buzzer sound (2/22), 'electric chime sound' (1/22) and one study simply referred to the use of a 'tone'. • None of the studies that focused on applying positive reinforcement involved training any behaviours associated with ridden work.
Negative Reinforcement	20	'Negative reinforcement (NR)' was defined as 'removal of aversive stimuli after a behaviour is performed to increase the likelihood that it is repeated'. In all NR studies, pressure was applied until the horse showed the desired response. It was also common for this pressure to first be used to obtain the behaviour	• All (100%) of studies referred to this approach as 'negative reinforcement'. • In three studies, assessors felt that another approach (e.g. positive punishment or positive reinforcement) would also have played a role in shaping the horses' response, although this was not mentioned by study authors. • All but one study (19/20, 95%) applied only 'contact' negative reinforcement, whilst one used a combination of 'contact' and 'no-contact' pressure *(see discussion for definitions of these).*

		(for example applying pressure to the horses side until they take a step away) and later become the cue. If used in conjunction with PR, this was classified as 'combined reinforcement'. If used with PP, this was considered 'combined positive punishment and negative reinforcement'.	• 6/20 (30%) did not state whether any pressure applied was escalated or maintained until the desired response was shown by the horse. • 13/20 (65%) stated that the pressure was escalated. • Only one studies clearly said that pressure applied was kept consistent until the desired behaviour was seen. • 5/20 (25%) studies involved training behaviours associated with ridden work.
Positive Punishment	1	'Positive punishment (PP)' was defined as 'addition of aversive stimuli after a behaviour is performed to reduce the likelihood that it is repeated'. If used with NR, this was considered 'combined positive punishment and negative reinforcement'.	• Only one study clearly described the use of positive punishment. • The aversive applied in this study was the delivery of 'immediate and ventral pressure on halter lead'.
Combined Reinforcement *('blended positive and negative reinforcement')*	3	'Combined reinforcement (CR)' involved the use of both negative and positive reinforcement together to reinforce the same behaviour.	• In all studies, NR was to elicit the performance of a desired behaviour at which point any pressure applied is released (NR) and food reinforcement delivered (PR). • 2/3 (66.6%) studies called it 'combined reinforcement' whilst one never used this term, but just referred to 'the additional of positive reinforcement to negative reinforcement'. • All studies applied 'contact' pressure for the NR element and food reinforcement for the PR part of the protocol. • One study used a secondary reinforcer (word *'good'*) to mark a correct response. No others reported the use of secondary reinforcers. • Only one study involved training behaviours associated with ridden work (shaping a halt response on long lines). This was the only study within this review that involved using PR for ridden behaviours. They used a 'telemetrically operated reward device' to remotely deliver a reinforcer (molasses water) directly to the horse's mouth through the bit. This may support the idea that positive reinforcement is (or is perceived to be) difficult for the rider to deliver in training (McLean and McGreevy, 2004; Waran et al., 2002).
Combined Positive Punishment and Negative Reinforcement *('avoidance learning'; 'avoidance conditioning')*	2	'Combined positive punishment and negative reinforcement' involved the combined use (applied sequentially) of positive punishment, followed by negative reinforcement.	• Both of these studies referred to their approach as 'avoidance conditioning/ learning'. • In both studies, trainers preceded the desired behaviour with a noise cue, if no response was given and aversive was applied (PP) which only ceased when horses performed the desired behaviour (NR). • 'Electric shock' and 'puff of air' were the aversives used.

Habituation	4	Habituation was defined as 'repeated exposure to a stimuli that does not result in any reinforcement or punishment which results in decreased response to the stimulus'.	• It was difficult for assessors to separate out habituation as its own TA, as it was frequently combined with techniques based around associative learning and was considered to play a role in shaping equine behaviour even when trainers were not consciously applying it. For this reason, it should be noted that >4 studies would have involved the use of this approach, however only four specifically outlined a protocol that highlighted habituation as a key feature.
Conspecific Model *('round pen technique', 'Join up', 'Monty Roberts technique', 'natural horsemanship', 'natural training', 'Parelli Natural Horsemanship', 'round pen technique', 'sympathetic training', 'training')*	14	Emphasis placed on horse-human interaction/ communication through the use of body language. Attempts to replicate horse-horse communication were a key theme throughout. It was common for early stages of the training process to involve teaching the horse to look at/ approach/ spend time near the trainer. This was not mentioned in relation to any other TAs. This was most commonly achieved with the use of NR, although some also describe using PP or PR (never food, only tactile reinforcement). Much more reliance on the use of 'non-contact pressure' than any of the studies that were classified as using purely NR (which all involved making contact with the horse). 'Desensitization of the horse to touch and equipment' also appeared to be a common feature of this TA, however, details of how this was achieve were lacking in many of the studies. Some 'sensitisation' to pressure cues were also alluded to. Elements of this method appeared to be unique to the trainers themselves or reliant on trainer skill (which may be why many of the studies failed to outline a 'step-by-step' protocol, as it relies on the trainer observing, interpreting and responding to each individual horse and adapting their approach accordingly).	• Learning theory principles mentioned by study authors did not fully align with those identified by assessors in any of the studies *(see table 1).* • In 10/14 (71.4%) studies, the assessors felt it was not possible to reliably determine which learning principles were being applied within the study methodology. • Habituation, negative reinforcement and positive punishment were most frequently identified by assessors. • 9/14 (64.3%) studies aimed to compare the outcomes associated with 'conspecific model' to those of different training approaches. It was compared against NR (n=1), PR (n=2) and conventional training (n=6). • 9/14 (64.3%) studies involved training behaviours associated with ridden work.

Conventional Training *('traditional'; 'European training method')*	9	Not possible to consistently identify key feature of this approach, as its meaning appears to vary between studies, and in most instances was not described. The term was typically used to refer to methods considered to involved habituation, NR and some PP. It was less likely to involved adding reinforcement (PR) or place emphasis on attempting to replicate equine communication. More focus was placed on detailing the tasks horses were required to complete (e.g. lunging, accepting a rider) rather than outlining the methods used to achieve this.	• In 7/9 (77.8%) studies, the assessors felt it was not possible to reliably determine which learning principles were being applied within the study methodology. This also meant that it would not be possible to accurately replicate these studies. • 6/9 (66.7%) studies involved training behaviours associated with ridden work.
T-touch Equine Awareness Method	1	Only one study that reported using this approach was included in this review, which ultimately means that it is not possible to identify common features across multiple studies. The only feature that differentiated this from those other TA categories was the addition of 'bodywork' as part of the training session. Other than this, assessors considered the approach described to simply involve applying NR, and at times PR, to influence horse behavioural response to handler cues when being asked to work over/ around obstacles. Interestingly, the study authors reports that this training approach *'does not use force or physical pain to motivate the horse to comply'* and described it as a *'non-aversive'* technique, despite the fact that NR features quite heavily as part of this approach.	n/a (only one study)
Imprinting *('Imprint training')*	3	'Imprint training' involved exposing foals to a range of different stimuli and handling techniques shortly after they are born. The way in which this training is applied varied across studies, but always included rubbing the foal all over its body and exposing it to novel procedures (e.g. electric clipper, plastic bags, water spray) whilst	• One study began 'imprint training' within 10 minutes of foals being born. Both other studies trialled applying imprint training at various different timepoints within the for 72 hours of a foals life.

	restraining the foal so that it could not evade the treatment applied.	

Along with identifying which TAs have been studied within the scientific literature, a secondary aim of this study was to evaluate the way in which the methodologies of these studies were reported, which included exploring terminology use and identifying areas within the text that could limit accurate study interpretation, replication, or reduce the impact of the findings in practice. This assessment resulted in four key areas for discussion being identified. These were (1) the use of inconsistent terminology and poorly described methodologies (2) within-approach variation in method application (3) lack of information provided in some studies limiting readers ability to identify/ replicate the methods applied, and (4) misrepresentation/ mislabelling of learning principles that underpin an approach. These points will be further discussed and examples of each provided. Further discussion around the fact that 'negative punishment' was not mentioned by any authors, and the limited recognition of 'combined positive punishment and negative reinforcement' as an approach to modify horse behaviour is also provided.

3.3 Inconsistent terminology and poorly described methodologies

Whilst only ten unique TA categories were identified within this review, 29 different terms were used by study authors to describe the training applied within their studies *(Fig. 3).* Whilst some of these represent well defined, pre-existing scientific terminology (e.g. relating to operant and classical conditioning), others were more reminiscent of subjective descriptors (e.g. 'Sympathetic', 'Natural') that appear to reflect the intentions behind the way in which horses were trained, but do not provide information about the strategies applied to modify horse behaviour. Additionally, several of the terms used to describe the training (e.g. 'conventional' or 'traditional') were specific to the countries/ regions within which the studies were conducted.

'Avoidance-conditioning'	'Food reward'	'Parelli Natural Horsemanship'
'Avoidance-learning'	'Habituation' (4)	'Positive punishment'
'Blended positive and negative reinforcement'	'Imprinting' (3)	'Positive reinforcement' (25)
'Clicker training'	'Join up'	'Reinforcement' (8)
'Combined reinforcement'	'Monty Roberts'	'Reward learning'
'Conventional' (3)	'Natural horsemanship' (2)	'Round-pen-technique' (3)
'Differential-reinforcement-of-other-behavior (DRO)'	'Natural training' (4)	'Sympathetic' (5)
'European training method'	'Negative Reinforcement' (20)	'Tellington-Touch Equine Awareness Method'
'Food reinforcement' (4)	'Negative reinforcement + positive reinforcement'	'Traditional' (4)
	'no-reinforcement'	'Training' (2)

Figure 3 Phrases used to describe the training approaches applied within the studies (n=75) reviewed. Those used in more than one study are accompanied by a number to illustrate how many studies used this phrase.

The use of these more subjective or location specific terms to describe the training applied would not have been so problematic if these were accompanied by accurate descriptions of what this training constitutes. However, in many cases this was lacking, with the apparent assumption being made that these terms alone were sufficient to communicate the way in which training was applied, and subsequently renders the reader unable to understand how the training was applied or reliably replicate the results. In place of clear protocol descriptions, broad statements such as *"the horse was taught to accept the saddle"* and *"getting the horse accustomed to the whip's movements over its head"* were commonplace within the studies reviewed. Statements of this nature do not specify how these steps were achieved, the extent to

which stimuli were applied, whether the horse was systematically desensitised, whether the horse was restrained, or if any punishment/ reinforcement were applied to facilitate this process.

Variation in the terms used to describe training was most evident in TAs considered to fall within the 'conspecific model' category, with nine different terms used when describing these *(Table 1).* This raised the question of whether these should be further categorised as different approaches. This was initially attempted; however, it was not possible to identify distinctive features that clearly differentiated between these approaches based on the descriptions alone. As a common feature across these studies was the fact that they are reportedly based on how horses communicate with other horses in a naturalistic setting, with trainers applying a 'herd-leader' premise to explain human-to-horse attachment (McGreevy et al., 2009), the term 'conspecific model' (DeAraugo et al., 2014) was used. Several of the terms used to describe training within this category relate to the people (e.g. 'Monty Roberts', 'Parelli') who developed or popularised their own approach. Given this, it was initially assumed that defining features of these would have been clearly evident and render them sufficiently different to classify as separate approaches. However, this was not possible, and even though some training techniques were trademarked (e.g. Join up®) other studies that reported using a very similar 'round-pen technique' which (based on the, often limited, description given) appeared to follow the same process, but do not specifically attribute this to the trademarked method.

Ultimately, the reliance on poorly defined and often subjective terminology in many of the reviewed studies highlights considerable concerns around the quality and value of the research being produced. Not only does this limit opportunities for study replication but also hinders accurate result interpretation and reduces real-world utility of the findings.

3.4 Variation in method application

Even when the wording used to describe TAs was consistent across studies, this did not necessarily mean that the way in which the methods were applied was comparable. In several instances, differences in TAs application were identified even within studies that reportedly used the same approach. Differences in application will again limit the potential for inter-study comparison and could alter how horses respond to training, thus reducing ability to generalise study outcomes to one specific approach. For example, the application of 'negative reinforcement' (NR) involves removing something aversive (e.g. pressure) to reinforce a behaviour, and is the most commonly used method in horse training (McLean, 2005; McLean and Christensen, 2017). However, there are a variety of ways in which NR can be used in practice. This review highlighted that the type of aversive stimuli applied during NR protocols fell into two distinct categories; one involving the trainer or training equipment making physical contact with the horses' body (e.g. pressure is applied through a lead rope or reins), the other involving no physical contact, with the trainer instead using their body position, posture or equipment to direct the horses movements within an enclosed space (e.g. stable, round pen). Further consideration needs to be given to whether or not NR involves making physical contact with the horse, and work conducted to compare the effects of each on equine learning and welfare. If substantial differences are seen, it may be beneficial to consider these as two separate methods in future work – for example referring to them as 'contact' or 'no-contact' negative reinforcement, rather than using the one term to refer more generally to both. This further distinction between the approaches may also be relevant when the welfare implications of NR are discussed, as it will likely influence the way in which the approach is perceived. Anecdotally, training approaches that involve 'no-contact' NR are often viewed or

marketed as being 'force free', thereby implying that it is more 'ethical' or has less potential to compromise welfare, which could result in psychological distress being overlooked.

Another observation made when reviewing studies that involve applying NR was that several did not clearly report whether the trainer waited for the full desired behavioural response to be performed before releasing the aversive applied, or whether they reinforced progressive steps towards the desired behaviour ('shaping'). Not only is this problematic in the sense that it would not facilitate study replication, but both Egenvall et al. (2012) and Warren-Smith et al. (2005) suggest this difference in application may have implications for horse learning success, and thus has potential to alter study findings. In addition, many studies failed to report whether the pressure exerted was escalated, or simply maintained following its application. It's logical to assume that this difference may influence the outcome of studies that use 'completion time' or 'latency to perform desired behaviour' as a measure of TA success, and may ultimately influence how horses perceive and respond to the training.

The application of positive reinforcement (PR) was similarly subject to variation in application across studies. Whilst the majority used food-based reinforcers *(see Table 1)*, the type of food given differed between studies, from perceived 'low value reinforcers' such as *'handfuls of the horses' usual hay'*, to those that are unlikely to be given in large quantities within the horses' normal diet, such as the *'pieces of carrots, apples, vanilla wafers, sugar cubes, crackers, bread, and sweets'* used in another. Whilst the impact of reinforcers perceived 'value' on horse training performance has not been explicitly studied, reward preference and volume (which was also not standardised across equine studies) has been shown to predict performance outcomes in dog training (Riemer et al., 2018; Vicars et al., 2014). It's therefore possible that these differences in reinforcer value could influence equine performance related outcomes and subsequently prevent reliable cross-study comparison. Furthermore, some studies reported that horses were food deprived (for as much as 8 hours in one instance), or that their diet was altered prior to training in an attempt to increase food motivation. This in itself may be considered ethically questionable and highlights a need to acknowledge the wider welfare implications associated with different TAs (Baumgartner et al., 2020; Clauss et al., 2014) that may exist outside of formal training sessions. The way in which food restrictions were reported was inconsistent between studies, or not mentioned at all, meaning that it was not always possible to reliably determine whether or not horses' diet had been altered prior to training.

3.5 Lack of information about study methodologies provided

Within the scientific community, it is widely accepted that the 'method' section of a research study should be written in sufficient detail to enable replication (Avey et al., 2016; Strech and Dirnagl, 2019). However, this was not always seen within the horse training studies reviewed. Authors frequently failed to provide the level of detail needed to fully understand or replicate the methods used. An example of this seen across many of the studies was the fact that information about the individuals applying the training was limited or not provided. Within some studies, specialist trainers were recruited to apply the training approaches, whilst in others, it appears to be the researchers carrying out this part of the methodology themselves. However, this was not always made clear as the amount of information given about the trainers was highly variable, with many studies failing to provide sufficient (or at times any) information about the trainers, their ability or experience *(see Table 1)*. Very few stated which, if any, qualifications trainers possessed, or applied any objective means to assess their ability, with many providing only vague and subjective statements, such as *'trainers were highly qualified'*. This is concerning given that fact that trainer experience has been shown to

influence equine stress response during training (Kimura et al., 2023; Kydd et al., 2017) and correct timing when applying techniques that involve reinforcement or punishment is considered to be vital (McLean and Christensen, 2017). There is also some evidence to suggest that handler sex, which is another factor that was not widely reported within the studies, may influence equine behavioural response (Anzulewicz et al., 2021). One study within this review mentioned that they specifically chose to use two *'inexperienced trainers'*, another split the sample horses between one experienced and one inexperienced trainer, and one study involved the horses' owners applying the training. Whilst potentially more representative of industry practice, the use of inexperienced trainers calls into question the reliability of the finding, as any reported effects may have been due to the way in which these individuals applied the technique, rather than a consequence associated with the TA itself. Furthermore, it has been shown that horses can differentiate between humans and, whilst they don't seem to show a preference for a familiar individual (Ijichi et al., 2018), there is evidence to support the idea that they associate handlers and trainers with the valance of past experiences (d'Ingeo et al., 2019; Hartmann et al., 2017; Sankey et al., 2010). Thus, any previously learned association with the trainer also has the potential to influence the horses' response to a TA. Furthermore, studies rarely stated whether trainers were naïve to the research hypothesis. Horses have been shown to use human pointing and body position cues during object choice tasks (Proops et al., 2013, 2010) and respond to attentional cues that include the human gaze (Proops and McComb, 2010). Knowledge of the research question or study variables being measured could therefore have led to trainers inadvertently (or deliberately, given that in several instances trainers were professionals whose livelihood was reliant on the popularity of their training approach) altering the outcome. It is possible that many of the trainers within these studies were in fact blinded to the research question, and that this was just not acknowledged in the final published report. This is disappointing given that this would be a relatively simple way of increasing experimental rigour, a feature of equine research that is often criticised (Thompson and Haigh, 2018).

3.6 No reported use of Negative Punishment

A key finding that warrants further discussion is the fact that none of the research articles reviewed reported using 'negative punishment' to modify horse behaviour, despite the fact that both of the assessors in our study agreed that this approach was utilised by some. Negative punishment (NP) is one of the four operant conditioning quadrants, and involves the removal of something appetitive to reduce the occurrence of a behaviour. Speculations can be made as to why authors did not mention NP. It's possible that it is simply an error on the authors part, and they may genuinely be underestimating or failing to understand the role that this quadrant plays in training. If this is the case, it may be wise for the scientific community to place as much emphasis on ensuring their own members have a clear understanding of learning theory as they do on investigating lay horse owners and trainers. Alternatively, authors may intentionally be underemphasising the role of NP in their study as ethical approval for research that does not claim to involve using any punishment may be more likely to be granted.

Discussion surrounding NP, its role in horse training, and whether PR can even be used without it coming into play, continue to be had amongst equitation science researchers, so the fact that its use appears to be under-reported by academics themselves adds a new dimension to this area of discussion. Further work is ultimately required to better understand perceptions and knowledge of NP within the equestrian sector, as failing to acknowledge its role in training may further contribute to the use of punishment in horse training, or the use of NP mislabelled as PR.

3.7 A note about combined PP and NR

Unlike 'combined reinforcement' which is a term that has become relatively commonplace in relation to horse training (McLean and Christensen, 2017), the use of combined PP and NR appears to have received less attention. These two operant condition quadrants are often considered to be linked in the sense that poorly timed NR can easily become PP (similarly, PR and NP are also considered to be linked in this way) (McLean, 2005; McLean and Christensen, 2017), yet their combined use is not widely discussed. The apparent lack of regard for this is problematic as we posit it is likely reflective of regular training practice within the industry. For example, if a rider cues their horse to walk on and the horse does not respond in the desired way, the rider may 'give the horse a kick' or 'tap with the whip' (PP - as this occurs after the undesirable behaviour occurs) and then continue to apply strong leg pressure which only ceases when the horse walks on (NR). It is vital that the application of multiple and prolonged (and potentially escalating) aversives in these instances is not overlooked or mislabelled as solely involving NR. Doing so may increase the likelihood that equine welfare is compromised, through increased use of aversives and reduced trainer awareness of their own actions. This subject was also raised by Henshall (2021), who suggests reconceptualising 'positive punishment' and 'negative reinforcement' in horse training as a single continuum, rather than considering these separate training modalities, to better reflect how horses experience their application. Ultimately, greater consideration regarding the way in which 'combined PP and NR' is defined and discussed within the equestrian sector is warranted to encourage more effective and ethical training.

3.8 Limitations

It is likely that the search terms and study retrieval process used will not have captured every paper that involves horse training, and instead should be considered to provide an overview of existing horse training research published in English, rather than an attempt to document all work in this field. Furthermore, the ratio of TAs implemented within this research does not appear to be representative of real-world practice, as PR based methods were most commonly applied, despite NR being recognised the predominant method for training horses (McGreevy and McLean, 2009; McLean, 2005). This is likely due to the inclusion of equine learning studies, where PR is commonly used (Nicol, 2002; Pfaller-Sadovsky et al., 2020), and may also be partly attributed to the fact that research studies are likely to trial more novel methods to assess their potential for real-world use, rather than well-established practices. Additionally, methods using high levels of punishment may be less likely to be granted ethical approval or accepted for publication. It was also found to be common for individual researchers to publish multiple papers, which is likely to have biased representation of how the different TAs are described. For example, whilst five studies referred to the training they applied as 'sympathetic', the same author was involved with three of these.

3.9 Recommendations for future researchers

As researchers continue to investigate the impact of different TAs on training efficacy and equine welfare, it is vital that greater consideration is given to the way in which these studies are reported. Accurate and detailed reporting of a study's methodology is essential to provide background context, aid result interpretation and facilitate accurate replication in the future if deemed necessary. Robust method reporting also increases the perceived scientific and societal 'value' of a study, further justifying the inclusion of animals and increasing the extent to which

the research can be considered ethical (Strech and Dirnagl, 2019). To facilitate improved study reporting in the biomedical research field, regular reviews of existing research are carried out (Avey et al., 2016; Glasziou et al., 2008; Leung et al., 2018). When inconsistencies or problems within this are identified, effort can be made to mitigate future issues, for example through the development of guidelines like 'Animal Research: Reporting of In Vivo Experiments' (ARRIVE) (du Sert et al., 2020; Kilkenny et al., 2010; Percie du Sert et al., 2020). There is a distinct lack of similar reporting guidelines for animal research that sits outside of the biomedical field. Given the vast number of horse training studies emerging, it is vital that greater attention is paid to the way in which equitation science research is conducted and reported, to ensure the scientific integrity of research in this area is not compromised.

Some initial points for future researchers to consider prior to submitting research are provided in the form of a checklist *(Table 2).* However, a more formal approach to standardise equine training research reporting across the industry is warranted. The development of more comprehensive guidelines (similar to those used in other industries e.g. ARRIVE guidelines developed for the biomedical field) by a group of industry professionals would likely be beneficial. Similarly, the publication of work that aims to standardise terminology within this specific field, similar to Leach et al. (1984), should be encouraged. The promotion of a collaborative approach towards equine training research, for example through the development of a research consortium similar to that of 'ManyDogs' (https://manydogsproject.github.io/) (Alberghina et al., 2023) who aim to conduct reproducible cognition research relating to their target species, would also aid in establishing more consistent and robust equine research practices.

Table 2 Checklist for future research reporting

Points to consider when reporting horse training-related research
1) Has a full description of the training protocol that is sufficiently detailed to enable study replication been provided?
2) Has information about the individual/s carrying out the training, including their skills level/ experience, and their relationship to the horses used in the study, been provided?
3) Has detailed information about the study sample - including horse age, breed, sex, status (*'in foal'*, etc.), how they are usually managed, and the horses' training history (e.g. have they been exposed to a specific training approach before?) - been provided?
4) Have any changes to horses' usual management for the purpose of this study (e.g. whether horses were food deprived or their diet changed prior to training) been clearly stated and explained?
5) Have you outlined how any aversive stimuli have been applied? This includes detailing at what point they are applied, and explaining whether the intensity of the aversive is escalated or maintained throughout its application? Were there any attempts to standardise the way in which aversive stimuli were applied (e.g. use of a pressure gauge)?
6) Where reinforcement techniques were applied, is it clear whether attempts to perform the desired behaviour made by the horse were reinforced ('shaping'), or is only the full performance of a desired behaviour reinforced?
7) Have you considered whether any other learning principles (e.g. positive punishment, negative punishment) are playing a role in altering the horses' behaviour – if so, ensure this is acknowledged within your protocol.
8) If positive reinforcement is being used, has the type and amount (if applicable) of reinforcer been clearly reported?
9) Was the reinforcer assessed to ensure its efficacy in reinforcing behaviour (preference/ feeding motivation test)?
10) Was a secondary reinforcer used? Was the secondary reinforcer 'pre-conditioned'?
11) Where multiple or 'combined' training approaches are used – has the timing of each approach's application (particularly in relation to the other approaches used) been clearly explained?

4.0 Conclusion

Ultimately, it is extremely concerning that inconsistencies, and at times potential inaccuracies, were identified within the scientific horse training literature. Not only does this reduce the credibility of the findings which could potentially hinder their translation from research into practice and perpetuate the use ineffective or unethical horse training approaches, but it may be considered to reduce the overall scientific value of the research conducted. This is a topic that has been extensively discussed, and subsequently regulated, in the animal biomedical research field, but appears to be somewhat overlooked in companion animal behaviour and training research despite there being little reasoning to justify why this same level of scrutiny should not be applied to all animal research. Academics in this area frequently highlight 'poor understanding of learning theory terminology' or 'incorrect TA application' as an area of concern within the lay horse owning community. Yet this review highlights that it would be beneficial for work produced by the scientific community to be viewed with an equally critical eye. Despite the findings of this study, the vast amount of research being conducted in this area is undoubtably a positive step towards the aim of promoting more ethical equitation and retaining the equestrian industry's credibility and social licence to operate. Doing so is essential not only to promote improved human and horse safety during horse, but in enabling the equestrian industry to demonstrate its commitment to improving equine welfare.

Acknowledgements

We would like to thank Dr Lisa Riley for her invaluable support during the initial stages of this project.

Declarations

This research has not received any funding.

Conflict of interest statement

The authors have no conflicts of interest to declare.

Supplementary material

Supplementary file 1 – Categorisation of studies within this mapping review.

Authors contribution: All authors jointly conceptualised the study. E.B. developed the methodology, conducted the investigation, collected the data, conducted data analysis, and wrote the paper. E.J.B., J.H. and L.J.C. edited the paper and supervised the study.

References

Alberghina, D., Bray, E.E., Buchsbaum, D., Byosiere, S.E., Espinosa, J., Gnanadesikan, G.E., Guran, C.N.A., Hare, E., Horschler, D.J., Huber, L., Kuhlmeier, V.A., MacLean, E.L., Pelgrim, M.H., Perez, B., Ravid-Schurr, D., Rothkoff, L., Sexton, C.L., Silver, Z.A., Stevens, J.R., 2023. ManyDogs Project:

A Big Team Science Approach to Investigating Canine Behavior and Cognition. Comp Cogn Behav Rev 18, 59–77. https://doi.org/10.3819/CCBR.2023.180004

Anzulewicz, A., Fenner, K., Hyde, M., Heald, S., Burattini, B., Romness, N., McKenzie, J., Wilson, B., McGreevy, P., 2021. The impact of the sex of handlers and riders on the reported social confidence, compliance and touch sensitivity of horses in their care. Animals 11, 1–15. https://doi.org/10.3390/ani11010130

Avey, M.T., Moher, D., Sullivan, K.J., Fergusson, D., Griffin, G., Grimshaw, J.M., Hutton, B., Lalu, M.M., Macleod, M., Marshall, J., Mei, S.H.J., Rudnicki, M., Stewart, D.J., Turgeon, A.F., McIntyre, L., 2016. The devil is in the details: Incomplete reporting in preclinical animal research. PLoS One 11, 1–13. https://doi.org/10.1371/journal.pone.0166733

Baragli, P., Padalino, B., Telatin, A., 2015. The role of associative and non-associative learning in the training of horses and implications for the welfare (a review). Annali dell Istituto Superiore di Sanita 51, 40–51. https://doi.org/10.4415/ANN_15_01_08

Baumgartner, M., Boisson, T., Erhard, M.H., Zeitler-Feicht, M.H., 2020. Common feeding practices pose a risk to the welfare of horses when kept on non-edible bedding. Animals 10, 1–16. https://doi.org/10.3390/ani10030411

Brown, S.M., Connor, M., 2017. Understanding and Application of Learning Theory in UK-based Equestrians. Anthrozoos 30, 565–579. https://doi.org/10.1080/08927936.2017.1370216

Clauss, M., Schiele, K., Ortmann, S., Fritz, J., Codron, D., Hummel, J., Kienzle, E., 2014. The effect of very low food intake on digestive physiology and forage digestibility in horses. J Anim Physiol Anim Nutr (Berl) 98, 107–118. https://doi.org/10.1111/jpn.12053

DeAraugo, J., McLean, A., McLaren, S., Caspar, G., McLean, M., McGreevy, P., 2014. Training methodologies differ with the attachment of humans to horses. Journal of Veterinary Behavior 9, 235–241. https://doi.org/https://doi.org/10.1016/j.jveb.2014.05.001

d'Ingeo, S., Quaranta, A., Siniscalchi, M., Stomp, M., Coste, C., Bagnard, C., Hausberger, M., Cousillas, H., 2019. Horses associate individual human voices with the valence of past interactions: a behavioural and electrophysiological study. Sci Rep 9, 1–10. https://doi.org/10.1038/s41598-019-47960-5

du Sert, N.P., Ahluwalia, A., Alam, S., Avey, M.T., Baker, M., Browne, W.J., Clark, A., Cuthill, I.C., Dirnagl, U., Emerson, M., Garner, P., Holgate, S.T., Howells, D.W., Hurst, V., Karp, N.A., Lazic, S.E., Lidster, K., MacCallum, C.J., Macleod, M., Pearl, E.J., Petersen, O.H., Rawle, F., Reynolds, P., Rooney, K., Sena, E.S., Silberberg, S.D., Steckler, T., Würbel, H., 2020. Reporting animal research: Explanation and elaboration for the arrive guidelines 2.0, PLoS Biology. https://doi.org/10.1371/journal.pbio.3000411

Dumbell, L., Lemon, C., Williams, J., 2019. A systematic literature review to evaluate the tools and methods used to measure rein tension. Journal of Veterinary Behavior 29, 77–87. https://doi.org/10.1016/j.jveb.2018.04.003

Duncan, E., Graham, R., McManus, P., 2018. 'No one has even seen… smelt… or sensed a social licence': Animal geographies and social licence to operate. Geoforum 96, 318–327. https://doi.org/10.1016/j.geoforum.2018.08.020

Duncan, I.J.H., 2006. The changing concept of animal sentience. Appl Anim Behav Sci 100, 11–19. https://doi.org/10.1016/j.applanim.2006.04.011

Egenvall, A., Eisersiö, M., Roepstorff, L., 2012. Pilot study of behavior responses in young riding horses using 2 methods of making transitions from trot to walk. Journal of Veterinary Behavior: Clinical Applications and Research 7, 157–168. https://doi.org/10.1016/j.jveb.2011.08.006

Fenner, K., Hyde, M., Crean, A., McGreevy, P., 2020. Identifying sources of potential bias when using online survey data to explore horse training, management, and behaviour: A systematic literature review. Vet Sci 7, 140. https://doi.org/10.3390/vetsci7030140

Furtado, T., Perkins, E., Pinchbeck, G., McGowan, C., Watkins, F., Christley, R., 2021. Exploring horse owners' understanding of obese body condition and weight management in UK leisure horses. Equine Vet J 53, 752–762. https://doi.org/10.1111/EVJ.13360

Glasziou, P., Meats, E., Heneghan, C., Shepperd, S., 2008. What is missing from descriptions of treatment in trials and reviews? Bmj 336, 1472. https://doi.org/10.1136/bmj.39590.732037.47

Goodwin, D., McGreevy, P., Waran, N., McLean, A., 2009. How equitation science can elucidate and refine horsemanship techniques. Veterinary Journal 181, 5–11. https://doi.org/10.1016/j.tvjl.2009.03.023

Graham, R., McManus, P., 2016. Changing human-animal relationships in sport: An analysis of the UK and Australian horse racing whips debates. Animals 6, 1–17. https://doi.org/10.3390/ani6050032

Guinnefollau, L., Gee, E.K., Bolwell, C.F., Norman, E.J., Rogers, C.W., 2019. Benefits of animal exposure on veterinary students' understanding of equine behaviour and self-assessed equine handling skills. Animals 9. https://doi.org/10.3390/ani9090620

Hampton, J.O., Jones, B., McGreevy, P.D., 2020. Social license and animal welfare: Developments from the past decade in Australia. Animals 10, 1–11. https://doi.org/10.3390/ani10122237

Hartmann, E., Christensen, J.W., McGreevy, P.D., 2017. Dominance and Leadership: Useful Concepts in Human–Horse Interactions? J Equine Vet Sci 52, 1–9. https://doi.org/10.1016/j.jevs.2017.01.015

Havlik, H.S., Program, S.M., Clinic, C.M., 2010. Equestrian Sport-Related Injuries : A Review of Current Literature 28203, 299–302

Henshall, C., 2021. The effect of exercise and stress on equine learning, memory and welfare [Doctoral Thesis], Charles Sturt University, 248-250.

Holmes, T.Q., Brown, A.F., 2022. Champing at the Bit for Improvements: A Review of Equine Welfare in Equestrian Sports in the United Kingdom. Animals 12, 1–36. https://doi.org/10.3390/ani12091186

Horseman, S. V., Buller, H., Mullan, S., Whay, H.R., 2016. Current welfare problems facing horses in Great Britain as identified by equine stakeholders. PLoS One 11, e0160269. https://doi.org/10.1371/journal.pone.0160269

Ijichi, C., Griffin, K., Squibb, K., Favier, R., 2018. Stranger danger? An investigation into the influence of human-horse bond on stress and behaviour. Appl Anim Behav Sci 206, 59–63. https://doi.org/10.1016/j.applanim.2018.05.034

Kieson, E., Felix, C., Webb, S., Abramson, C.I., 2020. The effects of a choice test between food rewards and human interaction in a herd of domestic horses of varying breeds and experiences. Appl Anim Behav Sci 231. https://doi.org/10.1016/j.applanim.2020.105075

Kilkenny, C., Browne, W.J., Cuthill, I.C., Emerson, M., Altman, D.G., 2010. Improving bioscience research reporting: The ARRIVE guidelines for reporting animal research. J Pharmacol Pharmacother 1, 94–99. https://doi.org/10.4103/0976-500x.72351

Kimura, R., Borankulova, S., Maratbek, S.Z., 2023. Effect of difference in training skills on stress in horses trained by Kazakh trainers. Anim Sci J 94, e13800. https://doi.org/10.1111/asj.13800

Kydd, E., Padalino, B., Henshall, C., McGreevy, P., 2017. An analysis of equine round pen training videos posted online: Differences between amateur and professional trainers. PLoS One 12. https://doi.org/10.1371/journal.pone.0184851

Leach, D.H., Ormrod, K., Clayton, H.M., 1984. Standardised terminology for the description and analysis of equine locomotion. Equine Vet J 16, 522–528. https://doi.org/10.1111/j.2042-3306.1984.tb02007.x

Leenaars, C., Tsaioun, K., Stafleu, F., Rooney, K., Meijboom, F., Ritskes-hoitinga, M., 2021. Reviewing the animal literature : how to describe and choose between different types of literature reviews. https://doi.org/10.1177/0023677220968599

Leung, V., Rousseau-Blass, F., Beauchamp, G., Pang, D.S.J., 2018. Arrive has not arrived: Support for the arrive (animal research: Reporting of in vivo experiments) guidelines does not improve the reporting quality of papers in animal welfare, analgesia or anesthesia. PLoS One 13, 1–13. https://doi.org/10.1371/journal.pone.0197882

Luke, K.L., Mcadie, T., Warren-smith, A.K., Rawluk, A., Smith, B.P., 2023. Does a Working Knowledge of Learning Theory Relate to Improved Horse Welfare and Rider Safety ? Anthrozoos 0, 1–17. https://doi.org/10.1080/08927936.2023.2166713

McGreevy, P.D., 2007. The advent of equitation science. Veterinary Journal 174, 492–500. https://doi.org/10.1016/j.tvjl.2006.09.008

McGreevy, P.D., McLean, A.N., 2009. Punishment in horse-training and the concept of ethical equitation. Journal of Veterinary Behavior 4, 193–197. https://doi.org/https://doi.org/10.1016/j.jveb.2008.08.001

McGreevy, P.D., McLean, A.N., 2007. Roles of learning theory and ethology in equitation. Journal of Veterinary Behavior: Clinical Applications and Research 2, 108–118. https://doi.org/10.1016/j.jveb.2007.05.003

McGreevy, P.D., Oddie, C., Burton, F.L., McLean, A.N., 2009. The horse-human dyad: Can we align horse training and handling activities with the equid social ethogram? Veterinary Journal 181, 12–18. https://doi.org/10.1016/j.tvjl.2009.03.005

McLean, A., Varnum, A., Ali, A., Heleski, C., González, F.J.N., 2019. Comparing and contrasting knowledge on mules and hinnies as a tool to comprehend their behavior and improve their welfare. Animals 9. https://doi.org/10.3390/ani9080488

McLean, A.N., 2005. The positive aspects of correct negative reinforcement, in: Anthrozoos. Routledge, pp. 245–254. https://doi.org/10.2752/089279305785594072

McLean, A.N., Christensen, J.W., 2017. The application of learning theory in horse training. Appl Anim Behav Sci 190, 18–27. https://doi.org/10.1016/j.applanim.2017.02.020

McLean, A.N., McGreevy, P.D., 2010. Horse-training techniques that may defy the principles of learning theory and compromise welfare. Journal of Veterinary Behavior: Clinical Applications and Research 5, 187–195. https://doi.org/10.1016/j.jveb.2010.04.002

McLean, A.N., Christensen, J.W.J.W., 2017. The application of learning theory in horse training. Appl Anim Behav Sci 190, 18–27. https://doi.org/10.1016/j.applanim.2017.02.020

McLean, A.N., McGreevy, P.D.P.D., 2010. Ethical equitation: Capping the price horses pay for human glory. Journal of Veterinary Behavior: Clinical Applications and Research 5, 203–209. https://doi.org/10.1016/j.jveb.2010.04.003

Nicol, C.J., 2002. Equine learning: progress and suggestions for future research. Appl Anim Behav Sci 78, 193–208. https://doi.org/https://doi.org/10.1016/S0168-1591(02)00093-X

Osthaus, B., Proops, L., Hocking, I., Burden, F., 2013. Spatial cognition and perseveration by horses, donkeys and mules in a simple A-not-B detour task. Anim Cogn 16, 301–305. https://doi.org/10.1007/S10071-012-0589-4

Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E., Chou, R., Glanville, J., Grimshaw, J.M., Hróbjartsson, A., Lalu, M.M., Li, T., Loder, E.W., Mayo-Wilson, E., McDonald, S., McGuinness, L.A., Stewart, L.A., Thomas, J., Tricco, A.C., Welch, V.A., Whiting, P., Moher, D., 2021. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. J Clin Epidemiol 134, 178–189. https://doi.org/10.1016/j.jclinepi.2021.03.001

Percie du Sert, N., Hurst, V., Ahluwalia, A., Alam, S., Avey, M.T., Baker, M., Browne, W.J., Clark, A., Cuthill, I.C., Dirnagl, U., Emerson, M., Garner, P., Holgate, S.T., Howells, D.W., Karp, N.A., Lazic, S.E., Lidster, K., MacCallum, C.J., Macleod, M., Pearl, E.J., Petersen, O.H., Rawle, F., Reynolds, P., Rooney, K., Sena, E.S., Silberberg, S.D., Steckler, T., Würbel, H., 2020. The ARRIVE guidelines 2.0: Updated guidelines for reporting animal research*. Journal of Cerebral Blood Flow and Metabolism 40, 1769–1777. https://doi.org/10.1177/0271678X20943823

Pfaller-Sadovsky, N., Hurtado-Parrado, C., Cardillo, D., Medina, L.G., Friedman, S.G., 2020. What's in a click? The efficacy of conditioned reinforcement in applied animal training: A systematic review and meta-analysis. Animals 10, 1–31. https://doi.org/10.3390/ani10101757

Pierard, M., Hall, C., König von Borstel, U., Averis, A., Hawson, L., McLean, A., Nevison, C., Visser, K., McGreevy, P., 2015. Evolving protocols for research in equitation science. Journal of Veterinary Behavior: Clinical Applications and Research 10, 255–266. https://doi.org/10.1016/j.jveb.2015.01.006

Proctor, H., 2012. Animal sentience: Where are we and where are we heading? Animals 2, 628–639. https://doi.org/10.3390/ani2040628

Proops, L., McComb, K., 2010. Attributing attention: The use of human-given cues by domestic horses (Equus caballus). Anim Cogn 13, 197–205. https://doi.org/10.1007/s10071-009-0257-5

Proops, L., Rayner, J., Taylor, A.M., McComb, K., 2013. The Responses of Young Domestic Horses to Human-Given Cues. PLoS One 8, 26–28. https://doi.org/10.1371/journal.pone.0067000

Proops, L., Walton, M., McComb, K., 2010. The use of human-given cues by domestic horses, Equus caballus, during an object choice task. Anim Behav 79, 1205–1209. https://doi.org/10.1016/j.anbehav.2010.02.015

Randle, H., 2016. Welfare friendly equitation - Understanding horses to improve training and performance. Journal of Veterinary Behavior: Clinical Applications and Research 15, vii–viii. https://doi.org/10.1016/j.jveb.2016.10.005

Randle, H., Waran, N., 2019. Equitation Science in Practice: how collaboration, communication and change can improve equine welfare. Journal of Veterinary Behavior 29, viii–x. https://doi.org/10.1016/j.jveb.2018.12.014

Randle, H., Waran, N., 2017. Breaking down barriers and dispelling myths: The need for a scientific approach to Equitation. Appl Anim Behav Sci 190, 1–4. https://doi.org/10.1016/j.applanim.2017.02.010

Riemer, S., Ellis, S.L.H., Thompson, H., Burman, O.H.P., 2018. Reinforcer effectiveness in dogs—The influence of quantity and quality. Appl Anim Behav Sci 206, 87–93. https://doi.org/10.1016/j.applanim.2018.05.016

Sankey, C., Richard-Yris, M.A., Leroy, H., Henry, S., Hausberger, M., 2010. Positive interactions lead to lasting positive memories in horses, Equus caballus. Anim Behav 79, 869–875. https://doi.org/10.1016/j.anbehav.2009.12.037

Sebeok, T.A., Rosenthal, R. (Eds.), 1981. The Clever Hans phenomenon: Communication with horses, whales, apes, and people. Ann N Y Acad Sci 364, 309.

Sim, J., Wright, C.C., 2005. The Kappa Statistic in Reliability Studies: Use, Interpretation, and Sample Size Requirements. Phys Ther 85, 257–268. https://doi.org/10.1093/ptj/85.3.257

Starling, M., McLean, A., McGreevy, P., 2016. The contribution of equitation science to minimising horse-related risks to humans. Animals. https://doi.org/10.3390/ani6030015

Strech, D., Dirnagl, U., 2019. 3Rs missing: Animal research without scientific value is unethical. BMJ Open Science 3. https://doi.org/10.1136/bmjos-2018-000048

Thompson, K., Haigh, L., 2018. Perceptions of Equitation Science revealed in an online forum: Improving equine health and welfare by communicating science to equestrians and equestrian to scientists. Journal of Veterinary Behavior 25, 1–8. https://doi.org/10.1016/j.jveb.2018.02.002

Vicars, S.M., Miguel, C.F., Sobie, J.L., 2014. Assessing preference and reinforcer effectiveness in dogs. Behavioural Processes 103, 75–83. https://doi.org/10.1016/j.beproc.2013.11.006

Warren-Smith, A.K., McGreevy, P.D., 2008. Equestrian coaches' understanding and application of learning theory in horse training. Anthrozoos 21, 153–162. https://doi.org/10.2752/175303708X305800

Warren-Smith, A.K., McLean, A.N., Nicol, H.I., McGreevy, P.D., 2005. Variations in the timing of reinforcement as a training technique for foals (Equus caballus). Anthrozoos 18, 255–272. https://doi.org/10.2752/089279305785594117

Williams, J., Greening, L., Marlin, D., Randle, H., 2019. Understanding whip use in riders in sports horse disciplines. 15th International Conference of the International Society for Equitation Science. Uniwersytet Śląski. Wydział Matematyki, Fizyki i Chemii, University of Guelph, Guelph, Canada, pp. 343–354. https://doi.org/10.2/JQUERY.MIN.JS

Wolframm, I.A., Douglas, J., Pearson, G., 2023. Changing Hearts and Minds in the Equestrian World One Behaviour at a Time. Animals 13, 1–16. https://doi.org/10.3390/ani13040748