Dually Noted: The effects of a pressure headcollar on compliance, discomfort and stress in horses during handling

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ABSTRACT

Horse handlers often encounter problem behaviour resulting from a lack of stimulus control. Handlers are often only 15% of the weight of horses, which evolved strong flight responses. Therefore, many riders and handlers resort to the use of “aids” to maintain control of their animals. However, there are increasing concerns about the efficacy and welfare implication of such devices, particularly when applied to sensitive facial structures. One such device is a Dually® headcollar which aims to increase compliance. Despite its popularity, little is known about the effects of this aid on behaviour or stress. The aim of the current study was to determine whether the use of a Dually headcollar improves compliance during handling and, if so, whether this might be achieved with concomitant increases in stress or discomfort. Subjects completed two novel handling tests, one wearing a Dually with a line attached to the pressure mechanism and one attached to the standard ring as a Control. Crossing time and proactive behaviour were recorded as indicators of compliance. Core temperature and the discrepancy between eye temperatures were measured using IRT before and after testing as an indicator of stress. The Horse Grimace Scale (HGS) was used to measure discomfort caused by each configuration of the device. The Dually did not result in more compliant behaviour, compared to the Control ($p=0.935$; $p=0.538$). However, the Dually configuration did result in a significantly higher HGS scores ($p=0.034$). This may indicate that there is an impact on animal welfare by using this device that is not justified by improved behaviour. However, IRT readings of core temperature ($p=0.186$) and discrepancy between the eyes ($p=0.972$) did not indicate the Dually increased stress in subjects. Taken together, this suggests the Dually is ineffective in naïve horses but causes increased discomfort.

KEYWORDS: Infrared Thermography; Handling; Horse Grimace Scale; Dually; Proactivity; Ethical Equitation

1. INTRODUCTION

The owners and carers of horses often encounter problem behaviour resulting from a lack of stimulus control (McGreevy and McLean, 2007). In this instance, random environmental stimuli exert more control over the horse's behaviour than the handler or rider is able to. Humans are often only 15% of the weight of their horses (Halliday and Randle, 2013) and horses have evolved strong flight responses (Lansade et al., 2008). Therefore, it is not surprising that many riders and handlers resort to the use of training aids to maintain control. These may restrain the animal in some way, rendering them less able to express flight responses. Alternatively, they magnify the pressure that can be applied, increasing the salience of human stimuli as they compete with those of the environment. However, there are increasing concerns about the efficacy and welfare implication of such devices (McLean and McGreevy, 2010b), particularly when they are applied to sensitive facial structures (Doherty et al., 2017; McGreevy et al., 2012).

One such device is a Dually® headcollar designed and promoted by natural horseman Monty Roberts (Roberts, 1997). This is available commercially to aid owners in controlling their animals and is a standard tool used in many natural horsemanship demonstrations across the world. The headcollar fits around the horse's face in a similar manner to a conventional headcollar. It differs in that it is fitted more closely to the horses' face (though not in such a manner that would cause discomfort) and has an inbuilt pressure mechanism (Figure 1). This mechanism works when a line is connected to either side-ring. When the horse pulls back, or fails to walk forward upon pressure applied to the line, a rope just below the traditional noseband constricts, putting pressure around the jaws and nose of the horse. Proponents of the device state that it works by triggering the horses' *"…instinctive reaction…to move out of the pressure zone and come back towards you"* (Intelligenthorsemanship.co.uk, 2018). This headcollar can also be worn in a standard configuration with the line clipped to a ring under the chin of the horse, thus negating the pressure mechanism (Figure 2). The patent for this product states *"It is extremely effective for training the animal to lead, to stand still, to walk into a truck or trailer, to walk slowly through narrow passages, to walk over unfamiliar objects…"* (Roberts, 1999). Despite these claims, little is known about the effects of this aid on behaviour or stress.

Stress in horses may be non-invasively measured using mobile devices such as infrared thermography (IRT). Core temperature detected using IRT increases in response to arousal or stress (Stewart et al., 2008a, 2007) but decreases in response to pain and discomfort (Lush and Ijichi, 2018; Stewart et al., 2008b; Stubsjøen et al., 2009). This method has been used in a range of species including dogs (Travain et al., 2015), cats (Foster and Ijichi, 2017), cattle (Stewart et al., 2008a) and horses (Lush and Ijichi, 2018; Yarnell et al., 2013). Further, there is preliminary evidence that the discrepancy in temperature between eyes may indicate an emotional response to stress (Lush and Ijichi, 2018). The right hemisphere is typically more active than the left during the emotional processing of experiences (Farmer et al., 2010). Discrepancies in lateralised temperature may indicate lateralised cerebral blood flow indicated of hemispheric dominance (Riemer et al., 2016).

If the use of a Dually headcollar were to cause increases in stress response, this may be explained by discomfort caused by the pressure mechanism. Horses are typically trained using aversive sensations that the horse can avoid by offering the desired response (McLean, 2005). The Dually is no different in this respect, in that it is designed to increase the motivation of the horse to offer the desired response (stepping forward) by magnifying the aversive sensation a handler can apply. Aversive techniques are only ethical if they are proportional to the desired response, predictable and immediately release when the correct response is offered (McGreevy and McLean, 2009). However, there is currently no research on the effect of Dually pressure that would indicate whether this device causes proportional aversion. The Horse Grimace Scale is a novel means of measuring the discomfort or pain experienced by equine subjects (Dalla Costa et al., 2014). This system divides the horses' face into pertinent areas that have been shown to alter in response to pain. Each area is then scored to give a total which has been found to have high inter-rater reliability. This provides a second non-invasive method of determining the effect of the Dually on welfare.

The aim of the current study was to determine whether the use of a Dually headcollar improves compliance during handling and, if so, whether this might be achieved with concomitant increases in stress or discomfort. To this end, subjects completed two novel handling tests (Squibb et al., In Press), one wearing a Dually with a line attached to the pressure mechanism and one attached to the standard ring as a control. Crossing time and proactivity were recorded as indicators of compliance (Ijichi et al., 2013). Core temperature and the discrepancy in temperature between eyes were measured using IRT as an indicator of stress and arousal (Stewart et al., 2007). The Horse Grimace Scale was used to measure discomfort caused by each configuration of the device (Dalla Costa et al., 2014). It was hypothesised that the Dually would be associated with decreased crossing times and reduced proactive behaviour but increased core temperature, right eye dominance and Horse Grimace Scale scores, when compared with the control configuration.

2. METHODS

A total sample number of 20 privately owned horses were sourced from the liveries at Hartpury College (12 geldings and 8 mares). The participant ages varied between 4-15 years old (mean = 9 years ± 2.83). Subjects were housed and managed as per owner preferences on a large livery yard. In general, subjects were provided forage three times a day with hard-feed dependent on workload and nutritional requirements and constant access to fresh water. They were individually stabled with a minimum of 1 hour of exercise each day but received limited turn-out at the time of testing.

The study took place within an enclosed outdoor area at Hartpury College Equestrian Centre, Gloucestershire (UK) during November 2017. Subjects completed two novel handling tests in randomised test order, wearing a Dually® headcollar (Roberts, 1999) during both tests. The leadrope was attached to the side ring which applies increased pressure for the Treatment and the standard under-chin ring for the Control. Treatment order was randomised. Subjects were randomly allocated one of two experimental handlers (C.I. & K.S.) for both tests. Handlers wore protective footwear, a correctly fitted riding helmet and gloves.

Figure 1. The headcollar in the Dually configuration with the lunge-line attached to one of two side rings. This results in pressure being applied via the rope noseband which sits below the standard fixed noseband.

Figure 2. The headcollar in the Control configuration. Here the lunge-line is attached to the standard ring under the chin of the horses, as per typical headcollars.

2.1 Novel Handling Tests

Subjects completed two novel handling tests where they were asked to navigate two distinct obstacles (Squibb et al., In Press). Test order was randomised and horse order was pseudo-random depending on the availability of owners. The start of each test was marked by a horizontal pole placed on the ground 2m in front of the obstacle. Task A consisted of a 2.5m x 3m blue tarpaulin secured to the ground by 20 individual tent pegs. To complete this test, the subject walked over the tarpaulin (Video 1). Test B consisted of two jump wings extended to a height of approximately 2.5m with a 1.6m long pole suspended over-head, from which hung 2m long plastic streamers. To complete this test, the subject walked under the overhead pole, causing the streamers to touch the face and body of the subject as they passed through (Video 2). The handler attempted to lead each horse over the tarpaulin or under the streamer obstacles using only pressure on the lead-rope as a cue to the horse. Pressure was applied when the horse remained stationary, moved sideways or away from the novel object and was released when the subject took a step forward (McGreevy and McLean, 2007). No additional pressures, verbal commands or further encouragement such as whips were used.

A Sony video camera (Model, HDR-CX33OE, Tokyo, Japan) was used to record all tests for retrospective analysis. Crossing time for each test began when the subject's second front hoof crossed over the pole and bore weight on the ground. For Test A, time stopped when the last rear hoof bore weight on the tarpaulin. Horses engage their rear legs first when transforming into faster gaits. Therefore, horses that showed a flight response on the tarpaulin were not given faster crossing times. For the attempt to be classed as a successful crossing all four hooves must have been placed onto the tarpaulin. Crossing Time for Test B stopped once the whole body of the subject passed between the jump wings supporting the streamers. A time limit of 3 minutes was allotted for each attempt as previous research indicated that subjects which had not completed the test within this time were unlikely to do so (Ijichi et al., 2013). Once the 3 minute threshold had been reached the test was ended. A crossing time of 180 seconds was given to any horse reaching this time limit.

Refusal behaviour was defined as any behaviour which did not contribute to crossing the object (Ijichi et al., 2013). This included moving backwards, sideways, forwards but away from the tarpaulin, rearing or remaining stationary. Refusal that lasted for 10 seconds or more was analysed to determine how proactive that refusal was (Test A: N = 13, Test B: N = 14). Proactive refusal was defined as any refusal behaviour that involved movement.

Proactive refusal was then recorded as the percent of total refusal time for any individual which showed refusal behaviour (which included remaining stationary). A higher value indicated a greater amount of proactive behaviour (Ijichi et al., 2013).

2.2 Core Eye Temperature

A FLIR E4 thermal imaging camera (FLIR Systems, USA.) was used to record eye temperature. Images were taken at a distance of approximately 1m from the subject and at an angle of 90^{o} (Travain et al., 2015; Yarnell et al., 2013). Eye temperature images of each subject's left and right eyes were taken on entering the arena prior to each test and immediately after testing. All images were taken by the same researcher each time (S.T.). Subjects were positioned between two parallel jump poles in the same position and direction within an enclosed arena. This was to reduce the potential confounding effects of environmental factors, which may confound the accuracy of infrared thermography readings (Church et al., 2014).

Images were analysed using FLIR Tools software (ver. 5.9.16284.1001) to obtain a measurement for each eye. All images were analysed by the same researcher (C.I.) and checked against independent analysis (S.T. and E.P.). Eye temperature recordings were the maximum temperature within the palpebral fissure from the lateral commissure to the lacrimal caruncle (Yarnell et al., 2013). A mean of the left and right eyes was calculated for each subject, pre and post-test, for each test. The mean pre-test temperature was then subtracted from the mean post-test temperature, referred to as Change in Temperature. In addition, the temperature of the left eye was subtracted from the right eye to indicate the discrepancy between both eyes, for each test. A positive score indicates a hotter right eye, whilst a negative score indicates a hotter left eye. This is referred to as Post-Test Discrepancy in Eye Temperature.

2.3 Grimace Scale

A series of photographs were taken of each subject throughout the tests with a Panasonic camera (Model, DMC-FZ72, Japan). The photographer (E.P.) used a zoom lens to take detailed images of the subject's face from a distance of approximately 3 meters. Images were included in analysis if the lunge line formed a straight line from the handler's hand to the ring of the headcollar, indicating that pressure was being applied to the headcollar in that instance. Therefore, subjects who completed the task without hesitation did not provide images for analysis, as no pressure was required to indicate they should walk forward. Crossing time also influenced the number of images available for each subject.

A maximum of 5 images were used for each subject or the total number available if less than 5 (Table 1). These 5 images were randomly selected from the complete sample of useable images for that horse. Images with the full face visible and clearly in focus were preferentially selected where the subject provided more than 5 images. The photographs were then analysed against the Horse Grimace Scale (HGS) (Dalla Costa *et al*., 2014). Where an area of the face was obscured, this was not scored. Each Grimace score was expressed as a percentage to account for obscured points of the face. The average of all Grimace Scores obtained for each subject was used in analysis. Images were selected and analysed by C.I.

Table 1. The number of images available for Grimace Scale analysis of each subject in each treatment

Horse	Control	Treatment
1	3	2
2	5	2
3	1	5
4	0	3
5	1	5
6	0	0
7	5	4
8	0	5
9	4	0
10	5	1
11	5	0
12	1	5
13	0	0
14	0	4
15	5	0
16	0	4
17	5	0
18	1	5
19	5	5
20	4	2

2.4 Ethics

Owners provided informed consent for each subject via the completion of a participant information form. All data provided was held in accordance with the Data Protection Act (1998). Both researchers and owners had the right to withdraw a subject at any time, for any reason, until the point of data analysis. Prior to commencement, the current study was authorised by the Hartpury College Ethics Committee (ETHICS2017-02).

2.5 Statistical Analysis

Statistical analysis was carried out using R (*RStudio Team, 2015).* Variable normality and the sampling distribution of paired variables was tested for normality using Shapiro-Wilks (Field, 2009). Differences in Crossing Time, Temperature Change, between Treatment and Control were investigated using a Paired T-Test as the sampling distribution was normal. The difference in Post Test Discrepancy was analysed using a Wilcoxon test as the assumption of normal sampling distribution was not met (Field, 2013). Proactivity and Grimace Scores yielded only 8 samples as most subjects did not have matched data points. Therefore, an independent T-test was used to test for differences in unpaired Grimace Scales and a Mann-Whitney U-Test used to test Proactivity, as appropriate for variable normality. To avoid violating the assumptions of independence for this test, one data point was excluded for subjects that provided matched data points. The excluded data point was randomly allocated for each subject. Standard deviations are stated for normally distributed variables and Interquartile Ranges (IQR) for non-normal variables.

3. RESULTS

Crossing Time did not differ significantly between Control and Dually treatments (Paired T-Test: $t_{19} = 0.083$, $P = 0.935$). Mean Crossing Time was 68.68 seconds (IQR = 7 – 139.5) for Control versus 70.84 seconds (IQR = 9 – 137.5) for Dually Treatment. Proactivity did not differ significantly between Control and Dually treatments (Mann Whitney U-Test: $U = 42$, $N_1 = 9$, $N_2 = 10$, $P = 0.538$). Mean Proactivity was 15.99% (±12.744) for Control and 15.65% (IQR = 3.3 – 24) for Dually treatment. Grimace Scales were significantly different between Control and Dually treatments (Independent T-Test:

$t_{8,9}$ = 2.486, P = 0.034; Figure 3). Mean Grimace Scores were 31.5% (±7.584) for Control versus 49.76% (±19.34) for Dually treatment.

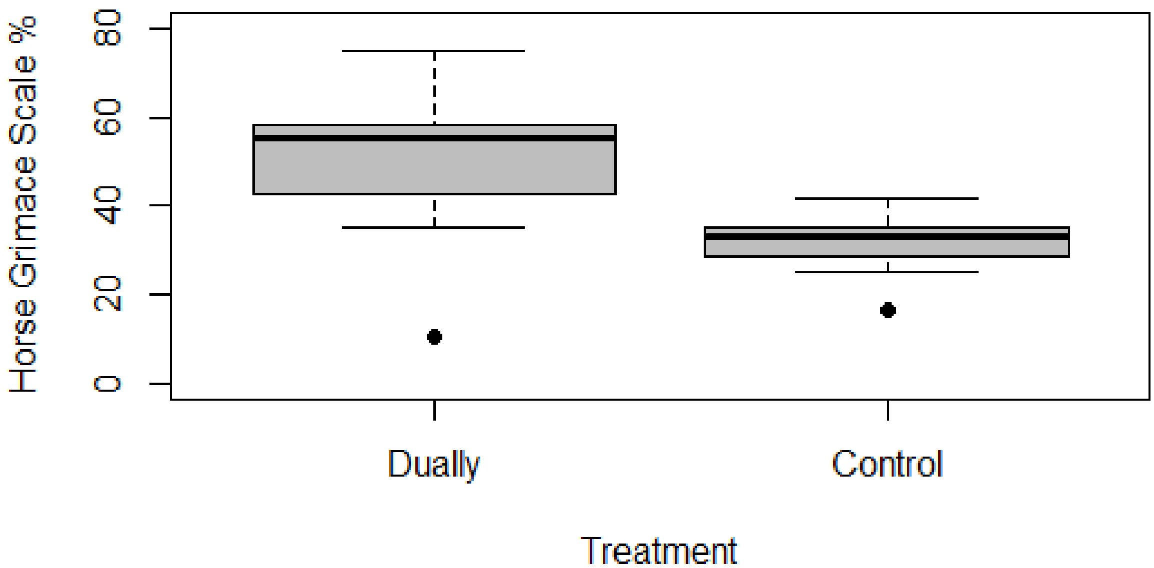

Figure 3. Differences in HGS between Dually and Control during handling tests ($t_{8,9}$ = 2.486, P = 0.034).

Change in Temperature did not differ significantly between Control and Dually treatments (Paired T-Test: t_{13} = 0.083, P = 0.186). Mean Change in Temperature was -0.443^0 C (±1.053) for Control and -0.196^0 C (±0.814) for Dually treatment. Post-test Discrepancy in Eye Temperature did not differ significantly between Control and Dually treatments (Wilcoxon: V = 46, N = 13, P = 0.972). Mean discrepancy in eye temperature was 0.1^0 C (±0.535) for Control versus 0.008^0 C (±0.895) for Dually treatment.

4. DISCUSSION

The purpose of the current study was to determine whether the Dually headcollar was more effective at inducing compliance in novel handling tests than a standard headcollar. In addition, the impact of the Dually on stress and pain responses was also investigated. Twenty horses were recruited to complete two novel handling tests, once with a Dually headcollar on the pressure setting and once on the standard configuration. Crossing time, proactive behaviour, Horse Grimace Scales and IRT recordings were taken to measure compliance, discomfort and stress. Results indicate limited effects of the Dually on behaviour and physiology in previously naïve horses.

Crossing Time was measured as an indicator of compliance but there was no significant difference between the Control and Dually headcollar. In fact, the mean crossing time for Dually was slightly higher than that of the control. In addition, dangerous proactive behaviour such as rearing, backing-up or rushing out the side of the obstacle did not differ between the two headcollar configurations. Taken together, this indicates that the Dually does not significantly affect ease of controlling horses undertaking novel handling scenarios. However, it is important to note that the subjects of this experiment were naïve to the Dually and had not been trained in how to reduce the pressure this aid applies. The Dually applied pressure around the lower face, an area of the body not typically utilised to illicit forward steps. Horses are typically poor generalised learners (Christensen et al., 2011). Consequently, subjects may not have known the targeted response to pressure from a Dually. Critically, the Dually is used in demonstrations on naïve horses for a range of reasons including trailer loading sessions, without prior training. In addition, they are marketed as acting on instinctive responses (Intelligenthorsemanship.co.uk, 2018), which would negate the need to train the correct response. This raises concerns as non-contingent punishment and unremitting pressures may result in learned helplessness and neurosis (McGreevy and McLean, 2009).

It could be argued by proponents of natural horsemanship that the Dually was ineffective in the current study because “Join-Up” had not been completed prior to the training session (Roberts, 1997). However, the ethological relevance and efficacy of this technique has been called into question (Henshall et al., 2012; Henshall and McGreevy, 2014). Further, the control group did not have a Join-Up session before testing and so the two treatments were consistent. Future work should take repeated measures of compliance throughout a training programme using the Dually headcollar. This would identify whether correct training results in improved compliance when wearing the headcollar. However, it is worth noting that horses may habituate to any increased pressures applied by the Dually, rendering them insensitive to standard headcollars. If this were the case, this may instigate a cycle of dependency upon progressively more severe devices in order to maintain control which contravenes the ethical obligation to train horses to respond to minimal pressures (McLean and McGreevy, 2010a).

Concerns about potentially increased pressures from the Dually are compounded by significant differences in scores for the Horse Grimace Scale (Dalla Costa et al., 2014). When pressure was applied to the lead-rope, mean grimace scores were 31.5% for control crossings but 49.76% during Dually use. It is widely recognised that horse training predominantly uses aversive sensations to motivate desired responses (McGreevy and McLean, 2009). From this perspective it is not surprising that both standard configurations and pressure headcollars likely apply potentially aversive pressures. However, the Dually configuration results in grimace scores analogous to those taken post-castration in horses (Dalla Costa et al., 2014). This contravenes the products claims that it applies *“pressure to the bridge of the animal's nose without causing significant pain and discomfort”* (Roberts, 1999).

If the Dually resulted in quicker crossing times or safer behavioural responses, any increased discomfort might be justified. In fact, this was not the case. Additionally, there is recent concern as to the proportionality and controllability of forces applied during training (McLean and McGreevy, 2010a), particularly in the use of tack upon the horse’s sensitive facial structures (McGreevy et al., 2012). In contrast to certain bridles (Casey et al., 2013), pressures that can be applied by a Dually have not been quantified. Certainly, when taut, the Dually constricts beyond the two-finger rule advocated for the noseband of bridles (Doherty et al., 2017). It is worth noting that the Dually is not consistently taut, unlike nosebands. If correctly timed pressure and release are used, the horse can remove the pressure by taking a step forward. None-the-less, this aid is likely to be used to motivate horses to step towards something they find aversive, such as a trailer. As such, wearing a Dually may result in relatively prolonged exposure to facial pressure. This is particularly the case if the handler does not train the horse in the correct response to pressure prior to any challenging handling scenario. It is therefore important to determine the pressures applied by this device and the underlying structures that may affected.

Higher grimace scores when Dually pressure is applied might be expected to cause changes in eye temperature. Recently, it has been observed that the application of nosebands in various degrees of tightness results in changes to eye temperature over time (McGreevy et al., 2012). In the current study, mean eye temperature dropped after both control and Dually conditions, though there was no significant difference between the two conditions. This is in support of the study by McGreevy et al (2012), which noted a drop of 1.18^0 C as a result of a tightly fitted crank noseband. Cattle disbudded without local anaesthetic show a temperature drop of 0.25^0 C 2-5 minutes after the procedure (Stewart et al., 2008a). Dogs recovering from castration show a 1.22^0 C mean drop in temperature 15 minutes post-extubation (Lush and Ijichi, 2018). Taken together, these studies consistently reveal a drop in temperature in response to pain or discomfort. Dually headcollar configuration resulted in a drop that was similar to that seen as a result of disbudding without anaesthetic (Stewart et al., 2008b) but less than that of the standard headcollar configuration in the current study, or tightly fitted nosebands (McGreevy et al., 2012). Further, there was no significant difference in eye discrepancy between the two conditions. Therefore, whilst grimace scores were significantly higher during Dually application than control, this does not appear to cause a magnified stress response. However, environmental conditions may affect IRT readings (Church et al., 2014) and the images in this study were taken outside. In order to fully ascertain the impact of a Dually headcollar on stress, complimentary measurements such as heart rate variability (von Borell et al., 2007) and salivary cortisol (Hughes et al., 2010) should be included in future research.

5. CONCLUSION

The aim of the current study was to determine whether the use of the Dually headcollar results in improved compliance during handling challenges and, if so, whether this was achieved with a concomitant increase in stress due to the increased pressures applied.

Contrary to predictions, the Dually did not result in more compliant behaviour, compared to the standard configuration of the same headcollar. However, subjects were naïve to the Dually and had not been trained in how to control the pressure applied by the headcollar. Therefore, further work is required to understand whether this device improves compliance in experienced horses. Despite not providing benefits in terms of control, the Dually configuration did result in a significantly higher Horse Grimace Scale score. This may indicate that there is a cost to animal welfare by using this device that is not justified by improved behaviour. It would be valuable to determine the pressure applied by the Dually in comparison to that applied by tight nosebands. However, IRT readings of core temperature and discrepancy between the eyes did not support the conclusion that the use of the Dually increased stress in subjects, when compared to the standard headcollar configuration. Further work utilising complimentary stress indicators are needed to more conclusively determine the impact of this device on stress.

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