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.

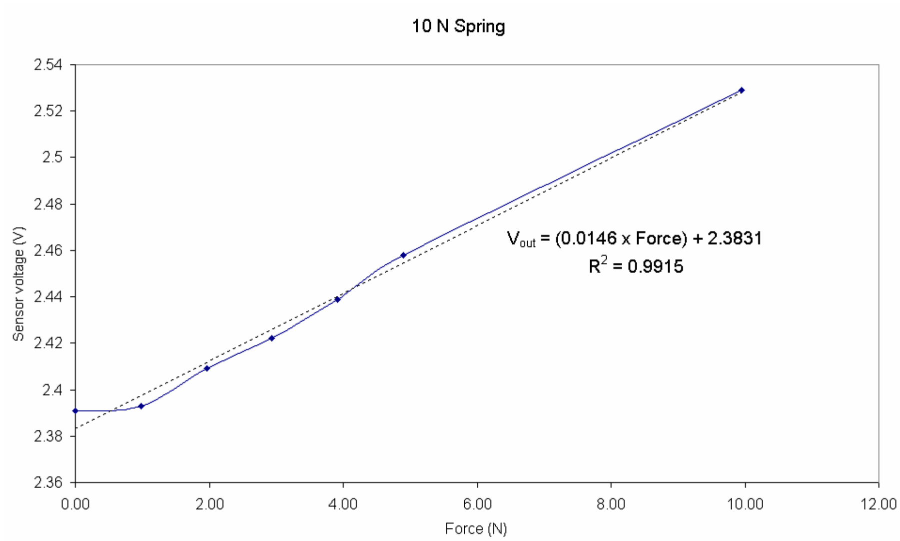

Figure 1: The calibration of the 10 N sensor.

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.

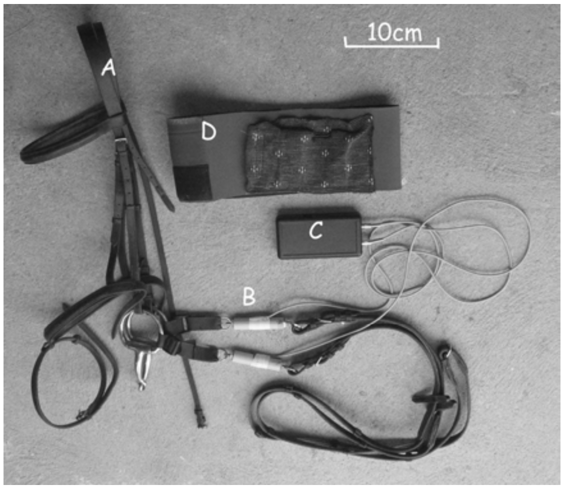

Figure 2: Parts of the Rein Gauge:
A = Full size bridle
B = Sensors attached to reins
C = Data logger

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).

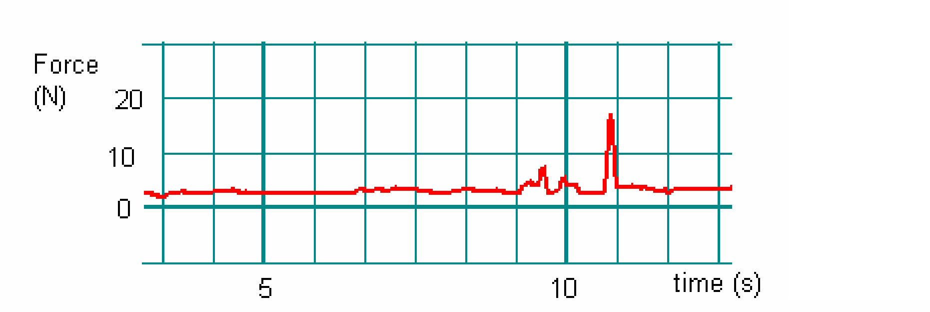

Figure 3a: The trace recorded from the Rein Gauge of a foal being led at the walk. The spike in the trace was when the stimulus was applied on the lead rein for the foal to make a transition from walk to halt.

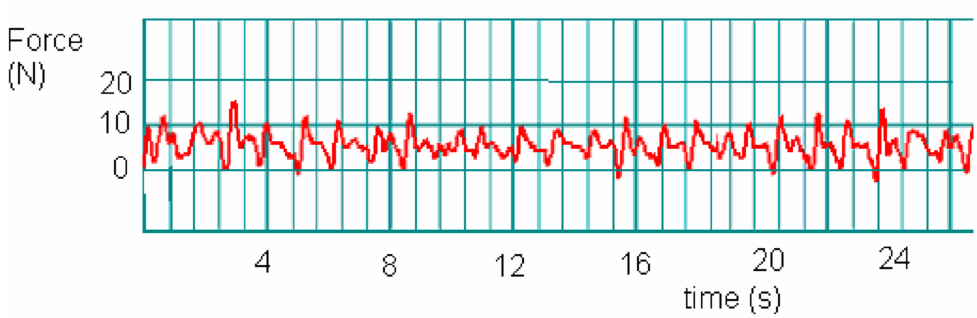

Figure 3b: The trace recorded from the Rein Gauge of a horse being lunged at the trot.

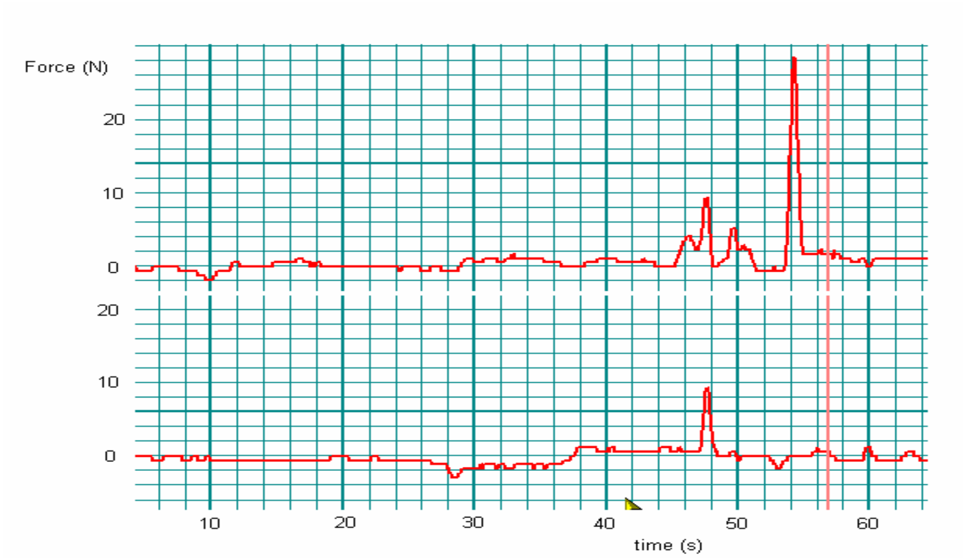

Figure 3c: The trace recorded from the Rein Gauge of a horse being ridden through a turn. The spikes in the trace represent when the stimulus was applied through the rein where the higher spike (top portion of graph) represents the inside or turning rein.

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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