Proceedings of the 1st International Equitation Science Symposium 2005

Friday 26th and Saturday 27th August, 2005

Australian Equine Behaviour Centre,
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Welcome Message

Welcome to the 1st International Equitation Science Symposium (ESS 2005). This forum is intended to pursue the discussions held at the Equitation Science Workshop in Edinburgh in 2004, which primarily centred on the application of learning theory to horse training with the aim of improving the welfare of horses in the human domain. We are a group of equine scientists, veterinarians, ethologists and behaviour therapists who share the view that human-related causes of undesirable equine behaviours can be largely attributed to the current lack of science in equitation. After a series of workshops on this topic over the past three years, we feel we are ready to offer a symposium to a wider audience with peer-reviewed papers.

Humans influence the behaviour of horses, in-hand and under saddle, with stimuli from their hands on the reins and their legs on the sides of the horse and more discreetly with the use of their seat, weight position and movement. Furthermore, devices such as whips and spurs are also used by some. Horse riding at its most humane relies on subtle interactions between horses and humans. This occurs through the correct application of negative reinforcement and the subsequent transfer of stimulus control to various classically conditioned cues (such as those coming from the seat). It is surprising therefore, that so little scientific endeavour has been directed towards the effects of aversive stimuli on horses and the ways in which horses respond to stimuli of human origin.

The performance of the horse under saddle and the consequent development of riding instruction tend to focus on outcomes rather than mechanisms. Additionally, riding manuals have historically by-passed the central tenets of learning theory. Since the ideals of equestrian technique combine art and science, students of equitation encounter a few measurable variables such as tempo, rhythm and outline alongside many more conceptual ones such as harmony, looseness, respect and leadership. This unbalanced mixture and the shortage of mechanistic substance frustrate attempts to express equestrian technique in empirical terms and account for some of the confusion and conflict that arises in many human-horse dyads.

Among the specific areas to be explored include an analysis of different approaches currently used for achieving key outcomes in dressage horses. The impact of training and management on the welfare of horses is also considered along with the role of behaviour-related disorders as a cause of industry wastage. Other topics include the way in which horses of different breeds may see the world differently and the effect of negatively reinforced head-lowering on horses. Each of the papers in these proceedings has been subjected to two independent peer reviews. However, this does not mean that we agree with all of the authors' opinions. We commend the papers to you as a source of discussion and hope that they help to establish immediate research priorities to meet welfare needs of ridden and driven horses.

It is worth noting that there is evidence of confusion about terminology among horse people. This presumably compounds a lack of rigour in identifying problem behaviours in horses. As the editors of the proceedings, our contribution is a paper that discusses the need for objective definitions in equitation science and offers some useful starting points. We warmly encourage discussion on these definitions.

We would like to thank our gracious hosts at the Australian Equine Behaviour Centre for making this event possible. In particular we wish to thank Manuela McLean and Sarah Botterill. In addition, we extend our thanks to Prof Danny Mills, Dr Alison Harman and Jack Murphy for their assistance in reviewing some of the papers, Sally Pope for her indexing work and the Postgraduate Foundation in Veterinary Science for publishing the proceedings.

We sincerely hope that all our efforts help to produce a thought-provoking and enjoyable experience. Once again, welcome!

The Organising Committee

The evolution of schooling principles and their influence on the horse's welfare.

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Abstract

The welfare of animals used for sport has been recognised since long as part of applied ethology (Ödberg, 1976). However, scientists started to express concern about the particular ways in which horses are treated a long time after the scientific approach to farm animal welfare had developed (Ewbank, 1985; Ödberg, 1987). A probably underestimated welfare problem concerns inappropriate riding and schooling. A short survey will be given of the history of equestrianism and its implications for welfare. According to available historical documents, and as far as we can interpret such texts correctly, there has not been a clear progressive linear evolution from antiquity to modern times concerning schooling competence and gentleness. Each period saw probably gentle and violent people. For example, Xenophon appears very knowledgeable in understanding horse behaviour and often insists on gentleness, giving concrete advice. Drawings and the few writings available from the Middle Ages and the renaissance suggest rather forceful techniques. Even if some authors (e.g., Grisone, 1550) mention horses should be treated with kindness, their methods elicit quite a bit of scepticism. One can however identify a gradual improvement in schooling refinement from the end of the renaissance (e.g., Newcastle, Pluvinel) up to the baroque period. The latter and its plethora of masters represent the acme of riding. A functional technique became an art in itself. One could argue this could be due rather to an increase of written sources. However, it is unlikely that more refined authors were less inclined to write in the renaissance, while more violent ones were so in the 18th century.

The 19th century represents a struggle with new challenges. While some masters kept the baroque tradition alive, many others experimented with new methods that influenced a lot riding practices in the 20th century. There are three reasons for those changes: an interruption of tradition due to the closing of academies by the French revolution, the development of the fashion of racing and foxhunting and the concomitant change in favoured breeds, the development of competition in the 20th century (Ödberg and Bouissou, 1999). Unfortunately, most of the time those changes represented a regression. The modern way of schooling is too often quite coercive as compared to the baroque philosophy (de Bragance, 1976; Loch, 1994; Henriquet and Durand, 1996; Racinet, 1999). It might contribute to the high percentage of horses being slaughtered at a young age (von Butler and Armbruster, 1984; Ödberg and Bouissou, 1999) or at least before reaching normal retirement age (Wallin *et al.*, 2000).

In order to approach these problems as scientifically as possible, one is confronted with the problem of measurement. One the one hand, how true are the riding principles? On the other hand, how can we evaluate the welfare of horses according to schooling philosophies?

During centuries, a wealth of empirical knowledge has been gathered by riding masters. It is based on visual impressions, tactile and proprioceptive sensations, dealing especially with equilibrium, and all of this is mixed with a more or less developed tact for applying learning principles, without any scientific knowledge of them. Can modern technology help us investigate objectively to what extent those masters were right? In the 19th century, as far as we know, only François Baucher and captain Morris (Lesbre, 1920)[1] endeavoured to measure the distribution of weight by putting one horse (N=1!) with its fore and hind legs on two separate scales (Table 1).

[1] Cited by Ollivier (1999). The 11th edition from 1859 of the complete works of Baucher strangely do not mention those measurements.

Table 1: Weight (kg) repartition between the fore and hind legs as measured by Baucher and Morris (Lesbre, 1920). Horse's weight = 384 kg. No mention was made of a saddle.

	Fore legs	Hind legs
Natural	210	174
Neck lowered - nose at level of breast	218	166
Neck higher - nose at level of withers	200	184
Poll-flexion	202	182
Mounted by Baucher	251	197
Baucher puts his shoulders backwards	233	215

It appeared that neck position of the horse, poll-flexion and shift in shoulder position of the rider do influence weight distribution. Computerised analysis of movements and telemetric transmission of data obtained by various types of sensors have since been applied to horses. Some authors have applied laws of physics to riding. The purpose is usually to study kinetics of free movements or abnormal gaits. Nevertheless, some are closely relevant for equitation, e.g., when the effect of head and neck position is examined (Rhodin *et al*., 2005). There are a few studies on the effects of various gears or the fitting of the saddle (e.g., Preuschoft *et al*., 1995; Preuschoft *et al*., 1999; Werner *et al*., 2002; De Cocq *et al*., 2004). Some have shown interest for the effect of the rider's position and aids on the horse (Ollivier, 1993; 1999; Hubener, 2004, 2005). However, several of those studies are interpretations of laws of physics without carrying out actual measurements. We have found no study yet on a refined analysis of specific and discrete aids on the horse during performance of a given movement. For example what is simply the effect of translating more weight on the left hip during a left circle on the pressure of the four hoofs respectively on the ground? Does the left hind leg "carry" indeed more weight, or at least undergoes more pressure pushing the whole mass forward? Electromyography might help understanding the relative importance of conditioned and unconditioned responses. For example, to what extent is putting the right hind leg forward when feeling the pressure of the rider's right leg an unconditioned response and the result of an operant conditioning (whether using a positive or a negative reward)? One of the differences between the academic principles and present day riding is the lack of lightness in the latter. This is, amongst other ways, expressed in a strong tension on the bit through the reins. One can put forward the hypothesis that the welfare of horses being ridden with coercion is decreased. Hence the necessity to develop for example, a way of measuring reins tension.

As far as welfare is concerned, the question is how can one adapt the already widely used parameters to riding? One could for example, compare baseline values of horses schooled according to various techniques after months of procedure. However, one is then confronted with the problem of adaptation. Could one use anticipation or a challenge? For example compare stress parameters between horses schooled differently, when they see the rider approaching with the saddle. One could on the contrary focus on short time scale events: e.g., how does heart rate change each time the spur is used repetitively as compared to one brief attack that results in the subsequent obedience to a few grams of the calf? Do some parameters correlate with evasive behaviours, vernacularly called “resistances”?

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Defining the terms and processes associated with equitation

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The need for precise definitions is accepted in human psychiatry (DSM-IV, 1994) and is increasingly called for in veterinary behaviour medicine (Overall, 1997; 2005). In contrast, the use of non-scientific terms is customary in equestrian circles and is added to by contemporary trainers and self-styled horse whisperers. Data suggest that qualified equestrian instructors frequently confuse the meaning of terms that originated in behavioural science (Warren-Smith and McGreevy, *in prep*). Several descriptors may be used for the same behaviour, depending on the observer (Mills, 1998). The use of such terms may encourage imprecise and inappropriate interpretations of equine behaviour. For example, many layman's terms imply subjective mental states in the horse and that horses are culpable participants in the training process. These assumptions can have negative welfare implications for the domestic horse and safety implications for riders and handlers (McLean, 2004).

Publication of the *Equid Ethogram* (McDonnell, 2003) is welcomed, since it defines terms that appear in the literature on free-ranging and managed horses. However, the *Equid Ethogram* includes discussion on few human-horse interactions. Since equitation science seeks to improve the welfare of horses and improve clarity of communication in their interface with humans, it is appropriate to address this apparent gap in the agreed hippological terminology. This paper advocates the need for a glossary of terms that provide a scientific framework on which to base future discussions and debate. The challenge for equitation science is to define and quantify as many elements of the interaction between riders and horses as possible. Ethological and anatomical nomenclature can and should be used to describe a horse's manoeuvres but the description and measurement of more conceptual and less tangible qualities, such as feelings (including happiness), depends on the development of more innovative techniques than are currently available. That said, it is possible to quantify acute and chronic stress through the measurement of heart rate and corticosteroid concentrations.

The glossary and definitions offered below will be presented at the First International Equitation Science Symposium and remain a living document that can be reviewed by subsequent symposia and downloaded from a nominated web-site. Underlined words have separate entries in this glossary.

Above the bit: A posture characteristic of a hyper-reactive ridden horse exhibiting conflict behaviour in which the horse attempts to escape the aversive situation by raising its head, quickening the pace, shortening its neck and stride and bracing its back, which becomes dorsally concave. The horse thus assumes a posture appropriate for running and therefore does not show impulsion.

Accepting the bit: The way a horse responds to the bit in particular and aids in general. During locomotion and transitions, the horse's mouth remains closed, soft in the jaw and with relaxed lips. A horse that accepts the bit does not shorten or lengthen its neck or alter its head position during travelling and transitions. Accepting the bit is generally accompanied by relaxation of the neck and body.

Activity: The rhythmical speed of movement of the horse's legs within any gait. *See* Tempo.

Against the hand: When a horse does not stop/slow/step-back from the bit correctly. Consequently the rein contact feels heavy to the rider. This is usually accompanied by a hyper-reactive (hollow) posture in which the neck shortens or lengthens during locomotion or transitions. There may be an element of learned helplessness in this behaviour. A horse may also be described as being against one of the rider's hands, in which case it is heavy on one rein only (lugging), demonstrating a diminished response to the turn signal of that rein.

Against the leg: A description of a horse that is not straight in its body and is continually flexing its thorax (*see* Flexion) against one of the rider's legs. Such a horse drifts or attempts to drift sideways. In addition, the horse may be against both legs (i.e., not going forward).

Aid: Any of the signals or cues used to elicit responses in horses. Rein, leg, whip and spur aids are initially learned through negative reinforcement and then transformed to light aids (light rein, light leg, voice, seat) via classical conditioning because of the temporal relation between the two. In traditional horsemanship, the aids are divided into two groups: the natural aids and the artificial aids. This distinction is misleading as it neither identifies nor correlates with the two different learning modalities through which the horse acquires its responses to the aids.

Artificial aids: Equipment used to alter a horse's behaviour under-saddle or in-hand (e.g., whips, spurs). When employed correctly, these are generally used to negatively reinforce various locomotory responses and are most commonly used to fortify the light or natural aid to achieve the desired response. By convention, these are distinct from the natural aids since they do not involve direct use of parts of the rider's body.

Asking with the rein: Cues sent by the rider through the rein to signal the horse to respond in a specific way.

Balanced seat: The position of a mounted rider that requires the minimum of muscular effort to remain in the saddle and which interferes least with the horse's movements and equilibrium. It is generally understood that the balanced seat allows delivery of the aids in the most effective manner. The rider has equal weight on both seat bones and feet. *See* Independent seat.

Bars of the mouth (diastema): Area of the horse's mandible between the incisors and the molars that is free of teeth and in which the bit lies.

Baulk: Refuse to move forward, usually because of the presence of an aversive object or obstacle (as in jumping). *See* Napping.

Behind the bit: A head and neck posture that is generally described as an evasion and which involves the horse persistently drawing its nose toward its chest, sometimes allowing the reins to become slack. This occurs in training because of mistakes made in negative reinforcement or due to the use of restraining devices (such as draw reins) that force the neck to be shortened. In this situation the horse gives two different and independent responses to one signal (i.e., slowing or dorsoventral flexion) and thus frequently develops conflict behaviour. This posture thwarts the development of impulsion.

Behind the leg: A horse that lacks self-maintained speed and rhythm requires the rider to continually deliver leg aids with each stride or each alternate stride.

Behind the vertical: The appearance of a horse with a shortened neck posture. As a result, it positions its nasal planum behind the vertical line (the horse's chin becomes closer to its chest). Such a horse is generally heavy in the feel of the reins or has no contact during locomotion and transitions and, when this occurs, its stop/slow/step-back response is diminished. As the horse offers two independent responses (shortening neck or slowing) to one signal, it often exhibits conflict behaviours.

Bend (lateral bend): The lateral curvature of the body that arises principally by the flexing of four sites of the horse's vertebral column: the cervical region in general, and the thoracic (10^{th} thoracic vertebra), lumbar (1^{st} lumbar vertebra) and sacral (3^{rd} sacral vertebra) regions (Faber *et al.,* 2001). Bend allows the horse to step into its fore tracks with its hind feet on a curved line or circle that is greater than 6 m in diameter. Bend is usually accompanied by flexion, lateral, longitudinal and vertical, and is an accepted correct feature of all work on curved lines and all lateral movements.

Bit: An apparatus usually consisting of metal or other hard substances or a combination of both. It is positioned in the diastema of the horse's mouth and connected to the reins. As a result of tension in the reins, this apparatus places pressure on the lips, tongue and bars of the horse's mouth and results in the horse learning to stop/slow/step-back and turn, through the processes of negative reinforcement and classical conditioning.

Bitting: Accustoming a horse to having a bit in its mouth or the selection of the most appropriate bit for a horse.

Blocking: a) Preventing a horse from performing appropriately in any given gait by the application of simultaneous rein and leg pressure. This can result in conflict behaviour.
b) The deleterious effects of the simultaneous application of two intense aids such that neither will be learned (Hull, 1943).

Blow-up: When a ridden or handled horse becomes hyper-reactive during training and exhibits behaviours ranging from mild tension to bucking or breaks from the gait in which it is meant to be travelling. It is most common in early training and exposure to novel environments as in 'showing'. It is generally a symptom of conflict behaviour.

Bolting: a) Accelerating, usually to a gallop out of stimulus control (*see* Running away) and showing a lack of response to the stop/slow/step-back cues. Bolting reflects an extreme activation of the HPA axis (hypothalamic-pituitary-adrenal axis). This is a manifestation of conflict behaviour. Sometimes referred to as 'running blind'.

b) Eating (concentrated food) too rapidly.

Break gait: The random change from one gait to another that is not under stimulus control.

Break in (gentle, start): The basic foundation training of a young horse to respond to aids and cues that control its rhythm and tempo, direction and posture for whatever purpose it may be required.

Bridle lameness: An irregularity of gait under-saddle that has the appearance of lameness. Mostly seen in the trot, it arises as a result of a long-term training error in which the horse is unable to free itself of simultaneous and persistent bit and leg pressure during locomotion and transitions, or from persistent rising on the same or incorrect diagonal at trot. There is usually an associated crookedness to the longitudinal axis of the body.

Broken neck (over-bent): The appearance of the neck of a horse in which there is a (usually) sudden change in angle (a break in the curve) in the vicinity of the third cervical vertebra. This is usually a result of persistent use of side reins that are too short, especially during early training, or draw reins that cause the neck to be too flexed and the nasal planum to be behind the vertical. It is believed that there is degeneration of the vertebrae and/or ligaments at the third cervical vertebra. Horses with broken necks generally exhibit conflict behaviours and tend to flex their necks to light rein pressure rather than give the stop/slow/step-back response.

Bronco: An unbroken or imperfectly broken wild horse, or one maintained in this state for rodeos.

Bucking: A sudden humping or arching of the back with the head and neck lowered, usually kicking out with the hindlegs or jumping/bounding forwards/sideways with an arched back and ears laid back (Waring, 2003). Bucking is a manoeuvre that evolved to dislodge predators. Persistent bucking is a manifestation of conflict behaviour to the rein and leg aids (McLean, 2005).

Cadence: The result of the combined effect of correct training that a horse shows when it moves with well-marked regularity, impulsion, balanced and rhythmic strides. There should be an enhanced period of suspension between steps that gives the horse the appearance of springing off the ground so the feet lift clear of the ground and float to the next step.

Champing (US): *See* Mouthing.

Cinch bound (US): *See* Cold-back.

Classical conditioning: The process whereby the unconditioned or conditioned response becomes elicited from a conditioned stimulus (Pavlov, 1927). In equitation it is the process where learned responses are elicited from more subtle versions of the same signal or to entirely new signals.

Cold-back (girth shy, US Cinch bound): Hyper-reactive behaviour (occasionally bucking) or instability sometimes to the extent of collapse when the girth is tightened, the saddle is placed on the back or a horse is mounted.

Cold-jawed (US tough-mouthed): *See* Hard-mouthed.

Collected walk/trot/canter: Where each step of the stride of the gait is shorter and higher rather than longer. The horse should remain on the bit, the hindquarters should be engaged (lowered), with the horse showing activity, impulsion and lightness. Collected paces should develop from the correct schooling of the horse over time so that it is physically able to travel showing true collection.

Collection: The progressive development of increased carrying power in the hindquarters of the horse. The resultant transfer of weight from the forequarters to the hindquarters allows the poll and withers to be carried higher, the hindquarters to drop slightly and the hind feet to step further forward and to carry more bodyweight with higher and shorter steps. This confers more power to the hindquarters, enabling the horse to perform more collected movements. In classical equitation, collection develops from repeated gait and stride length transitions that occur in three beats of the rhythm. The combined effect of the transitions and the inertia of the animal result over time in changes in the horse's physique. The propulsion of the body is then in a more upward and forward direction giving greater cadence to the strides and increased lightness of the forehand (Anon, 1986). *See also* False collection.

Conflict behaviour: A set of responses of varying duration that are usually characterised by hyper-reactivity and arise largely through confusion. In equitation, confusions that result in conflict behaviours may be caused by application of simultaneous opposing signals (such as go and stop/slow/step-back) such that the horse is unable to offer any learned responses sufficiently and is forced to endure discomfort from relentless rein and leg pressures. Attempts to flee the aversive situation result in hyper-reactivity. In addition, the desired response to one or both aids diminishes. Conflict behaviours may also result from one signal eliciting two or more responses independently, such as using the reins to achieve vertical flexion independently of the stop/slow/step-back response, or using a single rein to bend the neck of the horse independently of its previously conditioned turn response. Similarly, conflict behaviour may result from incorrect negative reinforcement, such as the reinforcement of inconsistent responses, incorrect responses, no removal of pressure or no shaping of responses. Often referred to as evasions and resistances.

Conformation: Features of the external morphology (i.e., the relative musculoskeletal dimensions) of a horse that interest breeders and exhibitors, not least because they can affect its performance (Loch, 1977).

Connection: The contact of the rein, seat and leg. This contact may be absent (no connection), correct (an easily habituated light connection) or too strong (unendurable pressure).

Contact: The connection of the rider's hands to the horse's mouth, of the legs to the horse's sides and of the seat to the horse's back via the saddle. The topic of contact with both hand and leg generates considerable confusion related to the pressure that the horse should endure if the contact is deemed to be correct. In classical equitation, contact to the rein and rider's leg involves a light pressure (approximately 200 g) to the horse's lips/tongue and body, respectively. Although a light contact is the aim, there are brief moments, (seconds or parts of a second), when contact may need to be stronger, particularly at the start of training, or in re-training, to overcome resistances from the horse. Many contemporary horse trainers insist that the contact should be much heavier than a light connection. This view may cause progressive habituation leading to learned helplessness to the rein and leg signals as a result of incorrect negative reinforcement and/or simultaneous application of the aids. Contact may therefore need to be the focus of discussion and debate.

Counter-bending, counter-flexing: The practice of bending or flexing the horse to the outside of the circle or away from the direction of turn. As flexion and bend are shaped qualities of the turn response, counter-bending and counter-flexing can result in conflict behaviour because no turn response is involved.

Crabbing: A conflict behaviour in ridden and in-hand horses where the horse fails to go straight and the resistance manifests as a sideways and forward (frequently alternating the direction) crab-like motor behaviour. Crabbing may also be associated with a hyper-reactive horse under restraint.

Cue: An event that elicits a learned response. In equitation, cues are termed aids. These are learned through classical conditioning when a response comes increasingly under stimulus control.

Deep and round (rolkur): A modern tendency to train the horse to carry its head low and its cervical vertebrae maximally flexed (chin closer to the chest) in the belief that the hindquarters are engaged and that the activity and power of the hindlegs is improved. To critics, the deep and round technique is seen as a form of false collection and may have welfare implications.

Detraining: Where a stimulus is applied without the learned response being performed. The result is reduction or extinction of the likelihood of the learned response arising from the stimulus.

Diagonal: a) Refers to the forefoot moving in unison with the opposite hind foot as seen in the gaits of trot (two diagonal pairs) and canter (one diagonal pair).
b) Being on the correct diagonal refers to the rising and sitting of the rider being synchronised with the trotting horse's footfalls so that the rider sits when the outside foreleg and inside hindleg are on the ground and rises as they move forward.

Diagonal advanced placement (DAP): As a result of incorrect negative reinforcement and in particular the simultaneous application of forward and restraining pressures accompanied with maximal flexion of the cervical vertebrae (rolkur), it has been suggested that the diagonal pairing of legs during the trot and canter may be temporally split, with subsequent losses in the purity of the gaits and the possible emergence of conflict behaviours (*See* Rolkur).

Direct rein/indirect rein: A direct rein is one held out wide away from the neck in an attempt to make the turn response clearer to the horse. By contrast, an indirect rein is one that is parallel to the horse's neck. For the horse to turn in response to an indirect rein, it must already have a clear learned response.

Disunited canter: An undesirable broken gait, most often seen in horses with a tendency to pace or horses that are not straight (*see* Straightness). It occurs when there is a shift from ipsilateral to contralateral coupling of fore and hindlegs.

Dominance/submission: Suites of behaviours in social interactions that signal rank or determine priority of access to resources (a dynamic process affected by motivation). A belief in horse training that horse interactions are governed by dominance/submission implies that trainers need to be dominant over horses to train them effectively. This notion that a horse must respect a human to be effectively controlled may be at odds with learning theory. In equitation the significance of dominance, submission and respect need further investigation.

Double-gaited: A horse that can both trot and pace.

Downhill: Conformational fault in a dressage horse, where the horse is noticeably higher at the point of the croup than at the withers. Such a horse may feel heavy on the forehand to the rider.

Driving: a) Where either a horse or a team of horses pulls a vehicle.
b) *See* Long-reining.

c) Locomotion (*see* Engagement) in which the horse is pushing forward with its hocks underneath it at the moment of pushing. The moment of push should not continue to where the fetlock is behind the vertical line of the hock.

Engagement/engaging the hocks (tarsal joints): Where the horse brings its hind feet underneath its body so that proportionally more weight is placed on the hindlegs. Classically, this process is trained over time with concomitant physique changes; however, in contemporary training, it is sometimes produced by riders forcing the horse to shorten and raise its head and neck with rein pressure while simultaneously applying leg/forward pressure. Deep and round is frequently used as a precursor to this technique termed false collection. It should be clear that engagement is not the same as collection, but is a precursor to it.

Evading the bit: Oral behaviours (such as moving the tongue aborally) and neck postures (such as dorsoventral flexion) that enable horses to reduce the discomfort caused by bits or the extent to which riders can apply and maintain pressure. In training, these result from errors in negative reinforcement.

Evasions and resistances: Descriptive terms for conflict behaviours where evasions are similar to resistances, except that evasions refer to the more severe and violent behaviours. These terms arose because of the horse's natural tendency to avoid pressure/pain by learning through negative reinforcement to perform any attempted behaviour that results in lessening of pressure/pain. The problem with these terms is that they imply malevolent and calculated behaviour on the part of the horse whereas, in fact, these behaviours are more likely the result of errors in negative reinforcement.

Extension/extended strides: The longest stride within the rhythm of the particular gait. In equitation, extended paces arise only from collected paces. These strides involve straightened limbs at the end of the swing phase of the stride that allow the horse to cover as much ground as possible with each stride.

For the average horse, in the extended walk and trot, the hind track should land approximately 20 to 30 cm in front of the fore tracks and in extended canter the hind tracks land about 2 m in front of the fore tracks.

False collection: Forcing a horse into an apparently collected outline through the simultaneous actions of the rein and leg or with the use of gadgets and pulleys rather than the progressive development of collection over time through training. False collection frequently results in conflict behaviour because concurrent stop and go signals cause confusion and pain.

Flexion: a) Longitudinal: The dorsoventral lowering, lengthening and relaxing of the horse's neck and back. In reality this is not a flexion but an extension and should be redefined as longitudinal extension. This is the most fundamental quality of being on the bit. Longitudinal flexion should not be confused with 'longitudinal bend' (*See* Impulsion).

b) Lateral: The lateral bending of the atlanto-occipital junction and including the first three cervical vertebrae of the horse's neck. This is primarily a shaped quality of correct turning and in the well-trained horse is thus involved whenever the turn, circles or the turn-position is required such as in lateral movements. The extent of lateral flexion negatively correlates with the size of the circle. As lateral flexion is a shaped quality of the turn response, counter-flexing can result in conflict behaviour. Lateral flexion is a secondary precursor of being on the bit. Lateral flexion should not be confused with 'lateral bend' (*See* Bend).

c) Dorsoventral, vertical or direct: The dorsoventral flexion of the horse's cervical vertebrae so that the nasal plane is almost perpendicular to the ground (the nasal plane may be up to 6 degrees in front of vertical). For a horse to be showing vertical flexion it must be relaxed, straight, pushing forward from behind with its hocks underneath it, relaxed in its jaw and showing longitudinal flexion (Wallace, 1993). This is a precursor of the horse being on the bit. Dorsoventral flexion may be seen as a result of correct longitudinal flexion.

Falling in/ falling out: Losses of straightness associated with the horse drifting in or out of the circle. Similar to lugging, but more apparent at the slower gaits.

Forehand (forequarters): Those parts of the horse that lie in front of the rider (i.e., the head, neck, shoulders, withers and forelegs).

Freeze: The sudden alert motionless stance associated with a highly attentive reaction to an external stimulus (often visual) and typically resulting in conflict behaviours such as napping/spinning.

Girth shy: *See* Cold-back.

Go: The acceleration response in horse training that provides forward motion. The go response is trained via negative reinforcement using the rider's legs under-saddle and using anterior lead rein pressure when working a horse in-hand. Through classical conditioning, these responses are converted first to light versions of the leg or lead rein and then to the cues of seat, position and perhaps voice.

Good mouth: *See* Soft mouth.

Green: a) An inexperienced horse with no training or one that has undergone foundation training but is not fully trained.
b) A racehorse that has yet to undergo a time trial.

Habituation: The waning of a response to a repeated stimulus as a result of frequent exposure (not fatigue).

Half-halt: A subtle, sequential application of the seat, leg and rein aid that is separated in time by one beat of the rhythm of the gait. The half-halt is intended to increase the attention and balance of the ridden horse.

Hanging: *See* Lugging.

Hard-mouthed (US Cold-jawed, tough-mouthed): Habituation to rein pressure. This is generally a result of incorrect negative reinforcement and can result in learned helplessness and conflict behaviours in susceptible animals.

Hitch: a) To tether a horse.
b) A defect in gait noted in the hindlegs, which seem to skip at the trot.

Hollow: Undesirable contraction of the vertebral column, so that the head comes up and the neck and back become slightly concave. The strides of the horse generally become faster and shorter ('choppy'). Habitual hollowness is usually a result of incorrect negative reinforcement and is frequently associated with conflict behaviours. Because of its reported association with activation of the HPA axis, hollowness should be further researched.

Horse breaking: *See* Break in.

HPA axis (Hypothalamic–Pituitary–Adrenal axis): The physiological response to arousal, involving the limbic system, which stimulates the hypothalamus to produce corticotrophin releasing factor, which in turn stimulates the anterior pituitary gland to produce adrenocorticotrophic hormone, which then stimulates the adrenal cortex to secrete glucocorticoids.

Hyper-reactive behaviour: Behaviours characteristic of an activated HPA axis and associated with various levels of arousal. Such behaviours typically involve the horse having a hollow posture and leg movements with increased activity and tempo, yet shorter strides. Hyper-reactive behaviours are quickly learned and resistant to extinction because of their adaptiveness in the equid ethogram. Behavioural evidence of hyper-reactivity ranges from postural tonus to responses such as shying, bolting, bucking and rearing.

Impulsion: The response of a horse that is correctly trained in its go/stop responses so that it moves forward energetically with a self-maintained rhythm, straightness and outline when signalled to do so. Impulsion is an early expression of the progressive development of collection, in which the animal progressively carries more weight on its hindquarters. There have been proposed to be three types of impulsion: 1. *Instinctive* - i.e., the inherited tendency to have more or less impulsion; 2. *Mechanical* - develops from Instinctive Impulsion and improves with work and gymnastic training; 3. *Transmitted* - that given to the horse by the rider in collecting the horse (Winnett, 1993). True impulsion, in which the horse conveys itself calmly under a light rein and without constant pressure from the rider, is distinct from states of general excitement in which the horse pulls at the bit and requires forceful restraint to be controlled.

In front of the leg: A desirable quality in equitation describing a horse with a correctly trained go response such that it is neither slowing nor accelerating of its own volition (i.e., it self-maintains its rhythm).

Independent seat: The ability of a rider to maintain a secure, firm and balanced position on a horse's back, without relying on the reins or stirrups. *See* Balanced seat.

In-hand: In a routine of schooling in-hand, the trainer works from the ground rather than from the saddle, positioned beside and/or behind the horse and controlling it with rein, voice and schooling whip. In-hand work allows the horse to acquire signal response entities of go and stop as a prelude to foundation training, or during retraining or when training advanced movements.

Inside/outside: Identifies either side of the horse as it is being schooled. These require some clarification as to whether one is referring to the relative position in the arena, to the curvature of the path, or to the bend of the horse (e.g., inside leg usually refers to the leg of the rider or horse nearest to the centre of the circle the horse is following, or on the bent side, which can be the outside of the arena as in renvers).

Jog: a) A slow, short-striding trot, usually associated with heightened arousal and involving short choppy steps and constant tendencies to accelerate as the horse is attempting to flee the aversive situation. Habitual jogging can be associated with conflict behaviours and result in diminished responses to the slow/stop/step-back signals (McLean, 2005).
b) In harness racing the term given to the exercise conducted on non-hopple days. (Hobble = restraint, hopple = harness).
c) A slow trot used mainly in Western pursuits.

Join-up: An element of round-pen training (popularised by US trainer Monty Roberts) in which the horse learns to remain close to the human.

Lateral movements: Any of the schooling exercises (such as leg-yield, shoulder-in, travers, renvers and half-pass) that involve the horse having longitudinal bend and travelling with the forelegs and hindlegs on two, three or four different tracks with the aim of improving its engagement and collection.

Leadership: A belief in natural horsemanship that requires debate owing to its inherent anthropomorphism. According to this theory, the horse must accept the human as a leader to respond correctly in training. This assumption may be contradicted by learning theory, so the significance of leadership in equitation calls for further study.

Leaning on the bit: A sign of habituation to bit pressure which manifests with the horse persistently pressuring the rein(s) as though relying on the rider to support the weight of its head. This arises through incorrect negative reinforcement and can be associated with conflict behaviours and learned helplessness.

Learned helplessness: A state in which an animal has learned not to respond to pressure or pain. Arises from inappropriate application of negative reinforcement, which results in the horse not being able to obtain release from aversive stimuli. If this continues over a period of time the horse will no longer make responses that were once appropriate. Learned helplessness has the following characteristics: a disinclination to trial behavioural responses to pressure; lowered levels of aggression; dullness; loss of appetite; physiological and immunological changes.

Leg-yield: The simplest of lateral movements in which the horse moves both forward and sideways from the rider's single leg signal. Leg-yield is usually trained before more complex lateral manoeuvres. In leg-yield, the horse is almost straight, except for slight lateral flexion away from the direction of travel.

Lightness: A desirable quality that reflects self-carriage and the horse's self-maintenance of rhythm, straightness and outline. Lightness involves the bringing into action by the rider and the use by the horse of only those muscles necessary for the intended movement. Activity in any other muscle groups can create resistance and thus detract from the lightness.

Long-reining: A method of schooling the horse using two reins, each attached to the horse's bit and returning to the handler, who moves behind and/or beside the horse, as if driving it without being attached to any vehicle or load. Long-reining is sometimes used as a prelude to foundation training, retraining or in the training of advanced movements.

Long and low: Training the horse to go with its poll extended and lowered and its neck slightly dorsoventrally flexed while attempting to achieve more activity and impulsion.

Loose schooling: Often used as an alternative to lunging, long reining or round pen for exercise and training. The horse is typically loose schooled in the outer lane of an arena and frequently encounters grid exercises or series of fences for jumping on pre-determined distances and stride patterns and so is said to learn independently.

Lope: The Western version of a very slow canter, this is a smooth, slow gait in which the head is carried low.

Lugging, pulling: A term, mostly used in horse-racing, that refers to a straightness problem where the horse drifts sideways, particularly at the gallop. In doing so, the horse becomes heavy on the rein on the side away from which it is drifting. A horse that habitually lugs does so as a result of incorrect negative reinforcement, because the rider holds the heavy rein tighter as he attempts to maintain a straight line; in other words, the horse is failing to respond to the turn cue.

Lunge (also longe): Exercising a horse in circles with the trainer in the middle of the circle using a long lead/rein or rope. Lunging is used to habituate a horse to the saddle during foundation training, to train obedience, to warm up a horse and to tire a hyper-reactive horse.

Mouthing: a) The process of habituating a horse to a bit in its mouth and learning to respond to the stop/slow/step-back and turn signals of the reins.
b) Champing (US): Where the horse gently moves the bit. Mouthing is a response that is sometimes encouraged in bitting a young horse. Use of a bit

with ‘keys’ attached to the mouthpiece facilitates saliva flow and keeps the mouth moist.

Napping, propping: When a horse fails to respond appropriately to the rider’s signals, as in refusing to go forward, running sideways, spinning or running backwards. This conflict behaviour could also result in attempts at rearing.

Natural aids: The body, seat, hands (reins), legs, weight and voice, as used to signal to the horse. Some of these aids are acquired via negative reinforcement (e.g., leg and rein responses), while others are acquired by classical conditioning (e.g., weight and voice aids). The distinction therefore is not based on learning theory.

Natural horsemanship: A relatively modern system of horse training that originated in Western training. It is based on an interpretation of the natural ethogram of the horse. Natural horsemanship focuses on concepts of dominance/submission, respect and leadership, which are currently controversial and may be at odds with learning theory.

Neck rein: To turn or steer a horse by pressure of the rein on the neck.

Negative reinforcement: The subtraction of something aversive (such as pressure) to reward the desired response and thus lower the motivational drive (Skinner, 1953).

Obedience: In traditional horsemanship, compliance to the aids. Perhaps a more objective definition is the horse’s immediate initiation of the required response to a light aid (McLean, 2003).

Off the bit: A lack of at least one of the three prerequisites for on the bit; usually referred to as being above the bit or behind the bit. The horse does not have a contact or connection to the rider's hands through the reins.

On the bit: The self-maintained neck and head position of the horse in correct schooling where vertical flexion of the cervical vertebrae and atlanto-occipital joint (also known as poll flexion or roundness) results in the nasal planum being approximately 6 degrees in front of the vertical or 12 degrees at walk. This posture is intended to improve the balance of the ridden horse (relocating extra weight to the hindquarters) and its willingness to respond to the signals transmitted by the rider through the reins. There are three precursors to the horse being on the bit. The first is longitudinal flexion, followed by lateral flexion and finally vertical flexion. To most people, 'on the bit' means that the horse travels with its neck arched and nose tucked in. However, a vertical nose does not necessarily mean that the horse is on the bit. On the bit is necessary in horse training because, as a result of vertical flexion, the centre of gravity shifts posteriorly toward the rider's centre of gravity. There are various forms of false roundness where the horse is forced by the rider's hands or with the use of mechanical devices to flex his cervical vertebrae.

On the forehand: An undesirable form of locomotion that involves the horse carrying an inappropriate proportion of its weight on its forequarter, a posture that runs counter to impulsion, collection and self-carriage. Usually seen in young or poorly schooled horses where the withers appear lower than the croup of the horse during locomotion.

Operant conditioning: Training the horse to respond consistently to signals through positive reinforcement and negative reinforcement (Skinner 1938; McLean, 2003).

Out behind: *See* Trailing hindquarters.

Outline (US shape, frame): An aspect of the horse's posture that refers to the curvature of the vertebral column and so encompasses the degree of flexion of the neck and poll and the associated flexion of the lumbosacral region. According to the ideals of equitation, the nasal planum should be no more than 12 degrees from the vertical at the walk and 6 degrees from the vertical at other gaits and never behind the vertical, because such a departure results in loss of self-carriage and lightness. The back should be soft and relaxed and give the impression of being raised.

Outside: *See* Inside/outside.

Over-bent (Broken-neck): Where the horse assumes a posture in which its nasal planum is described as being behind the vertical. Usually caused by faults in negative reinforcement, such as unrelenting pressure from the rider's hands on the bit.

Overface: Undertaking a task during riding or training that is beyond the horse's capacity or current experience.

Over-shadowing: The effect of two signals of different intensity being applied together, such that only the most intense will result in a learned response (Hull, 1943).

Pace: A two-time lateral gait in which the hindleg and the foreleg on the same side move together.

Pig-rooting: A conflict behaviour involving lowering the head and arching of the back and a kick out or bounding of the back legs (a minor form of bucking) often as a prelude to bucking.

Positive reinforcement: The addition of something pleasant (a reinforcer) to reward the desired response and thus lower the motivational drive for that reinforcer (Skinner, 1953; McLean, 2003).

Progressive desensitisation: A step-by-step weakening of an fear response to a given stimulus or set of stimuli to the point of extinction (McGreevy, 2004).

Pulling: *See* Lugging.

Punishment: The presentation of an aversive stimulus that decreases the likelihood of response or, in the case of negative punishment, the removal of a reinforcing stimulus. Punishment is often used incorrectly in horse training (i.e., when not contingent with the offending response). Incorrect use of punishment can lower an animal's motivation to trial new responses, desensitise the animal to the punishing stimulus and create fearful associations (Mills, 1998a).

Purity of the gaits: The regular temporal sequence of the natural footfalls of the gaits of the horse. These are considered fundamental to the sport and practice of dressage (F.E.I., 2003). When these are not present due to incorrect negative reinforcement or the simultaneous application of go and stop/slow/step-back pressures, hyper-reactive behaviours may emerge and conflict behaviours may develop.

Rapping, touch up: Inappropriate strategy used to sensitise the legs in an attempt to improve jumping performance in the horse, various substances being applied to the anterior aspects of the 3rd metacarpal or cannon of the forelimbs such that the horse will avoid hitting a fence when jumping.

Rearing: A sudden postural change in a horse so that it stands only on its hindlegs. Rearing is both an innate anti-predator manoeuvre and an intraspecific social behaviour, usually between stallions or colts. Habitual rearing in horses usually accompanies other conflict behaviours.

Refusal: A conflict behaviour that is typically associated with the approach to jumping an obstacle during which the horse suddenly stops. A precursor to or a form of napping.

Rein back: A step-back or a series of steps backwards with the legs in diagonal pairs. It is initially trained by the decelerating effects of the reins and later cued via classical conditioning by leg position of the rider.

Reinforcement: The process in which a reinforcer follows a particular behaviour so that the frequency (or probability) of that behaviour increases (Wolpe, 1958; McGreevy, 2004).

Reinforcement schedule: The frequency of the reinforcers used in training the horse by the handler. The schedule may be continuous, intermittent or declining.

Reinforcer: An environmental change that increases the likelihood that an animal will make a particular response, i.e., a reward (positive reinforcer) or removal of an aversive stimulus (negative reinforcer).

Resistance: *See* Conflict behaviour, Evasions and resistances.

Respect: A term used in general horsemanship and Natural horsemanship that emphasises the significance and relevance of the hierarchy in horse-human interactions. The notion of respect may imply subjective mental states that the horse may not possess. Furthermore, in training and retraining, the concept of respect may encourage remedies for behaviour problems that are unrelated to the original behaviour problem. Thus, from the viewpoint of learning theory, such a concept may be inappropriate and have negative welfare implications.

Rhythm: The beat of the legs within the particular gait. In ideal equitation, rhythm is trained to be self-maintained.

Rolkur: *See* Deep and round**.**

Round: Synonymous with on the bit.

Round-pen (round-yard) training: The practice of causing a horse to flee forward in a round yard until it offers a desirable response (such as slowing), at which point the sending forward is instantly terminated. This can be interpreted as negative reinforcement. Critics of this technique question the accepted interpretation of the responses of the horse undergoing this process and, in particular, the allowance of fearful behaviour because of its obvious association with humans and the risk of spontaneous recovery.

Running (away): A hyper-reactive state in the horse characterised by acceleration and usually heaviness in the reins. The horse is exhibiting conflict behaviour and attempting to flee the aversive situation. Such states are usually the result of incorrect negative reinforcement and can be associated with conflict behaviour. *See* Rushing.

Rushing: A horse that is not under the stimulus control of the cues to slow, usually in relation to approaching a jumping obstacle. Often anthropomorphically interpreted as 'keenness'.

School: a) An enclosed area, either covered or open, in which a horse may be trained or exercised.

b) To train a horse for whatever purpose it may be required.

Scope: The range of both the stride patterns associated with the gaits and the ability to spring or jump.

Self-carriage: The way in which an educated horse deports itself. Due to the obtrusive and aversive potential of rein and leg pressures, it is important that the horse travels in-hand and under-saddle free of any constant rein or leg pressure for fear of habituation and/or conflict behaviour. Self-carriage refers to the self-maintenance of rhythm, tempo, direction, straightness and outline.

Shape, frame (US): *See* Outline.

Shaping: The successive approximation of a behaviour toward a targeted desirable behaviour through the consecutive training of one single quality of a response followed by the next. In horse training, a shaping program is known as a Training scale. Not paying due attention to shaping in horse training has been associated with conflict behaviours (Morgan, 1974; McLean, 2003).

Shying: The sudden hyper-reactive sideways leaping of the horse either from an aversive object it encounters or as an expression of conflict behaviour that has arisen due to unresolved problems in negative reinforcement (e.g., when the contact is too strong). A shy begins with a turning away of the horse's forequarters followed by an acceleration response. Shying is frequently associated with other conflict behaviours and may be followed by bucking.

Signal: *See* Cue.

Slow gait: One of the gaits of the five-gaited breeds characterised by a prancing action in which each foot in turn is raised and then held momentarily in mid-air before descending.

Soft condition: Easily fatigued or unfit.

Soft mouth: Sensitive mouth, responsive to bit pressure.

Spinning: A sudden change in direction, akin to shying in origin and expression; it has associations with conflict behaviour.

Spooky: Shys or baulks readily/frequently.

Star-gazer: A horse that moves in-hand or under-saddle in an awkward position with its head elevated, as if looking upwards.

Step: The single complete movement of raising one foot and putting it down in another spot, as in walking, used in equitation parlance to describe the nature of the movement in an individual horse and often erroneously based on observation of the forelimbs only.

Stereotypy: A repeated, relatively invariant sequence of movements that has no function obvious to the observer. A number of stereotypic behaviours are seen in horses and are erroneously referred to as stable vices.

Stimulus: *See* Aid.

Stimulus control: The process by which a response becomes consistently elicited by a signal or cue.

Stimulus generalisation: The reinforcement of a response in the presence of more than one stimulus.

Stop/slow/step-back: The decelerating response in the trained horse that results in it ceasing or decreasing its forward movement in-hand and under-saddle. The stop response is most commonly trained by negative reinforcement, using the bit in the horse's mouth, stimulated by the reins in the rider's hands. Classical conditioning converts the stop response to light aids and then to the bracing of the seat. Decelerating involves activation and emphasis of different musculature from that involved in forward motion. These muscles are isolated by the step-back response. Therefore, it is not surprising that training of the step-back trains the stop response. Slowing the horse can occur through shortening the stride or slowing the activity or tempo of the legs.

Straightness: A fundamentally desirable trait in equitation such that the hindlegs move into the line of the fore tracks on lines and circles and the longitudinal axis of the vertebral column is straight. Straightness is necessary in order to achieve maximal biomechanical and motor efficiency in the horse and consequently considered a tenet of basic training (Murphy *et al.,* 2005). When horses are not straight, they tend to drift toward the convex side. Thus crookedness may be seen as a symptom; the deeper problem is that the horse is not following the rider's (or handler's) intended line (McLean, 2004).

Stress (acute and chronic): Stress, in its acute form, is a short-term dysfunction of the signal-response relationship presenting variously as raised tension levels, agonistic behaviours, redirected aggression and displacement activities. Chronic stress manifests as raised corticosteroid levels, physiological disturbances, gastric pathology, repetition and ritualisation of original conflict behaviours, redirected, ambivalent and displacement behaviours, development of stereotypies and injurious behaviours, such as self-mutilation and increased aggression (Wiepkema, 1987; Moberg and Mench, 2000).

Stress colic: Abdominal pain thought to be associated with inability to cope with aversive conditions (Hungerford, 1975).

Stride: a) The set of changes occurring during a single complete locomotory cycle that includes the stance phase and the swing phase of a limb, from the one landing of a particular foot to the next.

b) Used in jumping to describe a rider's appreciation of the number of whole steps a horse takes between obstacles.

c) Medium walk/trot/canter: A descriptive term for strides that are longer than at working paces, but not as long as extended paces. Medium strides are therefore part of the development of longer strides in equitation. For the average horse in medium walk and trot, the hind tracks should land approximately 10 to 20 cm in front of the fore tracks, whereas in medium canter the hind tracks land approximately 1.5 m in front of the fore tracks.

Stubborn: A horse that appears unwilling to respond to the aids, probably due to lack of motivation or habituation to signals as a result of incorrect negative reinforcement.

Submission: *See* Dominance/submission.

Switch off, tune out: A lack of response to any signal (altered attention and motivation levels) provided by a rider or handler when a horse becomes hyper-reactive. This may be an expression of learned helplessness. Switching off and becoming 'dead to the aids' is likely to be accompanied by raised corticosteroid concentrations and may be partly caused by state dependent learning, i.e., learning that takes place and is only retained when the internal milieu of the horse is in the particular state at the time of learning. When this state shifts, memory and learning may be reduced or absent. There are training implications associated with this concept if horses are trained only when they are calm.

Tail swishing: Lateral and dorsoventral movements of the tail symptomatic of conflict behaviour in hyper-reactive horses. In the absence of other irritants, tail swishing can be a clue to incorrect negative reinforcement of the go response or indicate a dislike of too-tight reins and unrelenting leg/spur pressure.

Teeth grinding: In the absence of dental or other health disorders, grinding the teeth is a response to unresolved stressors encountered during training, or a product of general management. It may be associated with incorrect negative reinforcement of the stop/slow/step-back response.

Tempo: The timing or rhythm of the horse's strides.

Tension: In equitation, hyper-reactivity and presumably heightened HPA axis activity. Tense horses are frequently hollow and show various behavioural indicators of stress.

Tilting nose: A posture adopted by some horses during locomotion under-saddle such that the nose tilts to one side. It results from incorrect negative reinforcement, principally during the training of the turn response (no release for the correct response or pressuring for the turn when the inside leg is on the ground and unable to respond) but also in the training of the stop response (no release and contact too tight).

Track up, overtracking: Associated with engagement of the hindlimbs to the point where the foot fall of the hindlimb reaches forward and overlays or surpasses the print of the ipsilateral forelimb.

Trailing hindquarters: In equitation, the action of the hindlegs such that, at the moment of thrust, the hind hooves are not underneath the hocks but behind them. The horse is said to out behind and is usually also hollow. This prevents the horse from attaining impulsion and collection.

Training scale: A progressive order of training particular qualities of responses through the process of shaping. Shaping programs merit further research.

Transition: The change from one gait type to another, or from one stride length to another. A transition can be between gaits, within a gait or from one tempo to another as well as into and out of the halt.

Tune out: *See* Switch off.

Turn: A change in line of locomotion by the horse. The turn is initiated by the forequarters with the hind feet following the fore tracks. Turning occurs through shifting the inside leg slightly to the side, decelerating it on contact with the ground, and accelerating the opposite foreleg in contact with the ground. The turn is trained by negative reinforcement using the stimulus of the single rein, which classically conditions to the light rein aid and then to cues of associated changes of the rider's position at the initiation of the turn. The turn aid should be applied when the turning leg is beginning to go forward.

Unlevel/uneven: A euphemism for abnormal action caused by either clinical lameness or a physical abnormality that changes the action of the horse.

Working trot/canter: A term that refers to the normal stride length within the gaits. In the working trot the stride length is where the hind feet land into the fore tracks. In the working canter the hind tracks land approximately 1 m over the fore tracks. There is no working walk in equitation; the basic walk is the medium walk, such that the hind track lands in front of the fore track.

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A low cost device for measuring the pressures exerted on domestic horses by riders and handlers.

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Abstract

Unwelcome problems with horses usually develop because of the inappropriate application of training techniques. People working with horses generally have varying levels of skill in horse handling and large numbers of horses are used worldwide for a vast range of activities. Despite these causes of variability, the welfare implications of behavioural problems in general suggest that horse handlers and riders should become conversant in learning theory since it is the basis of good training. Traditional methods currently used in training horses are predominantly based on negative reinforcement. Perhaps because workers in the horse industry are mostly unaware of the scientific basis of their training systems, negative reinforcement is often inappropriately applied, causing much resistance and conflict for the horse.

The amount and duration of pressure required to elicit a standard response (such as leading forward) varies from horse to horse. Preuschoft *et al*. (1999) and Clayton *et al*. (2003) have measured pressures placed in a horse's mouth during training, but the expense of the systems they used may preclude from use in everyday training. Therefore, a low cost sensor and ambulatory recording system worn on the horse that can be used in everyday training to measure the pressures commonly applied to horses (via equipment such as reins and leads) was developed.

Two sensors were tested on horses that were being led, lunged and ridden and the range of pressures for normal light rein contact were in the range of 0 - 30 N.

Other studies that have recorded rein pressures found a range of up to 60 N. This, in itself, highlights the need for further research to be conducted on the pressures applied to horses and importantly, the subsequent education of riders and trainers so that horses are not subjected to unnecessary pressures. The results from this preliminary trial have shown that this form of data collection is potentially valuable as both a research and training tool and that much lighter pressures than those previously recorded can and should be used when training horses.

Introduction

The majority of behaviour problems with horses usually arise from the inappropriate application of training techniques (Ödberg, 1987; Mills, 1998). Large numbers of horses are used worldwide for a vast range of activities (Hobbs *et al.*, 1994; Paix, 1999; Gordon, 2001) by people with extremely variable competence. So, the potential for welfare concern is tremendous. Ensuring that horse handlers and riders become well versed in learning theory provides the basis of good, humane training.

Traditional methods currently used in training horses are predominantly based on negative reinforcement although those people in the horse industry are mostly unaware of this (Warren-Smith and McGreevy, *in prep*.). Negative reinforcement employs the principle that the probability of a behaviour being performed is increased by the removal of an aversive stimulus (Skinner, 1953; Voith, 1986; Cooper, 1998; Karrasch and Karrasch, 2000; Nye, 2000). Negative reinforcement is often inappropriately applied, causing resistance and conflict in the horse. For example, direct observation shows that a large proportion of riders and trainers continue to exert and maintain significant and unnecessary pressure on a horse's mouth whilst handling and riding. When the horse has habituated to the constant pressure on its mouth, its responses to rein cues diminish. Where this lack of contingency of the response-reinforcement relationship continues, the result may include a variety of unwelcome responses that range from reduced performance (Matute, 1994) to non-responsiveness (Mal and McCall, 1996), both of which are forms of learned helplessness. This results in riders using more force or increasing the severity of the bit and thus the cycle of increased pressure and habituation continues.

An earlier study showed that the amount and duration of pressure required to elicit a standard response (such as leading forward) varies from horse to horse (Warren-Smith *et al.,* 2005). Therefore, the amount of pressure as well as the timing of its release may be critical in the success of training techniques applied to horses.

Preuschoft *et al*. (1999) and Clayton *et al*. (2003) measured pressures placed on a horse's mouth during training. However, the sensors used by Preuschoft *et al*. (1999) weighed approximately 300 g and were subject to hysteresis, and the cost of the sensors used by Clayton *et al*. (2003) may preclude their use in everyday training. Likewise, the telemetry-based system used by Clayton *et al*. (2003) is also expensive and may have range problems for distance work such as on racehorses or cross-country training, as well as being complicated by using a multi-channel system. Therefore, there exists the need for a low-cost sensor and a low-cost ambulatory recording system worn on the horse that can be used in everyday training to measure the pressures that are commonly applied to horses via equipment such as reins and leads. We have called this device the *Rein Gauge*.

Methodology

There are several possible approaches to the construction of a coaxial tension dynamometer for measuring rein tension. The specifications for the device must include a highly linear and repeatable response to an appropriate range of tensions. It should be light compared with the weight of the rein itself and sufficiently rugged to withstand the high dynamic forces associated with volatile horses. To prolong battery life, both sensor and data-logger should consume minimal power while, to reduce overall cost, there should be minimal interface electronics with the data-logger.

Various techniques were investigated by the current team for fulfilling the above specifications. Conductive rubber strips and granular carbon packed tubes proved to be sufficiently sensitive and simple to interface. However, although they have short-term linearity, they are extremely prone to load-tension hysteresis. Load cell dynamometers, as presented by Clayton *et al.* (2003) give excellent linearity and repeatability, but require the added complexity of strain gauge amplifiers (a pair of load cells and strain gauge amplifiers to cover the range of 100 N cost over $AUS 1200).

The current technique produces a voltage which is linearly proportional to the tension applied to a spring (Figure 1). This scheme gives good linearity (as per Hooke's Law), is very low cost (a pair of these devices cost around $AUS 50) and requires no additional interface circuitry. The device is rugged, lightweight (10 - 50 g) and would be suitable for application in training large numbers of riders and horses. The spring chosen extends by a maximum of only 15mm, which has minimal effect on rein technique. The measuring and recording range of the sensors used in this trial of the Rein Gauge was 0.1 to 4 kg. The total cost of the complete system is $AUS 600.

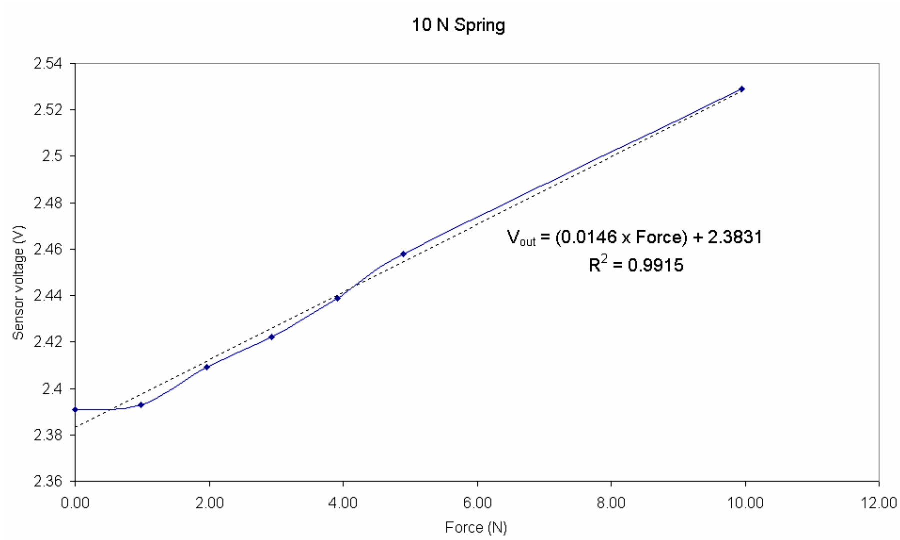

Figure 1: The calibration of the 10 N sensor.

Two sensors were tested on horses (n=2) that were being led, lunged or ridden. With the horses that were led and lunged a single sensor was used in the lead rein and lunge rein respectively, while on the ridden horse a pair of sensors were used with one sensor in each rein. Data were collected for five testing episodes of each. The first sensor measured between 0 - 15 N pressure while the second measured 0 - 50 N pressure. This trial determined that the range of pressures for normal light rein contact was between 0 - 15 N and when a specific stimulus such as for turning is applied, this can reach up to 30 N.

The signals from a pair of dynamometers were recorded using two of the eight channels of an ambulatory data logger (Signal Scribe Data Logger, Crafted Software, Curtis *et al*., 2005, robac@ieee.org). The data was sampled at a rate of 100Hz for each channel with a 10 bit resolution. The data logger records to a Flash Memory Card (Multi Media Style) file which can be opened post-test by the Signal Scribe Data Analysis System.

The data logger was secured in a pouch on a Velcro fastened neck sweat on the horse in the region of the third cervical vertebrae lateral to the surface of the neck to keep it clear of the reins (Figure 2). There are short cables (approximately 20 cm) connecting the dynamometers to the data logger system.

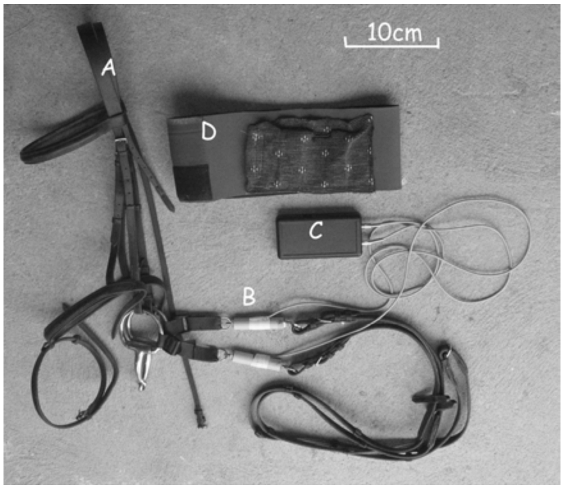

Figure 2: Parts of the Rein Gauge:
A = Full size bridle
B = Sensors attached to reins
C = Data logger

Three test situations were employed on a standard-sized dressage arena (60 x 20 m) with crusher dust surface. Firstly, a foal had a standard web headcollar with cotton lead rein attached. The sensor was fitted between the headcollar and the lead rein so the foal could be led as it would under normal conditions. The foal was then led at walk and trot for 20 min on the arena. During this leading, the foal was given the stimuli to walk, halt, trot and for standard arena movements such as turns, circles, diagonals and serpentines. The pressures applied to the lead rein were measured constantly during the leading.

The second test session involved lungeing a horse, where the sensor was connected between the lunge cavesson and the lunge rein. The horse was walked and trotted in both directions on the lunge for approximately 15 min and the pressures recorded constantly. Thirdly, the same horse then had two sensors attached (one on each rein) between the rings of an eggbutt snaffle bit and the reins of the bridle. The horse was then ridden on the arena at walk and trot to complete standard arena movements and the pressures recorded constantly.

The experimental protocol was approved under Protocol OAC/1-2003/3/3705 (Animal Care and Ethics Committee, University of Sydney, Australia).

Results

From the trial of leading, lungeing and riding a horse wearing the Rein Gauge, the range of pressures for normal light rein contact was in the range of 0 - 15 N but that when a stimulus is applied to the horse via the reins in these instances, that the pressures can reach up to 30 N (Figure 3).

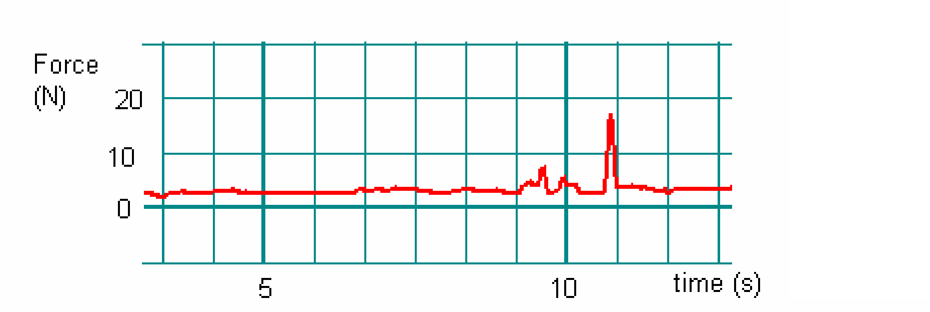

Figure 3a: The trace recorded from the Rein Gauge of a foal being led at the walk. The spike in the trace was when the stimulus was applied on the lead rein for the foal to make a transition from walk to halt.

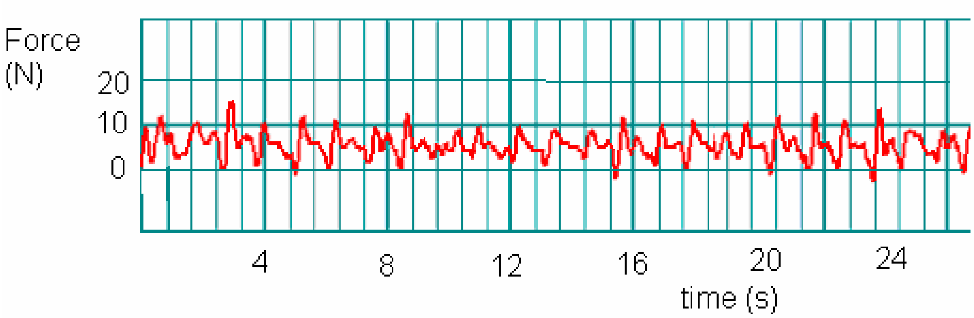

Figure 3b: The trace recorded from the Rein Gauge of a horse being lunged at the trot.

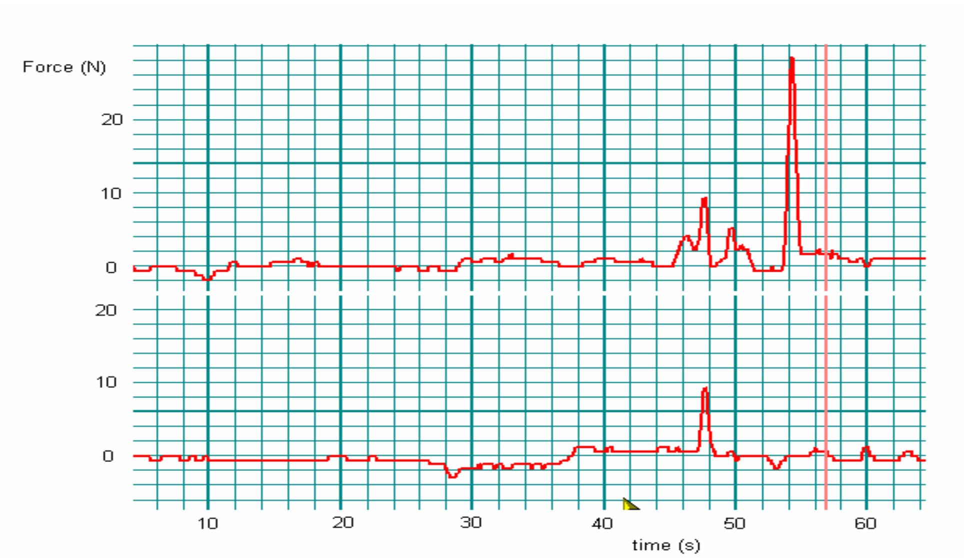

Figure 3c: The trace recorded from the Rein Gauge of a horse being ridden through a turn. The spikes in the trace represent when the stimulus was applied through the rein where the higher spike (top portion of graph) represents the inside or turning rein.

Discussion

The results from this preliminary trial of the feasibility of the use of the Rein Gauge indicated that this form of data collection is potentially valuable as a research tool and for the education and training of people handling and riding horses. The Rein Gauge could ultimately be used to improve the welfare of horses in training, especially to reduce the persistent use of excessive and unnecessary rein pressures.

By definition, one cannot avoid the use of negative reinforcement as the training modality when a bridle or headcollar is used to give a horse signals. If the effectiveness of this training is to reach its potential, then those people involved in riding and handling horses need to become aware of the appropriate pressures required to elicit responses from horses. The device could also be used to record the physical interactions between horses and novice riders and contrast them with those that arise between horses and competent riders who use negative reinforcement correctly. Given that the focus of other studies has been on the relationship of rein pressures in relation to the gait of the horse, we advocate that the amount of rein pressure a rider exerts on a horse and perhaps more importantly, the timing of the release of this pressure, should form the focus of future equitation science studies.

Previous studies that have recorded rein pressures (e.g. Preuschoft *et al*., 1999; Clayton *et al*., 2003) found a range of pressures up to 60 N. The data from the current trial indicate that when specific cues were given to the horse via the reins the range of pressures employed was much lower (being less than 30 N). This, in itself, highlights the need for further research to be conducted on the pressures applied to horses and importantly, the subsequent education of riders and trainers so that horses are not subjected to unnecessary pressures.

Conclusion

Learning theory provides the clearest basis for good animal training. When using equipment such as headcollars and bridles on horses, the use of negative reinforcement cannot be avoided. However, it needs to be appropriately applied. The results from this preliminary trial have shown that the Rein Gauge is potentially valuable as both a research and training tool and that much lighter pressures than those previously recorded (eg, Preuschoft *et al*., 1999 and Clayton *et al*., 2003) can and should be used when training horses.

Acknowledgements

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Breed differences in equine retinae

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Abstract

There is a wide range of skull shapes within the domestic horse (*Equus caballus*). This is of interest because skull morphology, in particular nose length, has been shown to correlate strongly with the distribution of retinal ganglion cells in dogs. The current study examined the skull morphology and retinae of 30 horses from a variety of breeds to determine whether skull morphology was a predictive factor of ganglion cell distribution in the equine retina and therefore a potential influence on visual field.

The density of ganglion cells varied significantly between individuals, with breed being a significant predictor. There was a strong positive correlation between the nasal length and the density of ganglion cells in the visual streak. There was also significant variation in the density of ganglion cells in the area centralis but this variation did not correlate with any of the skull morphology measurements.

The density of ganglion cells in an individual's retina, along with its retinal magnification factor, can be used to calculate an estimate of that animal's visual acuity. The relative estimated visual acuity of the Standardbred, Thoroughbred and Arabian horses in the current study were calculated and it was demonstrated that the Standardbreds (with their longer noses) are likely to have better visual acuity in the visual streak than the Arabians (shorter noses). This may have implications for the comparative ability of horses from various breeds to detect visual stimuli, especially in the peripheral field. This, in turn, has implications for equitation especially in terms of control of flight responses.

Introduction

Ganglion cells in the retina relay visual information from the photoreceptors to the brain for interpretation. The variation in quality of vision across the retina can be assessed by mapping the distribution of these cells (Hughes, 1977). It has been reported that the distribution of ganglion cells correlates with skull morphology in domestic dogs such that dolicocephalic breeds have a well defined visual streak while brachycephalic breeds have a strong area centralis (McGreevy *et al.,* 2004). The aim of the current study was to investigate the distribution of ganglion cells in the equine retina and compare it to their skull morphology.

Three studies had previously mapped the distribution of equine ganglion cells using whole-mounted retinae (Hebel, 1976; Harman, *et al.,* 1999; Guo and Sugita, 2000). They all described the presence of a visual streak, which is a narrow (~1 mm) high density linear band of ganglion cells extending both nasally and temporally, 2-3 mm dorsal to the optic disc. Dorsal and ventral to the streak, all three studies reported a decrease in cell density towards the periphery of the retina. The three horses examined by Guo and Sugita (2000) were Thoroughbreds. The other two studies (Hebel 1976; Harman *et al.,* 1999) examined 3 horses each, but did not specify the breeds examined. A wider variety of breeds need to be examined before it can be assumed that all members of this morphologically diverse species have similar retinal ganglion cell distributions.

The visual acuity of individual horses can be estimated using anatomical variables such as ganglion cell density and posterior nodal distance (PND, see below) (Hughes, 1977).

Methodology

Animals and Tissue

Tissue for this study was obtained from horses destroyed by a commercial pet food abattoir (Burns Pet Foods Pty Ltd, Rouse Hill, NSW). As all tissue was collected post-mortem, no ethical approval was required. Eyes were enucleated from 30 adult horses for creation of retinal ganglion cell density maps. The horses were from the following breeds: Thoroughbred (16), Standardbred (5), pony (2), Arabian (3), Anglo-Arab (1), Quarter Horse (1), Warmblood (1) and Appaloosa X (1).

Skull Measurements

For each horse, breed (or type), approximate age (estimated from dental wear), colour, and sex were recorded. Head measurements (skull length [sub-divided into cranial length and nasal length], cranial width, zygomatic width, ratio of cranial length: nasal length, nasal profile area, cranial profile area, and mandibular depth [measured from frontal-nasal suture line to angle of the mandible]) were recorded post-mortem using methods established by Evans and McGreevy (in press) to quantify skull morphology. The following indices were also calculated: skull index (zygomatic width x100/skull length), cranial index (cranial width x100/cranial length), nasal index (zygomatic width x100/nasal length), nasal profile index (nasal profile area/nasal length), cranial profile index (cranial profile area/cranial length) and mandibular index (mandibular depth x 100/skull length).

The orbit volume of all eyes was measured by water displacement and they were fixed in 10% buffered formalin. To compare relative size as opposed to absolute size, an ‘eye index’ (average eye volume x100/skull length) was also calculated for each horse.

Retinal dissection and mounting

The eyes were fixed for 1 - 4 weeks and then the retinae were whole mounted using the method established by Stone (1981). The retinae were then stained with 1% neutral red.

Retinal maps

Retinal maps were created after a light microscope (40 X objective) was used to count ganglion cells across the whole slide in a grid fashion. At each sample site, all ganglion cells that fell within a 250μm X 250μm square area were counted. By multiplying that number by 16 the number of ganglion cells per mm^2 was calculated. Sample sites across most of the slide were 2 mm apart. However, as the visual streak is only approximately 2 mm wide, it could easily be missed between two sample sites. Therefore, as densities started to rise (using 20 cells in the 250μm X 250μm area as an arbitrary cut-off point), the sample sites were spaced only 1 mm apart.

The counts were then recorded on a spreadsheet (Microsoft Excel, Microsoft Corporation 1997) and the variation in density of ganglion cells across the retina was visualised using 3D surface plots. For each map, the highest ganglion cell density (in cells/mm^2) found in the area centralis, the highest ganglion cell density (in cells/mm^2) found in the visual streak, and the ratio of those two values (peak density in area centralis: visual streak) were recorded.

Statistical Analysis

Minitab 14.12 software (Minitab Inc 2004, Pennsylvania, U.S.A, www.minitab.com) was used to analyse the data. Relationships between skull measurements and ganglion cell data were investigated using Pearson correlations.

Estimates of relative visual acuity

The following equation from Harman *et al.* (1999) was used to calculate an estimate of potential visual acuity:

A: ($\sqrt{}$Peak ganglion cell density in visual streak)/2 = cycles/mm

B: ($2\pi r$)/360 = retinal magnification factor (mm/degree)

Where r = posterior nodal distance (PND)

A x B = cycles per degree.

Posterior nodal distance can be calculated as 0.67 x the axial length of the eye (Harman *et al.,* 1999). However, only eye volume was recorded in this study, not the axial lengths of the eyes. Therefore, the radius of each eye was estimated from the eye volumes, using $4/3\pi r^3$. However, as equine eyes are not spherical (they are slightly compressed in an antero-posterior direction) (Dyce *et al.,* 1996), the value calculated was not the true radius. Therefore, the values calculated should not be read as accurate measures of visual acuity, but rather as relative values that allow comparison between horses in this study.

Results

Retinal ganglion cell distribution

There was a sparse distribution of ganglion cells over the majority of the retina, with densities in the periphery ranging from 16 to 304 cells/mm^2. However, a narrow (1-2 mm across), well demarcated, horizontally aligned band of cells in the ventral retina, approximately 3-5 mm dorsal to the ventrally situated optic disc and spanning the entire width of the retina was identified as the visual streak. Here the cell densities were much higher with peak cell density ranging from 1376 to 3328 cells/mm^2. The area centralis also showed variation in peak ganglion cell density, with values ranging from 1680 to 4304 cells/mm^2. The ratio of peak cell density in the visual streak to peak density in the area centralis varied from 0.797 to 1.868.

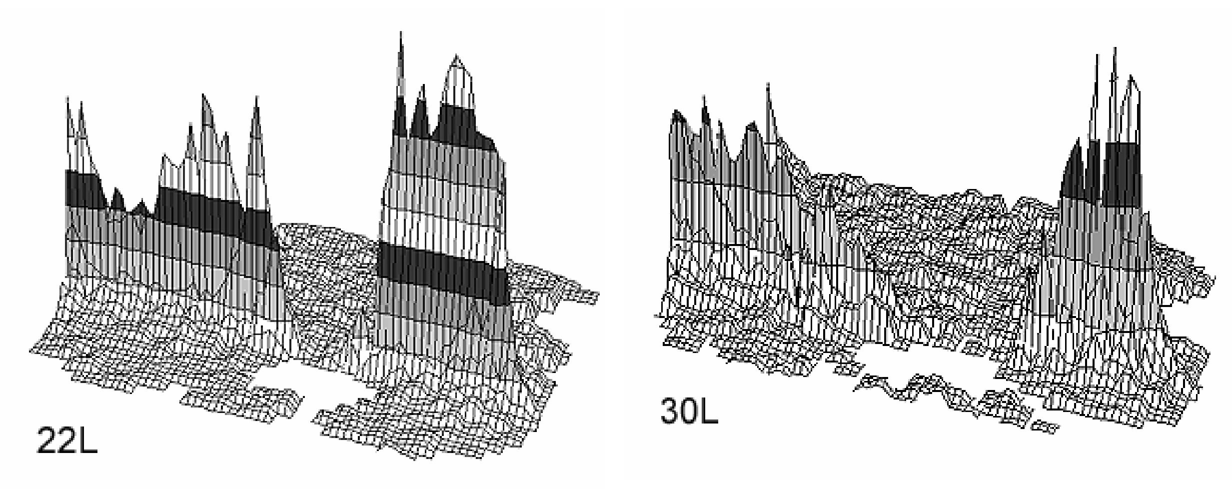
Eye Volume

The values for eye volume ranged from 42.0-62.5 ml. There was no significant difference in average eye volume (ANOVA F=1.86, p=0.180) or eye volume index (ANOVA F=0.09, p=0.910) between the Standardbreds, Thoroughbreds and Arabians in this study.

Retinal ganglion cell correlations

Size

Peak density of ganglion cells in the visual streak correlated positively with skull length (r=0.542, p=0.002). There was a stronger correlation between peak density in the visual streak and nasal length (r=0.554, p=0.001) than with cranial length (r=0.428, p=0.018). However, the correlation between these skull lengths and ganglion cell density in the visual streak was not present between horses of the same breed. This suggests the association is only apparent between breeds, not present between individuals of the same breed. The retinal ganglion cell density map in Figure 1a is from a Standardbred and demonstrates higher ganglion cell density than that of an Arabian in Figure 1b. None of the skull size measurements correlated with the peak ganglion cell density in the area centralis, or the area centralis:visual streak ratio.



a. Standardbred b. Arabian

Figure 1. Retinal ganglion cell density maps. The dorsal part of the retina is in the background, ventral is in the foreground, nasal is to the left, and temporal is to the right. Each shaded band represents 400 cells/mm^2.

Breed

There was significant variation in peak cell density in the visual streak across the breeds ($p=0.038$). Peak ganglion cell density in the visual streak of the Standardbreds and Thoroughbreds was significantly higher than in the Arabians (both $p<0.05$). However, the difference between the Standardbreds and the Thoroughbreds was not significant ($t=1.77$, $p=0.092$).

Peak ganglion cell density in the area centralis did not vary significantly between the Standardbreds, Thoroughbreds or Arabians (ANOVA $F=0.42$, $p=0.661$).

Age and Sex

The affects of age and sex were assessed but discarded due to their non-significance.

Estimates of relative visual acuity

There was a range in values for estimated relative visual acuity in the visual streak from 11.02 cycles/degree to 17.14 cycles/degree (mean = 13.77 cycles/degree, SD = 1.45).

There was a strong positive correlation between nasal length and estimated relative visual acuity ($r=0.604$, $p=0.000$). The Standardbred value was significantly higher than the value for the Arabians ($t=3.38$, $p=0.012$) and the Thoroughbreds ($t=2.18$, $p=0.042$). The Thoroughbreds also had a significantly higher estimate than the Arabians ($t=2.26$, $p=0.036$).

Discussion

Eye volume

Eye volume ranged from 42.0-62.5 ml. This range is wider than the 45.0-50.9 ml previously reported in the literature (Davidson, 1991). This variation does not appear to be a function of breed.

Retinal ganglion cell density and distribution

Peak retinal ganglion cell density in the area centralis and the visual streak showed a significant amount of variation among this sample of horses. The peak ganglion cell densities in the area centralis varied from 1680 to 4304 cells/mm^2, a difference of approximately 2.5-fold between horses. The recently reported study of the canine retina described a similar amount of variation with peak density in the area centralis ranging from 880 cells/mm^2 to 2640 cells/mm^2, a 3-fold difference (McGreevy *et al.* 2004). However, in the visual streak, the peak densities in the current sample of horses ranged from 1376 cells/mm^2 to 3328 cells/mm^2, a 2.4-fold difference, whilst in the dogs it ranged from 160 cells/mm^2 to 880 cells/mm^2, a 5.5-fold difference. The wider spectrum of skull morphology amongst the dogs, compared to the horses, probably explains the wider variation.

Ganglion cell correlations

Horses with longer heads, and more especially those with long nasal lengths, had more ganglion cells in their visual streak. This resulted in the peak cell density in the visual streak varying significantly between ‘long-nosed’ Standardbreds and ‘short-nosed’ Arabians, as well as between Thoroughbreds and Arabians.

The estimates of relative visual acuity ranged from 11.02 cycles/degree to 17.14 cycles/degree. Again, these values should not be interpreted as true acuity estimates as there was a lack of an accurate measure for axial length of the globe. However, they permit valid comparisons of the horses in this study and show that the ability to detect detail in the visual streak varies amongst individual horses. The difference between the highest and lowest values was 1.5-fold. This means that the horse with the highest value may have been able to see at 30 m what the horse with the lowest value could see only at 20 m. It is surprising to find this amount of variation within a single species. Also, the three major breeds in this study were all significantly different in this respect. Therefore, in general, it appears that Standardbreds can detect more detail with their visual streak than Thoroughbreds and in turn, Thoroughbreds more than Arabians. However, this study was unable to quantify the specific increase in visual acuity.

Interestingly, the correlation between skull morphology and ganglion cell density was not apparent within the area centralis. More variation occurred within the area centralis than in the visual streak but there was no correlation with any of the skull measurements recorded in this study or other factors such as breed, age, colour or sex. As the area centralis is used for binocular vision and depth perception, it would be useful to be able to predict which horses have increased cell numbers in this area when selecting mounts for disciplines that require good depth perception, such as show-jumping. Unfortunately, none of the morphological characteristics examined in this study appear to be predictive for increased ganglion cell density in the area centralis.

The visual streak is used for monocular scanning and, as such, facilitates early detection of approaching predators, especially when the horse is grazing with its head down (Harman *et al.,* 1999). Harmless moving objects, such as a branch in the wind, can be accurately identified without the need to stop grazing if the horse has good acuity in its peripheral field. However, if the horse has poor acuity in its visual streak, the horse must choose to either stop grazing and focus with the area centralis, or run from the possible predator without properly identifying it. Therefore, it may be theorized that the temperament of some breeds may be affected by their ability to detect detail in the visual streak. Of course, many factors other than eyesight will affect temperament and much more research, including comparative behavioural studies, would be needed to give weight to this theory.

Conclusion

The findings of this study provide us with further understanding of the equine visual system and how horses have individualised abilities to perceive and thus respond to, their visual environments.

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Equestrianism and horse welfare: *The need for an 'equine-centred' approach to training.*

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Abstract

Equine behavioural problems (often referred to as misbehaviours) in the horse, usually result from confusion (leading to stress) and sometimes pain, caused by the actions of riders/handlers/trainers in their attempts to train new behaviours or eliminate existing, unwanted natural behavioural responses. Using a case study approach it has been possible to identify common factors that appear to be related to poor training and riding ability. The horses discussed in this paper were presented as clinical cases at a large veterinary school in Scotland but after full veterinary examination no clinical problems could be found and they were considered to be exhibiting learned problem behaviour. All responded well to behaviour therapy. It is concluded that there is a need for an 'equine-centred' approach to training that involves a greater appreciation of natural behavioural responses and the use of learning theory in developing effective and humane training methods.

Introduction

Pain assessment in humans relies heavily on self-report or verbal description of pain. However, this is not possible in horses and owners often make the assumption that pain is not being experienced until the horse develops problem behaviours such as bucking, napping or rearing. The potential for causing the horse pain and stress during the training process is high. The equipment that is utilised for directing and stopping the horse (the bit and bridle) as well as sitting on the horse (the saddle) can lead to injury due to poor fitting and inappropriate use. Poor understanding of horse anatomy, behaviour and physiology can lead to stress due to confused messages, inappropriate expectations and inexperienced handling/riding. Recent surveys indicate that slaughter/ euthanasia due to the development of behavioural problems may be high (Ödberg and Bouissou, 1999) and an international horse charity (International League for the Protection of Horses, UK) recently stated that the number one reason for horses being placed with them was behavioural problems preventing the horse from being ridden (Jones, 2003).

Expectations of horse performance may result in the use of methods to achieve results that are not in the best interests of the horse. Furthermore it may not always be possible to determine and reward good approaches to training using the current systems for judging equestrianism. This was investigated in a recent preliminary study carried out in Belgium (D'Yves, 2004) of 30 horses ridden during a simplified dressage test. Each horse was videoed and judged by four internationally qualified dressage judges. The same footage was analysed for the occurrence of specific behavioural events or postures indicative of stress or tension (such as tail swishing and teeth grinding). Heart rate and rein tension was also monitored throughout each test. Rein tension was measured via a specially designed force logger attached to a force sensor placed on the rein between the horses' bit and the rider's hands. The results indicate that what the judges scored in terms of the visual appearance of the test did correlate with objective measures of the absence or presence of evasive behaviours, however the score given by the rider for rein tension applied to the horse in the test was not reflected in the dressage judges' assessment of 'lightness'. This suggests that it may not always be possible for the judges to determine and therefore reward good training and horsemanship.

Behaviour problems that are often the result of badly fitting or inappropriately used equipment and/or poor riding and training techniques are frequently believed by the rider to be related to a physical problem with the horse. Observations made during a one year period at the Royal (Dick) School of Veterinary Studies in Edinburgh, Scotland, suggest that even though the problem behaviours are believed by the owner to have a physical basis, many of them are learned behaviours that can be explained by observing the interactions and training methods employed by the rider. These problem horses are often presented to veterinarians, may be euthanased or given up to horse rescue societies because the riders/trainers are unable to understand the underlying causes for the behaviours their horse is exhibiting. Not only is there a need to improve our knowledge of the extent of these problems within the equine industry, there is also a need to develop a greater understanding of why such problems occur and how they can be prevented.

The observational study described in this paper developed from cases being presented as referrals to the veterinary hospital in Edinburgh for clinical assessment due to the belief by the owner that their horse had some serious physical problem that could explain its problem behaviour.

Methods

This study describes the behaviour of five of the seventeen ‘behaviour cases’ presented to the Easter Bush Veterinary Referral Centre at the Royal (Dick) School for Veterinary Studies during a six month period from 2003 to 2004. All 17 cases were referred to the behaviour clinic when no clinical explanation could be found to explain the behaviour and after the owner of the animal had been fully consulted. Clinical examinations were carried out by the orthopaedic veterinary team and if necessary (as in Case 5) a reproductive examination was carried out to ensure that all was normal. Procedures for assessment varied depending upon the presenting problem and included gait assessment, flexion tests, use of phenylbutazone daily for three days (e.g. Case 4) or up to a two week period (e.g. Case 1) whilst the horse was worked, palpation of the back, scinitigraphic examination (bone scan) and radiographic imaging of spine and skull and nerve blocks. In all cases clinical examinations were considered to be exhaustive and the cases were then referred to the behavioural clinic.

Cases

Case 1: A 6 year old chestnut Arab gelding standing approximately 14 hh owned by the current rider for two years and bought for pleasure riding. The horse was presented because he was reluctant to go forward, especially into canter and he performed excessive head shaking behaviour mainly when under saddle. This had led the owner to believe that there could be a problem with the saddle, the horse's back and teeth. Following extensive veterinary examination and testing there appeared to be no physical explanation for the problem behaviour.

Case 2: A 10 year old chestnut mare standing approximately 15 hh. She was bought almost one year previously for a 13 year old girl to use for pleasure riding. After approximately 4 weeks of being ridden, the horse developed a violent aversion to being bridled. She was described as showing signs of panic, head shaking and backing away when the bridle was raised towards her. She had not therefore been bridled or ridden for the previous 6 months. After extensive physical examination it was concluded that there was no obvious clinical problem with this horse's head, teeth, ears or back.

Case 3: An 8 year old, 16 hh, thoroughbred mare that had displayed an unwillingness to leave the stable yard for a period of about a year and if forced she would plant, spin and rear. The problem was frightening to her 35 year old lady owner since the mare had reared and unseated her rider in the past. The horse was quite happy to leave the yard whilst in the company of other horses and would exercise willingly in the outdoor arena. Having had a physical examination, no clinical problem could be identified that may have caused this behaviour.

Case 4: A 6 year old, 16.2 hh, thoroughbred gelding presented because he exhibited violent bucking when under saddle both with and without a rider on board. He was described as appearing nervous at the sight of the saddle and hunched his back when being saddled, as well as kicking out and bucking.

When lunged, he began to buck violently once asked for canter on both reins. His rider has been bucked off for no apparent reason. No immediate physical explanation could be found for his violent behavioural response to the saddle and being ridden.

Case 5: A 10 year old, 14 hh showjumping mare was presented with a variety of problem behaviours that were described as aggressive behaviour in the stable, striking and squealing when being handled, kicking when having her hind legs handled or whilst being shod, generally difficult to handle and unpredictable and dangerous. Her owners felt that she was permanently in oestrus since she showed 'mareish' behaviour towards other horses and humans. She was extremely difficult to bridle and the usual method used was to take the bridle apart and to then manoeuvre the bridle into place whilst the rider was in the saddle. In addition she showed a form of flehmen response when the bridle appeared, and squealed on a number of occasions particularly when her normal young male rider interacted with her. She was relatively quiet to saddle and girth up and ride. After a full reproductive and physical examination, no clinical problems could be found to explain her behaviour.

Results

In all five cases as described in this paper, the horses showed a marked improvement in behaviour after a mean of 6.4 days of behaviour therapy (range 8 to 5 days). In all cases the horses were returned to their owners and in all but one case (Case 4) the horse remained in the owners' possession for a period of 6 months or more. Follow up phone calls and questionnaires were used to assess the effectiveness of the behavioural treatment. In cases 1, 2, 3 and 5 positive feedback was obtained 6 months following therapy. The owner of Case 4 had sold the horse not long after it had been returned to her.

Standardised behavioural modification techniques (see Waran *et al*., 2002) were utilised to establish more appropriate responses and to reduce the incidence and severity of the problem behaviour. Each programme was individually tailored for each horse, taking into account the horse's history as well as the rider's experiences. For example, Case 2 involved a de-sensitisation and counter-conditioning programme, involving five short training sessions each day for 5 days. The sessions were aimed at shaping the pony's behaviour so that she had a new behavioural response in response to the words, 'Head-down' (lowering the head and neck). The bridling procedure was broken into its various components and she was systematically desensitised to each of the components that appeared to cause the most concern. Finally she was bridled on a number of occasions by three different people and in two different situations, so that she was prepared for bridling in her home environment and by her usual handler.

Subjective analysis of the video tapes made of a number of behaviour modification sessions involving these and other 'behaviour cases' suggests that many of the problems dealt with during the period from 2003 to 2004 were the result of poor riding and handling.

Discussion and Conclusion

There is a need for clarification amongst equestrian experts regarding both the process and goals of equestrianism, especially with respect to dressage where some of the concepts (e.g. 'lightness') appear difficult to assess and judge. This is essential since it appears that in trying to meet the perceived goals for competition, riders and trainers use traditional techniques that are not based on sound theoretical principles (e.g. learning theory). Breakdown in the horse-rider relationship as a result of poor training and riding occurs all too frequently and this often leads to horse welfare problems. The behaviour cases described in this paper were the end result of poor handling and training techniques. What is interesting is that in all cases they were presented at a UK veterinary school as possible clinical problems and the owners had not considered that their own behaviour may be related to the onset of the problem with their horse. This sample represents the first 6 months of only one year of the normal business of a vet school with an average case load of 500 clinical cases during that time. The behaviour cases (17) therefore represent 3.5% of the case load. It should be noted that the vet school had not advertised a behaviour clinic and the seventeen cases had been referred as clinical and not behavioural.

The numbers of horses kept for leisure or competition riding appears to be rising and so it is likely that there are increasing numbers of horses exhibiting problem behaviour associated with poor riding and training methods. A recent survey of horse numbers in Scotland suggests that there may be as many as 100,000 horses in the country and if only 1% of these animals develop a behaviour problem, this equates to 10,000 horses. The Scottish Branch of the International League for the Protection of Horses (only one of four main equine charities that rescue horses in Scotland) claim that 25% of their annual intake are horses that are 'given-up' by owners due to behaviour problems (Jones, 2003).

This evidence suggests that there is a need for an 'equine-centred' approach to training. Furthermore where behavioural modification is implemented, this should be conducted by professionals with expertise in learning theory. Training or re-training should involve a greater appreciation of species specific natural behavioural responses, a better understanding of the horse's responses to stress and pain, improved knowledge of the learning ability of the horse, the use of humane, effective training techniques as well as improved definitions in equestrian terminology. This approach will eventually lead to fewer horses exhibiting behavioural problems, less wastage due to training problems and an overall improvement in horse welfare.

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The use of head lowering in horses as a method of inducing calmness.

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Abstract

Globally, millions of horses are used for a range of purposes by humans with varying levels of skill in horse handling. Inappropriate handling techniques, especially those that cause flight responses or conflict behaviour, account for much of the wastage rates among horses as well as the majority of the deaths and injuries among handlers. In contrast, some techniques help to calm horses and thus facilitate training. Anecdotal evidence suggests that one such technique is lowering the height of a horse's head position. To determine the effect of head lowering, 20 horses were paired for age, sex and breed before one from each pair was allocated to Group 1 (treatment group: stimulus for head lowering applied during testing period) and the other placed into Group 2 (control group: no experimental stimulus applied during testing period). The stimulus for head lowering was downward pressure on the headcollar via the lead rope until the horse lowered its head such that its lips were approximately at mid-cannon height; as soon as this occurred the pressure was released. The testing period was 15 consecutive minutes divided into three 5-minute phases: Phase 1, in which neither group had experimental stimuli applied; Phase 2, in which Group 1 had the stimulus for head lowering applied and Group 2 had no stimuli applied; and Phase 3 that repeated the Phase 1 treatment. Behavioural responses of the head, neck and legs and the physiological responses of heart rate and heart rate variability were measured and analysed with one-way analysis of covariance. There were no significant differences between groups with any of the other responses measured, except for sniffing the ground (P=0.039), probably due to

the nature of the treatment. These results indicate that, under these conditions, head lowering does not result in increased calmness in horses.

Introduction

Large numbers of horses are used worldwide for a range of leisure, working and competitive activities (Hobbs *et al.*, 1994; Paix, 1999; Gordon, 2001). Training horses is one of the most important aspects (Marinier *et al*., 1988) of the human-horse relationship, but inappropriate training techniques result in unnecessary wastage of both horses (Ödberg and Bouissou, 1999) and humans (e.g. Cripps, 2000). Training problems result in horses exhibiting conflict behaviour which ultimately has welfare implications for the horse (McLean, 2004). This could be overcome by more appropriate training methods (Mills, 1998; Rushen *et al*., 1999) which could lead to calmness in the horse (McLean, 2004). Anecdotal evidence suggests that lowering the height of the horse's head results in calming the horse. This is supported by some associated observations that relate to postural tonus in the horse (Kiley-Worthington, 1987). Specifically, Waring (2003) and McGreevy (2004) concur that a lowered head position is the opposite of the main signal of alertness, which is that of the head raised.

There are a number of possible reasons why head lowering may induce calmness. It can significantly decrease mean arterial blood pressure (Parry *et al*., 1980); it replicates the position of resting (Feist and McCullough, 1976), grazing (Harman *et al*., 1999) and it enables the horse to have the binocular field of vision directed towards the ground and the lateral monocular fields in position to scan the lateral horizon (Harman *et al*., 1999). Hall *et al*. (2003) found that horses' performance in a visual discrimination trial was improved when the head was lowered and the stimulus presented at ground level compared to presentation of the stimulus at a height of 70 cm. The horses in this trial were reinforced for a correct choice by being given a food reward. For some commentators, lowering of the head is regarded as a sign of submission (Sighieri *et al*., 2003) along with licking lips and chewing (Miller, 1995).

However, these behavioural responses have not been recorded in scientific literature (Goodwin, 1999) as measures of calmness, whereas increases in heart rate and heart rate variability have been reported to be physiological measures of distress (Bachman *et al*., 2003).

Materials and methods

<u>Animals</u>

Twenty horses of varying age, sex and breed were familiarised with wearing a halter and a roller. The horses were housed in paddocks at the University of Sydney, Orange Campus Equine Centre. They were maintained on pasture and supplemented with a concentrate feed to meet National Research Council (1989) nutritional guidelines. The experimental protocol was approved under Protocol OAC/1-2003/3/3705 (Animal Care and Ethics Committee, University of Sydney, Australia).

<u>Methodology</u>

The horses were paired for age, sex and breed with one from each pair randomly placed into Group 1 (treatment; stimulus for head lowering applied) and the other placed into Group 2 (control; no experimental stimulus applied). Both horses of a pair had rollers and heart rate monitors applied, then led to the designated test area. The testing time was 15 consecutive min divided into three 5 min phases. Phase 1 was common to both treatment and control groups and no experimental stimulus was applied. In Phase 2, Group 1 had the stimulus for head lowering applied and Group 2 had no stimulus applied. During Phase 3, both groups had no experimental stimulus applied. The stimulus for head lowering was the application of downward pressure on the headcollar via the lead rope until the horse lowered its head such that its lips were approximately at mid-cannon height whereupon the pressure was released. When the horse raised its head such that its lips were above the height of its knee, the stimulus for head lowering was reapplied. This continued as necessary for the 5 min of phase 2. The sequence of testing of pairs alternated and the same handlers were used throughout testing.

Measurements and data analysis

Behavioural responses of the head, neck and legs were recorded on videotape and the physiological responses of heart rate and heart rate variability were measured for each phase and analysed with one-way analysis of covariance with blocking. All calculations were performed using Genstat (Genstat 7th Edition).

Results

The horses in Group 1 were more likely to sniff the ground during Phase 2 ($P<0.05$), but by Phase 3, the residual effect of the treatment was decreasing such that there was no difference between the groups ($P>0.05$). There were no significant differences with any of the other responses measured (Table 1).

	Phase 1		Phase 2		Phase 3	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Back Leg Steps	5.1*	6.2	6.6	6.7	5.9	4.2
Front Leg Steps	6.7	7.7	8.1	8.6	6.2	5.2
Chewing	1.2	0.7	0.5	0.6	0.4	0.7
Chew Lead	0.0	0.4	0.0	0.4	0.0	0.2
Ear Movements	6.7	10.0	5.3	9.3	6.7	8.5
Flehmen	0.0	0.0	0.0	0.0	0.1	0.0
Head Contact Human	0.4	0.8	0.6	1.1	0.7	1.0
Head Left	3.7	3.1	2.4	2.2	3.3	2.2
Head Right	2.5	2.6	2.5	2.0	2.1	3.0
Head Shake	0.7	1.0	0.9	1.6	1.0	1.1
Heart Rate	28.7	28.8	27.2	28.8	27.5	28.5
Heart Rate Variability	18.2	14.5	18.8	15.4	18.2	16.2
Lick	1.6	1.1	0.5	1.0	0.3	1.2
Lips	0.0	0.0	1.0	0.0	0.0	0.0
Need Reposition	0.5	0.3	0.5	0.3	0.6	0.7
Paw Ground	0.1	0.4	0.0	0.2	0.0	0.4
Rest Hind Leg	1.0	0.0	4.0	4.0	4.0	4.0
Rub nose on self	0.5	0.1	0.0	0.1	0.1	0.1
Sniff Ground	1.5	1.7	1.7a	0.9b	1.3	0.9
Snort	0.1	0.0	0.0	0.0	0.0	0.1
Stamp Hoof	0.0	0.8	0.4	0.1	0.0	0.1
Yawn	0.7	0.5	0.6	0.0	0.0	1.0

Table 1: The means of the responses exhibited by two groups of horses (Group 1 Treatment, Group 2 Control) during the three phases of testing where the stimulus for head lowering via negative reinforcement was applied in Phase 2.
*Values for each group were not significantly different within each phase except where indicated by different letters ($P<0.05$).

Discussion

The horses that underwent head lowering were more likely to sniff the ground. This could be attributed to the nature of the treatment whereby these horses had their muzzles closer to the ground and therefore, since olfactory stimuli on the ground would have been closer, the likelihood of sniffing as an opportunistic behaviour would have increased (Hall et al., 2003).

Heart rate and heart rate variability did not differ between treatments, indicating that the horses were not calmed by the use of head lowering. Parry et al. (1980) found that lowering the height of a horse's head significantly reduced mean arterial blood pressure. The horse's heads were held in position using halter pressure and the horses were also given food rewards to keep their heads in position. Unfortunately, Parry et al. (1980) did not measure heart rate or behavioural responses as we did in this study. Perhaps the influence of giving food rewards had some influence on the mean arterial blood pressure. Likewise, the horses in this trial showed no increase in licking and chewing in association with head lowering. As we were unable to achieve an objective measure of calmness in this trial, we cannot deduce that head lowering induces calmness, or that licking and chewing are signs of calmness. Perhaps the licking and chewing we observed here could be indicative of anticipation of food (Houpt et al., 1978), or being in a vulnerable position such as when grazing (Miller, 1995; Sighieri et al., 2003).

Conclusion

It cannot be concluded that, under the experimental conditions used in this study, head lowering resulted in calmness in horses, nor that licking lips and chewing are signs of calmness, or are associated with head lowering. However, it is possible that different results would be achieved under different conditions, e.g. when a horse is exhibiting postural tonus prior to the application of head lowering techniques.

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Epidemiology of horses leaving the Thoroughbred and Standardbred racing industries.

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Abstract

A survey of Thoroughbred and Standardbred trainers was undertaken to investigate the wastage rates of horses in racing stables. The reasons for horses leaving the stables were also investigated and the risk factors for different destinations were analysed. The main reasons for horses leaving stables were poor performance and illness or injury. Six percent of horses left stables for reasons related to behavioural problems. Standardbreds were more likely than Thoroughbreds to have a slaughterhouse as their destination. Thoroughbreds leaving racing due to "unsuitable temperament / behaviour" were also at increased risk of entering slaughterhouses. These results emphasise the high wastage rates and diverse destinations of horses after leaving a racing stable. Wastage rates may be reduced by greater attention to the factors that cause poor performance and injuries or illness. Additionally, improved foundation ("breaking in") training could also reduce wastage rates.

Introduction

A large number of horses exit the Thoroughbred and Standardbred racehorse industries each year. Previous estimates approximate that over one-third of the Thoroughbred horse population in race training from Victoria, Australia, is replaced each year (Bourke, 1995). The aims of the current investigation were to investigate the reasons for horses leaving Thoroughbred and Standardbred racing stables, and to describe their destinations after leaving. Risk factors for the alternative destinations were also investigated.

Particular emphasis was given to the slaughterhouse as a destination. The Australian horse meat industry consists of slaughterhouses selling the meat as pet food in the domestic market and those exporting the meat for human consumption. No known research has been conducted to characterise horses entering Australian slaughterhouses. However, a study conducted in the United States found that of the 1008 horses studied entering slaughterhouses, 7.7% had serious welfare problems, most of which were caused by abuse or neglect (Grandin *et al*., 1999). This led the authors to conclude that slaughterhouses may have an important role in providing a humane alternative for many horses. A study conducted in Germany (Ödberg and Bouissou, 1999) found that of the 2970 horses entering slaughterhouses, the average age was 8.5 years. Although it has been purported that a large number of ex-racehorses in Australia enter slaughterhouses (Duckworth, 2001), this has not been quantitatively investigated. This was one of the key aims of the current study.

Methodology

To characterise the wastage, a survey of 1,258 Thoroughbred and 981 Standardbred trainers was conducted through mailed questionnaires. Trainer details of all licence types were obtained from the relevant State/Territory racing authorities. The response rates to the questionnaires were 30.0% for Thoroughbred and 32.4% for Standardbred trainers. Due to data constraints, wastage rates were defined as the percentage of horses leaving stables in the total population over the previous official racing year (2002-2003), rather than those known to have conclusively left the industry altogether. The details of the last five horses to have left each stable were also obtained. Reasons for leaving the stable were categorised as “poor performance”, “illness/injury”, “unsuitable temperament / behaviour”, or “other”. Destinations for horses were categorised as “stud”, “different trainer”, “auction / new owner”, “spelling”, “slaughterhouse” or “other”.

The possible risk factors that were examined for horses leaving the industry included age, sex and number of years in training. Reasons for horses leaving the industry and destinations subsequent to leaving, particularly slaughterhouse destinations, were also analysed.

Results

From the questionnaire, it was estimated for the 2002-2003 official race year that the total wastage rates in the Thoroughbred and Standardbred racing industries were 38.6% and 38.1%, respectively. The reasons provided for horses leaving the industry were "poor performance / slow" (36.5% Thoroughbreds, 35.2% Standardbreds), "illness / injury" (31.0%, 27.1%), "to breed" (9.4%, 10.1%), "unsuitable temperament / behaviour" (6.4%, 6.4%) and "other" (16.8%, 21.2%). The destinations of these horses included to "stud" (18.2%, 16.1%), "different trainer" (17.2%, 28.6%), "auction / new owner" (16.6%, 11.1%), "spelling" (11.3%, 11.6%) and "slaughterhouse" (6.3%, 16.6%). Other destinations, including performance-riding destinations, accounted for 30.4% and 16.1% respectively.

Risk factors that significantly ($P<0.001$) influenced the fate of Thoroughbred and Standardbred racing horses included sex, age, time spent in racing and reasons for leaving. Those horses at increased risk of leaving for slaughterhouses tended to be geldings. Standardbreds at higher risk for this outcome were those that left the stable due to "poor performance". Standardbreds and Thoroughbreds leaving for "unsuitable behaviour / temperament", were also more likely to go to a slaughterhouse.

Discussion

Despite the similarity in wastage rates in the Thoroughbred and Standardbred industries, the destinations of the two breeds differed substantially. Thoroughbred horses were more likely than Standardbreds to go to stud, auctions or to enter ridden equestrian pursuits. In contrast, Standardbreds were more likely than Thoroughbreds to go to different trainers or directly to slaughterhouses. This difference may reflect the perceptions of the suitability and performance of ridden Standardbred horses.

Slaughterhouses were described as significant final destinations for Thoroughbred and Standardbred racing horses. Respondents described 6.3% of Thoroughbred racing horses having entered slaughterhouses, compared with 16.6% of Standardbred racing horses. These figures possibly underestimate the true rate because they do not take into account those horses that left a racing stable for another destination and then subsequently went to a slaughterhouse.

Thoroughbreds leaving racing due to “unsuitable temperament / behaviour” were at increased risk of entering slaughterhouses. Horses leaving for “illness/injury” were at the next highest risk and, due to the larger number of total horses leaving for this reason, constituted the largest number of total horses entering slaughterhouses.

Slaughterhouses appeared to provide a practical choice for the large numbers of horses leaving the racing industries. However, the continued viability of the horsemeat industry depends on the continued public demand for horsemeat in overseas countries and for pet food domestically.

Conclusion

This study provided a preliminary investigation of current wastage in the racing industries. Large wastage rates were identified and the destinations of horses leaving were described together with reasons for culling. Reducing the wastage rates should be an industry priority, given the importance of public perceptions of the industry and the economic implications of the wastage. Improved cardiovascular and musculoskeletal conditioning practices and foundation training may reduce the wastage rates and the apparent dependence on the horsemeat industry as a destination for horses after leaving a racing stable.

Acknowledgements

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A preliminary study on the relation between subjectively assessing dressage performances and objective welfare parameters.

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Abstract

Inappropriate schooling is probably an underestimated welfare problem. Technology could help evaluate whether particular practices are stressful to the horse. In contrast to academic principles, supple and unconstrained gaits ('lightness') are not widespread in modern riding. Intensity of rein tension is one expression of it. A tension meter was built in order to measure it telemetrically. A study was designed to explore whether the subjective assessment of dressage performances corresponded with objective measurements relevant for welfare. Potential relationships between the following parameters were analysed:

- The subjective assessment of eight dressage criteria by four judges and the evaluation of 'lightness' by the rider.
- The quality of a horse's training based on 'lightness' as measured through tension on a rein.
- The appearance of evasive behaviours suggesting decreased welfare.
- Heart rate indicative of the emotional state of the horse.

These measures were recorded whilst each of thirty horses were ridden by the same rider during a standardised test. It was presumed that using horses from

[2] The work was carried out in Belgium by the first author for the completion of the Master of Science in Animal Behaviour and Welfare at the University of Edinburgh.

three different backgrounds could control for the level of schooling: Professional Competition, Leisure Riding and Riding Instruction. The influence of sex (mares and geldings) was also investigated.

The tension meter functioned well. Inter-observer reliability was good as the subjective scoring between the four judges and the rider correlated ($P<0.05$) and was negatively related to the horses' frequency of evasive behaviours ($P<0.05$). However, subjective scoring was related to neither rein tension nor heart rate. Evasive behaviour frequency was neither related to rein tension nor to heart rate. Heart rate did not correlate with rein tension. Although differences in dressage scores were observed between the three groups of horses (Professional Competition > Leisure Riding > Riding Instruction), there were no differences when considering the three other parameters. The horses' sex influenced none of the parameters.

Introduction

Until recently, there was little scientific concern about the welfare of horses compared with other species and funding was not easy to obtain. Despite active campaigns (e.g., International League for the Protection of Horses), there are no major improvements in horse management. However, attention has grown to some extent, mainly on housing and management (due to the rather obvious stereotypies that horses develop when these areas are poor or neglected).

More attention has been drawn recently to subjects such as transport, racing and schooling (e.g., Waran, 2002). Inappropriate schooling and riding probably result in underestimated welfare problems. The modern way of schooling is too often quite coercive as compared to the classical 18th century philosophy (Ödberg and Bouissou, 1999). Therefore, it may contribute to the high percentage of horses being slaughtered at a young age (von Butler and Armbruster, 1984; Ödberg and Bouissou, 1999) or at least before reaching normal retirement age (Wallin *et al.*, 2000). Ignorance of academic principles has led to re-inventing the wheel through ‘ethological riding’, ‘horse whisperers’ and other lucrative businesses.

One of the differences between the academic principles and present day riding is the lack of lightness in the latter. This is expressed in a strong tension on the bit through the reins along with other symptoms. Given the hypothesis that the welfare of horses being ridden with coercion is decreased, it is relevant to develop a way of measuring objectively the tension on the reins. Therefore, a tension meter was designed and built at Ghent University. It was initially believed to be original, but later discovered that Preuschoft *et al*. (1999) and Clayton *et al*. (2003) had already designed and used similar devices.

An exploratory study was carried out in order to test the apparatus and explore whether a correlation could be found between the way the horse is schooled and ridden and some parameters relevant for welfare. Also, the subjective scoring of dressage tests was compared with various objective measurements. This aim was achieved by analysing the potential relationships between four factors:

- The subjective assessment of eight dressage criteria by four judges and of ‘lightness’ by the rider.
- The quality of a horse’s training based on ‘lightness’ as measured through tension on a rein.
- The appearance of evasive behaviours suggesting decreased welfare.
- Heart rate as an indication of the emotional state.

Methodology

1. Subjects

Thirty horses (Table 1) were randomly chosen from among fifty healthy horses with a minimum withers height of 1.48 m. They were subdivided into three categories according to their background:

- Professional Competition (PC): the horses compete (dressage, cross-country) at international level and are usually ridden by the same rider.
- Leisure Riding (LR): the horses are used for leisure and compete occasionally at national level. The same rider usually rides them.
- Riding Instruction (RI): the horses are used for instruction and are ridden by many different riders who have maximum 200 hours of riding experience.

All the horses had been ridden for at least two years and during the past six months at least four times a week. Apart from some RI horses, all were usually ridden in poll-flexion. They were either saddle horses (Belgian Warmblood Horse, Selle Français) or Thoroughbreds.

Table 1: Description of horses and atmospheric conditions during dressage test.

Horse Identity				Conditions during the Test	
Group	Horse Number	Sex	Date of Test	Temperature	Weather
RI	8	F	21 June	13	Sun/Windy
	9	F	21 June	13	Sun/Windy
	10	M	21 June	13	Sun/Windy
	11	M	21 June	13	Sun/Windy
	12	M	21 June	13	Sun/Windy
	26	F	30 June	22	Cloudy
	27	M	30 June	22	Cloudy
	28	M	30 June	24	Sun
	29	M	30 June	24	Sun
	30	F	30 June	24	Sun
LR	1	F	18 June	22	Sun
	2	M	18 June	22	Sun
	3	M	18 June	22	Sun
	4	M	18 June	22	Sun
	5	F	18 June	22	Sun
	6	F	20 June	20	Sun
	7	F	20 June	20	Sun
	17	F	22 June	16	Sun
	18	F	23 June	15	Sun/Windy
	19	F	23 June	15	Sun/Windy
PC	13	F	22 June	16	Sun
	14	M	22 June	16	Sun
	15	F	22 June	16	Sun
	16	F	22 June	16	Sun
	20	M	24 June	17	Sun/Windy
	21	M	24 June	17	Sun/Windy
	22	F	24 June	17	Sun/Windy
	23	F	24 June	17	Sun/Windy
	24	M	24 June	17	Sun/Windy
	25	M	29 June	24	Sun

2. Experimental design

Initially, a pilot study was conducted using two horses other than those described above. The experimental test consisted of a symmetrically ridden dressage session (Table 2) (duration range: 3 min 07 sec - 3 min 54 sec) in a 20 m x 40 m uncovered arena, during which rein tension, heart rate, evasive behaviours and dressage criteria (cf. 3.4) were assessed.

All horses were ridden in their familiar environment, close to their usual stables, for the first time by the same rider (= first author), using the same saddle (which fitted perfectly all horses), in about the same atmospheric conditions (absence of rain and heavy wind and temperature varying between 13˚C and 24˚C).

A standard pair of reins fitted with the rein tension-measuring device (Figures 1 and 2), were attached to the horse's snaffle. All horses were ridden in poll-flexion (i.e., flexion at the level of the atlas and axis cervical) apart from some of the RI horses that were too stiff to be ridden that way.

Table 2: The dressage test.

A	enter in working trot (rising)
C	track right
C-A	serpentine of three loops through the whole arena
K-X-M	change rein
X	halt, 3 steps backwards and proceed in medium walk
C	working canter left
E	circle of 15 meters diameter
A	working trot (rising)
A-C	serpentine of three loops through the whole arena
H-X-F	change rein
X	halt, 3 steps backwards and medium walk forward
A	working canter right
E	circle of 15 meters diameter
E-C	working canter

Figure 1. Force sensor fixed with clips between the snaffle and the rein.

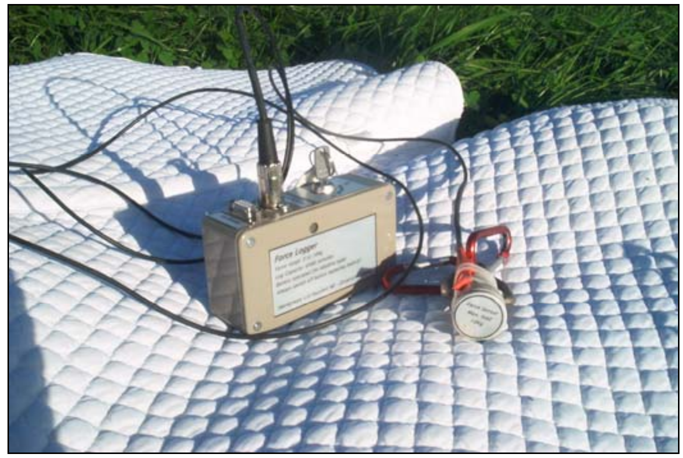

Figure 2. Force logger connected to the force sensor.

Before the dressage test, each horse was subjected to a standardised and symmetrical warm-up of ten minutes with loose reins. During the warm-up, horses were also familiarised with the different appliances (rein tension monitor, heart monitor and video camera).

Between the warm-up and the dressage test, 20 seconds of rest (halt in position ‘A’[3]) were added during which the heart monitor and the rein tension monitor were activated. Data recorded during these 20 seconds were deleted from the analysis in case the rider’s movements when starting the appliances would have induced artefacts.

[3] Such letters refer to the international description of the dressage arena (not shown).

3. Data recordings

3.1. Heart rate recordings

A Polar Horse Trainer S-610 (Electro Oy, Kempele, Finland) displayed and recorded heart rate every five seconds. The positive electrode was placed on the left of the withers under the saddlecloth and the negative one left ventrally underneath the girth. They were moistened with Rodosonic transmission gel (Pannoc Chemie, Olen). The receiver was attached at the rider's wrist.

3.2. Rein tension recordings

A force logger connected to a force sensor (Figure 2), designed and built by the workshop of the Science Faculty of the University of Ghent, measured the tension on the right rein with a precision of 3 grams at a rate of 11.6 samples per second. The same reins were always used. Using loggers on both reins would have increased costs and complicated unnecessarily the analysis at this preliminary stage. The sensor was attached to the rider's waist. In order to simplify the statistical analysis, one average value was calculated per five seconds, which coincided with the heart rate recording interval.

3.3. Evasive behaviours recordings

All dressage tests were video recorded from position 'C'. The films were monitored with a Panasonic AG-6730 time-lapse recorder and behaviour (Table 3) was analysed with the Video Pro software. Only behaviour frequencies were taken into account.

Table 3: Ethogram of evasive behaviours recorded during the dressage test.

Rearing	Both forelegs leave the ground, horse rises on hind limbs
Jigging	Short, stilted walk/jog with hollow back and high head
Balking	Refusal to take the bit, refusal to go forward
Bucking	Arching the back, lowering the head, kicking with hind or leaping
Running away, bolting	Galloping out of control
Backing	Refusal to go forward and few steps backwards
Head movement	Includes head shaking, head tossing, head flinging, head slinging or a throwing up of the head
Tail wringing	Switching and/or rotating tail intensively
Flattening the ears	Ears flattened on the head, with meatus directed backwards
Sneezing	Blow of air expelled rapidly and noisily through the nostrils
Rooting at the bit ('gagging' or 'yawing')	A stretching out of the neck accompanied by jaw movements, sideways and vertical. Described by some as a yawn that does not make it
Above the bit	Head high and outstretched, pokes the nose and puts the bit 'between its teeth'
Gaping	Open mouth
Lip movement	Lower lip slapped up and down, eventually noisily
Constant tongue movement	The tongue moves continuously and appears outside of the horse's mouth
Bit gnashing	Chomping and champing at the bit
Tongue over the bit	The bit is under the tongue
Grinding the teeth or grinding on the bit	Teeth rubbed against each other or on the bit
Locked jaw	Clenched teeth

3.4. Dressage criteria scorings

The videotapes were shown once in a randomised order to four national/international dressage judges, who after each clip scored and commented independently on eight criteria (Table 4) on the usual official dressage scale from 0 to 10. The four judges were unaware what kind of analysis was going to be performed.

The rider also scored the same criteria after each test as well as the time, the temperature, the atmospheric conditions and any comments concerning parameters that could have interfered with the performance of the dressage test.

Table 4: Dressage criteria

Suppleness	Pliability; showing ability to smoothly adjust the carriage (longitudinally) and the position or bend (laterally) without impairment of the flow of movement or balance.
Lightness	Refers to the horse's lightness on its feet and lightness in the reins, a component of self-carriage.
Impulsion	Thrust. The impression given by the horse of a desire to carry himself forward and spring off the ground, elasticity of steps, relaxation of the back.
On the Aids	The horse responds instantly y to all the aids accepting the contact and maintaining connection.
Roundness	1. The convexity of the profile of the horse's dorsal line. 2. The circular, as opposed to linear or flat quality, characterizing the movements or action of the horse's limbs.
Freedom of movements	Refers to the quality of the paces. The impression that the horse moves forward without constraints, as if it was moving freely in its natural environment.
Regularity of paces	The horse moves forward in a regular rhythm and the length from each stride is similar to all the other ones in a particular pace.
Relaxation and confidence	The horse presents a relaxed attitude, no bodily tensions and no hesitations.

3.5. Statistical analysis

The data were analysed using the Analytical Software Statistix7 and MINITAB. To analyse whether data conformed to a normal distribution, the Shapiro-Wilk Test was used (Statistix 7, 2000). The W statistic and corresponding p-values were calculated. Also, the Normal Probability Plot procedure was applied for each variable (Petrie and Watson, 1999).

Results

1. Relationships between subjective measures

A multicollinearity (Pearson's Correlation Coefficient) was observed between the scorings of dressage criteria by the four judges and the rider (Table 5).

2. Relationships between objective measures

Rein tension correlated neither with heart rate (Pearson's Correlation Coefficient, r=0.0365, P>0.05), nor with frequency of evasive behaviours (Pearson's Correlation Coefficient, r=0.028, P>0.05). In addition, heart rate did not correlate with frequency of evasive behaviours (Pearson's Correlation Coefficient, r=-0.1656, P>0.05).

Table 5: Multicollinearity between dressage scores.

	Rider	Judge 1	Judge 2	Judge 3
Judge 1	0.868 0.000			
Judge 2	0.812 0.000	0.865 0.000		
Judge 3	0.888 0.000	0.856 0.000	0.863 0.000	
Judge 4	0.738 0.000	0.757 0.000	0.805 0.000	0.826 0.000

Cell Contents: Pearson correlation P-Value.

3. Relationships between subjective and objective measures

The frequency of evasive behaviours correlated negatively with the total scoring of the eight dressage criteria by the rider (Pearson's Correlation Coefficient, r=-0.4864, P<0.05), with the average of the total scores given by the four judges on the eight dressage criteria (Spearman's Rank Correlation Coefficient, ρ=-0.5497, P<0.05), as well as with the average of the scores given by the four judges on the criterion 'relaxation and confidence' (Spearman's Rank Correlation Coefficient, ρ=-0.5197, P<0.05).

Rein tension correlated neither with the average of the total scores given by the four judges on the eight dressage criteria (Spearman's Rank Correlation

Coefficient, ρ=-0.216, P>0.05), nor with the average of the scores given by the four judges on the criterion 'lightness' (Spearman's Rank Correlation Coefficient, ρ=-0.3546, P>0.05). However, rein tension correlated negatively with the score given by the rider on the criterion 'lightness' (Spearman's Rank Correlation Coefficient, ρ=-0.3948, P<0.05). Heart rate did not correlate with scores on the eight dressage criteria given by the four judges (Spearman's Rank Correlation Coefficient, ρ=0.1302, P>0.05).

4. Differences between horses according to their background

Depending on their background, there was a difference between the horses in the dressage scores given by the four judges (Kruskal-Wallis Test, F=17.55, P<0.05) (Figure 3). The Professional Competition horses had the highest scores and the Riding Instruction horses had the lowest scores. No differences were found between the three groups related to the heart rate (Kruskal-Wallis Test, F=2.56, P>0.05) (Figure 4), the rein tension (Kruskal-Wallis Test, F=1.76, P>0.05) (Figure 5) or the frequency of evasive behaviours (Kruskal-Wallis Test, F=1.19, P>0.05) (Figure 6). Heart rate and rein tension did not differ between the three groups. Differences in the mean values between the groups could not exclude the possibility that the difference in heart rate (One Way Repeated Measures Analysis of Variance, F=1.479, P>0.05) or in rein tension (One Way Repeated Measures Analysis of Variance, F=3,008, P>0.05) was due to random sampling variability.

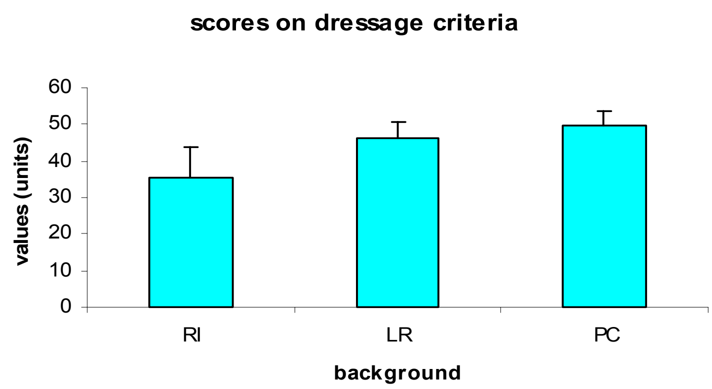

Figure 3. Average scoring on dressage criteria according to the horses' background (Riding Instruction, Leisure Riding, Professional Competition).

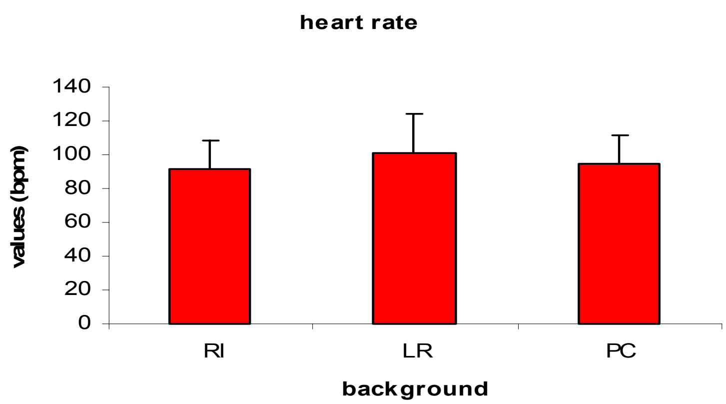

Figure 4. Average heart rate according to the horses' background (Riding Instruction, Leisure Riding, Professional Competition).

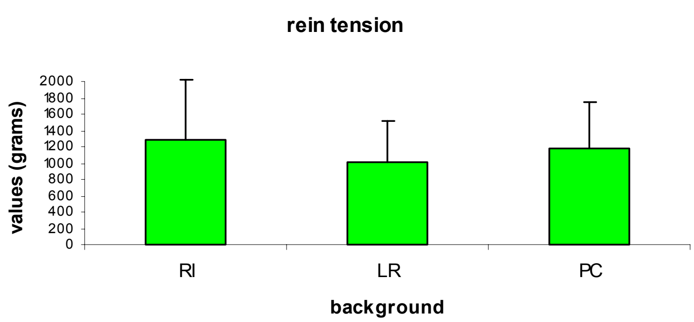

Figure 5. Average rein tension according to the horses' background (Riding Instruction, Leisure Riding, Professional Competition).

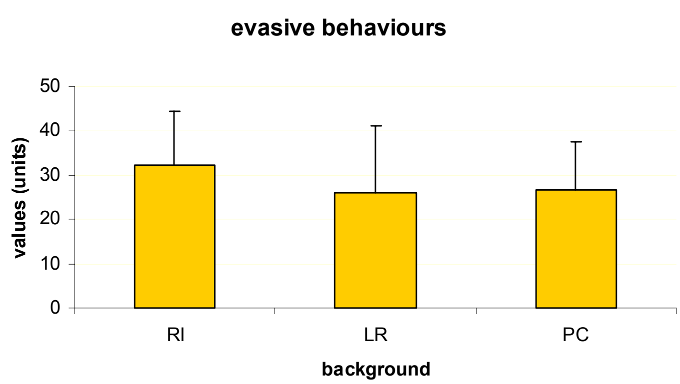

Figure 6. Average frequency of evasive behaviours according to the horses' background (Riding Instruction, Leisure Riding, Professional Competition).

5. Differences between horses according to their sex

According to the sex of the horses, no differences were found in heart rate (Wilcoxon Rank Sum Test, $U=1.560$, $P>0.05$), rein tension (Wilcoxon Rank Sum Test, $U=0.187$, $P>0.05$), frequency of evasive behaviours (Wilcoxon Rank Sum Test, $U= 0.5738$, $P>0.05$) or scores on dressage criteria (Wilcoxon Rank Sum Test, $U=0.042$, $P>0.05$).

6. Differences between the horses presenting extreme values in frequency of evasive behaviours or in rein tension

When considering only the group of horses that showed the lowest frequency of evasive behaviours (first quartile) and the group of horses that showed the highest frequency of evasive behaviours (fourth quartile), no differences in rein tension (Wilcoxon Rank Sum Test, $U=0.256$, $P>0.05$) or in heart rate (Wilcoxon Rank Sum Test, $U=1.406$, $P>0.05$) were found. Also, when considering only the group of horses with the lowest rein tension (first quartile) and the group of horses with the highest rein tension (fourth quartile), no differences in the frequency of evasive behaviours (Wilcoxon Rank Sum Test, $U=0.192$, $P>0.05$) or in heart rate (Wilcoxon Rank Sum Test, $U=0.000$, $P>0.05$) were found. Evasive behaviours which could have induced extreme rein tensions, such as bolting, did not occur.

Discussion

1. Relationships between subjective measures

Inter-observer reliability was demonstrated between the four judges and the rider.

2. Relationships between objective measures

The fact that heart rate and frequency of evasive behaviours do not correlate, might be explained by the difference in the horses' coping strategy (Ödberg and Bouissou, 1999). It is still unknown which theory is valid in horses: the theory of distinctive active and passive copers (von Holst, 1985; Bohus *et al*., 1987; Benus *et al*., 1991; Schouten and Wiepkema, 1991; Korte *et al*., 1992, 1998; Koolhaas *et al*., 1999) or the theory of a normal distribution of individuals according to temperament (Forkman *et al*., 1995; Jensen *et al*., 1995; Spoolder *et al*., 1996). Both theories may explain the absence of correlation in this study. Horses experiencing discomfort (e.g., high rein tension) may present an increase in heart rate without performing evasive behaviours because they have learned (eventually by punishment) that such behaviours do not lead to reinforcement. This could induce a decreased reactivity or even a state of learned helplessness (Seligman *et al*., 1971). Conversely, horses may perform evasive behaviours with no obvious changes in heart rate, because responses to previous aversive situations have become a habit (Kiley-Worthington, 1997).

Ideally speaking, a developmental study should be carried out from the first stages of schooling. An initial positive correlation could disappear with time. An additional problem is that various motor patterns could have different energetic requirements. A more detailed analysis might differentiate between energetic and emotional components.

A high pressure on the mouth is usually an indicator of a stiff horse ridden with hard aids. However, some individuals could be more or less sensitive to that pressure, while others experience more or less pain due to hard leg or seat aids. Hence evasive behaviours might depend from each individual's sort of sensitivity. The analysis of extreme values did not yield different results.

3. Relationships between subjective and objective measures

The negative correlation between the judge's and the rider's scores and the frequency of evasive behaviours shows that behavioural expression is taken into account when dressage criteria are evaluated, such as lightness, freedom of movements, relaxation, confidence and suppleness.

The judges' assessments did not correlate with rein tension and heart rate. The rider's evaluation of 'lightness' correlated with rein tension, whereas the average score of the four judges on that criterion did not. One explanation is that it is difficult to estimate the amount of pressure applied to the horse's mouth for an observer not riding the horse. A more likely explanation is that lightness is unfortunately not highly valued in modern dressage (de Bragance, 1976; Henriquet and Durand, 1996; Ödberg and Bouissou, 1999; Racinet, 1999), which results in judges not being sufficiently trained to correctly assess this criterion.

The negative correlation between the judges' assessment of the horse's 'relaxation and confidence' and the frequency of evasive behaviours is more straightforward, such behaviours being quite obvious.

4. Differences between horses according to their background

The fact that no difference in rein tension was found between the three groups might partly be due to the fact that the majority of the RI horses did not respond appropriately to the stimuli applied by the legs and were not usually ridden in poll-flexion. Given that any attempt to ride some of the RI horses in poll-flexion would stop them from going forward, they were allowed to carry their head higher in order to be able to complete the required exercises. Consequently, the tension on the rein was lower than if the rider had physically forced those RI horses to be ridden in poll-flexion. Although the LR horses and the PC horses were all ridden in poll-flexion, no difference in rein tension was found, suggesting that the training level was the same in those leisure stables as in those professional ones. Also, while being ridden during the test, some of the PC horses appeared not to be as advanced in their dressage training as some of the LR horses. Given that lightness is obtained progressively according to the horse's level of training and muscular development (Edwards and Geddes, 1973), this might have masked any differences in rein tension. Furthermore, the fact that all horses were submitted to the same warm-up might also have affected the tension on the rein during the dressage test. Indeed, a warm-up of ten minutes with loose reins in walk and trot might not be enough for some horses to obtain suppleness and lightness. Eventually, the fact that the rider tried to standardise her way of riding, to keep an equal contact with the horse's mouth during the entire dressage test and to interfere as little as possible, might have hidden the potential differences in rein tension as well as in the variability of rein tension between horses from different backgrounds. Therefore, it would be interesting to investigate whether a difference in rein tension would be observed when their usual riders ride the horses.

If the choice of the horses was based on different training methods instead of different purposes, a difference in rein tension might have been observed. Therefore, an additional study is planned in order to compare baroque breeds, trained according to the 18th Century principles, ridden by their usual rider, with modern dressage horses. Results from the only horse that was tested up to now show that the average rein tension of this Lusitanian (339 grams) is much lower than that found in the present study (horse with the minimum average rein tension = 639 grams; average rein tension of the 30 horses = 1184 grams; horse with the highest average rein tension = 1930 grams). Schooling method could be the cause of the difference, but the rider rode his own horse. Baroque breeds have a more natural predisposition for collection and the horse was ridden with a double bridle although only the snaffle reins (incorporating the tension meter) were used.

No difference was found between the three groups concerning the frequency of evasive behaviours, although there was a difference in dressage scores. Even if the RI horses did not perform the dressage test with as much ease as the LR and the PC horses (cf. the rider's and the judges' evaluations), they did not show more resistance. This might be due to the fact that they have been desensitised to the pressure because of the number of different novice riders they have to bear. Contrary to LR and PC horses, they are also used to being ridden by different riders. All this may explain why the expected higher frequency of evasive behaviours and heart rate in RI horses were not observed. All these emotional parameters may have compensated for the greater physical exertion and/or increased mental tension (Clayton, 1989) that would have been expected in the RI horses during the unusual demand of the test.

5. Differences between horses according to their sex

Since no difference in any of the variables was found between the geldings and the mares, the question of suppressing the reproductive activity in horses could be reconsidered. Stout and Colenbrander (2004) stress that there are a number of situations in which it is desirable to suppress part or all of the reproductive endocrine system in a horse, notably the competing animal whose tractability during training, or performance during competition, is compromised by the expression of sexual or aggressive behaviour. Some mares present a more extreme problem and, at certain stages of the estrous cycle (usually estrous but occasionally diestrous), become difficult to handle and even dangerous (Stout and Colenbrander, 2004). Yet, in this study the mares did not score less than the geldings on the dressage criteria, did not show a stronger rein tension, did not have a higher heart rate or did not exhibit more evasive behaviours.

Conclusion

The tension meter worked well and the data could be processed easily. However, using programmes automatically correlating behavioural, physiological and physical data, such as the new Observer XT, should greatly simplify the work.

Correlations at a behavioural level made sense (judge's scores, evasive behaviours), but no links were found between behaviour, rein tension and heart rate. In order to detect eventual measurable differences it might be necessary to use the following approaches:

- Focus rather on schooling techniques than on the current use of the horse. For example, examine dressage horses, but to compare different training histories and trainer's philosophies of schooling.

- Carry out the recordings from the very beginning of schooling on, in order to avoid not only habituation but also selection (difficult horses could have been already culled out).
- Carry out a more detailed analysis on shorter time scales with appropriate software, instead of using averages spanning several minutes.

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