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

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1 ABSTRACT

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

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

26

27 1. INTRODUCTION

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

40 One such device is a Dually® headcollar designed and promoted by natural horseman
41 Monty Roberts (Roberts, 1997). This is available commercially to aid owners in controlling
42 their animals and is a standard tool used in many natural horsemanship demonstrations
43 across the world. The headcollar fits around the horse's face in a similar manner to a
44 conventional headcollar. It differs in that it is fitted more closely to the horses' face (though
45 not in such a manner that would cause discomfort) and has an inbuilt pressure
46 mechanism (Figure 1). This mechanism works when a line is connected to either side-

47 ring. When the horse pulls back, or fails to walk forward upon pressure applied to the line,
48 a rope just below the traditional noseband constricts, putting pressure around the jaws
49 and nose of the horse. Proponents of the device state that it works by triggering the
50 horses' "...instinctive reaction...to move out of the pressure zone and come back towards
51 you" (Intelligenthorsemanship.co.uk, 2018). This headcollar can also be worn in a
52 standard configuration with the line clipped to a ring under the chin of the horse, thus
53 negating the pressure mechanism (Figure 2). The patent for this product states "*It is*
54 *extremely effective for training the animal to lead, to stand still, to walk into a truck or*
55 *trailer, to walk slowly through narrow passages, to walk over unfamiliar objects...*"
56 (Roberts, 1999). Despite these claims, little is known about the effects of this aid on
57 behaviour or stress.

58 Stress in horses may be non-invasively measured using mobile devices such as infrared
59 thermography (IRT). Core temperature detected using IRT increases in response to
60 arousal or stress (Stewart et al., 2008a, 2007) but decreases in response to pain and
61 discomfort (Lush and Ijichi, 2018; Stewart et al., 2008b; Stubbsj en et al., 2009). This
62 method has been used in a range of species including dogs (Travain et al., 2015), cats
63 (Foster and Ijichi, 2017), cattle (Stewart et al., 2008a) and horses (Lush and Ijichi, 2018;
64 Yarnell et al., 2013). Further, there is preliminary evidence that the discrepancy in
65 temperature between eyes may indicate an emotional response to stress (Lush and Ijichi,
66 2018). The right hemisphere is typically more active than the left during the emotional
67 processing of experiences (Farmer et al., 2010). Discrepancies in lateralised temperature
68 may indicate lateralised cerebral blood flow indicated of hemispheric dominance (Riemer
69 et al., 2016).

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

85 The aim of the current study was to determine whether the use of a Dually headcollar
86 improves compliance during handling and, if so, whether this might be achieved with
87 concomitant increases in stress or discomfort. To this end, subjects completed two novel
88 handling tests (Squibb et al., Under Review), one wearing a Dually with a line attached to
89 the pressure mechanism and one attached to the standard ring as a control. Crossing
90 time and proactivity were recorded as indicators of compliance (Ijichi et al., 2013). Core
91 temperature and the discrepancy in temperature between eyes were measured using IRT
92 as an indicator of stress and arousal (Stewart et al., 2007). The Horse Grimace Scale

93 was used to measure discomfort caused by each configuration of the device (Costa et
94 al., 2014). It was hypothesised that the Dually would be associated with decreased
95 crossing times and reduced proactive behaviour but increased core temperature, right
96 eye dominance and Horse Grimace Scale scores, when compared with the control
97 configuration.

98

99 2. METHODS

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

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



116

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



120

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

123 *2.1 Novel Handling Tests*

124 Subjects completed two novel handling tests where they were asked to navigate two
125 distinct obstacles (Squibb et al., Under Review). Test order was randomised and horse
126 order was pseudo-random depending on the availability of owners. The start of each test
127 was marked by a horizontal pole placed on the ground 2m in front of the obstacle. Task
128 A consisted of a 2.5m x 3m blue tarpaulin secured to the ground by 20 individual tent
129 pegs. To complete this test, the subject walked over the tarpaulin (Video 1). Test B
130 consisted of two jump wings extended to a height of approximately 2.5m with a 1.6m long
131 pole suspended over-head, from which hung 2m long plastic streamers. To complete this
132 test, the subject walked under the overhead pole, causing the streamers to touch the face
133 and body of the subject as they passed through (Video 2). The handler attempted to lead

134 each horse over the tarpaulin or under the streamer obstacles using only pressure on the
135 lead-rope as a cue to the horse. Pressure was applied when the horse remained
136 stationary, moved sideways or away from the novel object and was released when the
137 subject took a step forward (McGreevy and McLean, 2007). No additional pressures,
138 verbal commands or further encouragement such as whips were used.

139 A Sony video camera (Model, HDR-CX330E, Tokyo, Japan) was used to record all tests
140 for retrospective analysis. Crossing time for each test began when the subject's second
141 front hoof crossed over the pole and bore weight on the ground. For Test A, time stopped
142 when the last rear hoof bore weight on the tarpaulin. Horses engage their rear legs first
143 when transforming into faster gaits. Therefore, horses that showed a flight response on
144 the tarpaulin were not given faster crossing times. For the attempt to be classed as a
145 successful crossing all four hooves must have been placed onto the tarpaulin. Crossing
146 Time for Test B stopped once the whole body of the subject passed between the jump
147 wings supporting the streamers. A time limit of 3 minutes was allotted for each attempt as
148 previous research indicated that subjects which had not completed the test within this
149 time were unlikely to do so (Ijichi et al., 2013). Once the 3 minute threshold had been
150 reached the test was ended. A crossing time of 180 seconds was given to any horse
151 reaching this time limit.

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

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

160 *2.2 Core Eye Temperature*

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

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

180 2.3 Grimace Scale

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

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

198

199 **Table 1.** The number of images available for Grimace Scale analysis of each subject in
200 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

201 *2.4 Ethics*

202 Owners provided informed consent for each subject via the completion of a participant
203 information form. All data provided was held in accordance with the Data Protection Act
204 (1998). Both researchers and owners had the right to withdraw a subject at any time, for
205 any reason, until the point of data analysis. Prior to commencement, the current study
206 was authorised by the Hartpury College Ethics Committee (ETHICS2017-02).

207

208

209

210

211 2.5 Statistical Analysis

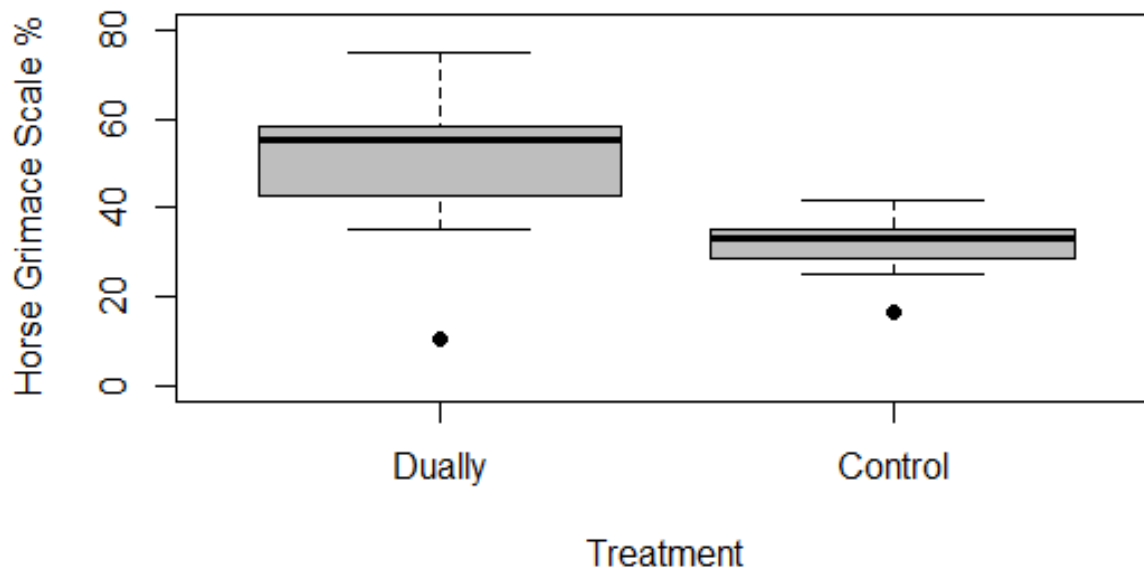
212 Statistical analysis was carried out using R (*RStudio Team, 2015*). Variable normality and
213 the sampling distribution of paired variables was tested for normality using Shapiro-Wilks
214 (Field, 2009). Differences in Crossing Time, Temperature Change, between Treatment
215 and Control were investigated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

225

226 3. RESULTS

227 Crossing Time did not differ significantly between Control and Dually treatments (Paired
228 T-Test: $t_{19} = 0.083$, $P = 0.935$). Mean Crossing Time was 68.68 seconds (IQR = 7 –
229 139.5) for Control versus 70.84 seconds (IQR = 9 – 137.5) for Dually Treatment.
230 Proactivity did not differ significantly between Control and Dually treatments (Mann
231 Whitney U-Test: $U = 42$, $N_1 = 9$, $N_2 = 10$, $P = 0.538$). Mean Proactivity was 15.99%
232 (± 12.744) for Control and 15.65% (IQR = 3.3 – 24) for Dually treatment. Grimace Scales
233 were significantly different between Control and Dually treatments (Independent T-Test:

234 $t_{8,9} = 2.486$, $P = 0.034$; Figure 3). Mean Grimace Scores were 31.5% (± 7.584) for Control
235 versus 49.76% (± 19.34) for Dually treatment.



236
237 **Figure 3.** Differences in HGS between Dually and Control during handling tests ($t_{8,9} =$
238 2.486, $P = 0.034$).

239
240 Change in Temperature did not differ significantly between Control and Dually treatments
241 (Paired T-Test: $t_{13} = 0.083$, $P = 0.186$). Mean Change in Temperature was -0.443°C
242 (± 1.053) for Control and -0.196°C (± 0.814) for Dually treatment. Post-test Discrepancy in
243 Eye Temperature did not differ significantly between Control and Dually treatments
244 (Wilcoxon: $V = 46$, $N = 13$, $P = 0.972$). Mean discrepancy in eye temperature was 0.1°C
245 (± 0.535) for Control versus 0.008°C (± 0.895) for Dually treatment.

246 4. DISCUSSION

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

255 Crossing Time was measured as an indicator of compliance but there was no significant
256 difference between the Control and Dually headcollar. In fact, the mean crossing time for
257 Dually was slightly higher than that of the control. In addition, dangerous proactive
258 behaviour such as rearing, backing-up or rushing out the side of the obstacle did not differ
259 between the two headcollar configurations. Taken together, this indicates that the Dually
260 does not significantly affect ease of controlling horses undertaking novel handling
261 scenarios. However, it is important to note that the subjects of this experiment were naïve
262 to the Dually and had not been trained in how to reduce the pressure this aid applies. The
263 Dually applied pressure around the lower face, an area of the body not typically utilised
264 to illicit forward steps. Horses are typically poor generalised learners (Christensen et al.,
265 2011). Consequently, subjects may not have known the targeted response to pressure
266 from a Dually. Critically, the Dually is used in demonstrations on naïve horses for a range
267 of reasons including trailer loading sessions, without prior training. In addition, they are
268 marketed as acting on instinctive responses (Intelligenthorsemanship.co.uk, 2018), which

269 would negate the need to train the correct response. This raises concerns as non-
270 contingent punishment and unremitting pressures may result in learned helplessness and
271 neurosis (McGreevy and McLean, 2009).

272 It could be argued by proponents of natural horsemanship that the Dually was ineffective
273 in the current study because “Join-Up” had not been completed prior to the training
274 session (Roberts, 1997). However, the ethological relevance and efficacy of this
275 technique has been called into question (Henshall et al., 2012; Henshall and McGreevy,
276 2014). Further, the control group did not have a Join-Up session before testing and so
277 the two treatments were consistent. Future work should take repeated measures of
278 compliance throughout a training programme using the Dually headcollar. This would
279 identify whether correct training results in improved compliance when wearing the
280 headcollar. However, it is worth noting that horses may habituate to any increased
281 pressures applied by the Dually, rendering them insensitive to standard headcollars. If
282 this were the case, this may instigate a cycle of dependency upon progressively more
283 severe devices in order to maintain control which contravenes the ethical obligation to
284 train horses to respond to minimal pressures (McLean and McGreevy, 2010a).

285 Concerns about potentially increased pressures from the Dually are compounded by
286 significant differences in scores for the Horse Grimace Scale (Costa et al., 2014). When
287 pressure was applied to the lead-rope, mean grimace scores were 31.5% for control
288 crossings but 49.76% during Dually use. It is widely recognised that horse training
289 predominantly uses aversive sensations to motivate desired responses (McGreevy and
290 McLean, 2009). From this perspective it is not surprising that both standard configurations
291 and pressure headcollars likely apply potentially aversive pressures. However, the Dually

292 configuration results in grimace scores analogous to those taken post-castration in horses
293 (Costa et al., 2014). This contravenes the products claims that it applies “*pressure to the*
294 *bridge of the animal's nose without causing significant pain and discomfort*” (Roberts,
295 1999).

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

311 Higher grimace scores when Dually pressure is applied might be expected to cause
312 changes in eye temperature. Recently, it has been observed that the application of
313 nosebands in various degrees of tightness results in changes to eye temperature over
314 time (McGreevy et al., 2012). In the current study, mean eye temperature dropped after

315 both control and Dually conditions, though there was no significant difference between
316 the two conditions. This is in support of the study by McGreevy et al (2012), which noted
317 a drop of 1.18°C as a result of a tightly fitted crank noseband. Cattle disbudded without
318 local anaesthetic show a temperature drop of 0.25°C 2-5 minutes after the procedure
319 (Stewart et al., 2008a). Dogs recovery from castration show a 1.22°C mean drop in
320 temperature 15 minutes post-extubation (Lush and Ijichi, 2018). Taken together, these
321 studies consistently reveal a drop in temperature in response to pain or discomfort. Dually
322 headcollar configuration resulted in a drop that was similar to that seen as a result of
323 disbudding without anaesthetic (Stewart et al., 2008b) but less than that of the standard
324 headcollar configuration in the current study, or tightly fitted nosebands (McGreevy et al.,
325 2012). Further, there was no significant difference in eye discrepancy between the two
326 conditions. Therefore, whilst grimace scores were significantly higher during Dually
327 application than control, this does not appear to cause a magnified stress response.
328 However, environmental conditions may affect IRT readings (Church et al., 2014) and the
329 images in this study were taken outside. In order to fully ascertain the impact of a Dually
330 headcollar on stress, complimentary measurements such as heart rate variability (von
331 Borell et al., 2007) and salivary cortisol (Hughes et al., 2010) should be included in future
332 research.

333

334 5. CONCLUSION

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

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

351

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360

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