

1        **An investigation into the effect of floor colour on the behaviour of the horse**

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13 **Abstract**

14 Adverse reactions of the domestic horse to environmental stimuli can be problematic  
15 in training and management. Hesitation and alarm reactions to visual features of the  
16 ground can occur in both ridden work and when handling horses. To assess the effect  
17 of one visual feature (colour) on the behaviour of the domestic horse, the reactions of  
18 sixteen riding horses to eight different coloured mats were recorded. The effect of  
19 stimulus position on these reactions was assessed by presenting them in two different  
20 positions, either on the ground (where the horses had to walk over them) or against a  
21 wall (where the horses walked past them). Each colour/position combination was  
22 presented twice in order to assess the effect of previous experience. An alleyway was  
23 constructed to allow the horses to be tested unconstrained and freely walking  
24 throughout. The time taken to traverse the alleyway and the observed reaction to the  
25 colour was recorded. Significant differences in both measures were found in relation  
26 to the position of the colour and whether the subject had previous experience of that  
27 colour/position combination. The initial presentation of the colours on the ground  
28 produced the highest percentage of adverse reactions. Certain colours encountered for  
29 the first time on the ground (yellow, white, black and blue) were found to cause a  
30 greater number of adverse reactions than others (green, red, brown and grey) and an  
31 increase in the time taken to traverse the alleyway. Although a significant difference  
32 in relation to colour was found in the behaviour observed during the second  
33 presentation on the ground, no difference was found in relation to the time taken to  
34 traverse the alleyway. No significant effect of colour was found when the coloured  
35 stimuli were presented against the wall. These findings have important implications  
36 for situations where the colour of flooring could be controlled in order to minimise  
37 adverse behavioural reactions, in particular during initial training.

38

39 *Keywords:* Horse; Colour aversion; Flooring; Vision

40

## 41 **1. Introduction**

42 The ability to predict the reaction of the horse to different stimuli is an important  
43 factor in their management and training. When training horses to perform a simple  
44 task of visual discrimination, it was advantageous to present the stimuli at ground  
45 level as opposed to at a height of 70 cm (Hall *et al.*, 2003). The relative salience of the  
46 stimuli in this position indicates the importance of the assessment of ground  
47 conditions to a prey species such as the horse, whose safety is reliant on the ability to  
48 flee from predators.

49 The visual features of flooring have been found to cause hesitation and alarm  
50 reactions in horses as well as in other species. Sudden changes in colour or texture,  
51 particularly of flooring and loading ramps, in the handling and transportation facilities  
52 for livestock (cattle, pigs, sheep and horses) have been suggested as the cause of  
53 hesitation or stopping, possibly to assess whether this change signifies a hole or  
54 uneven area (Grandin, 1989). Black rubber matting commonly is used in stables and  
55 for trailer and horsebox ramps, and the reluctance of some horses to walk up these  
56 ramps or enter an enclosed area may be partially the result of the texture or colour of  
57 this flooring. One horse that refused to walk up a black trailer ramp, although still  
58 hesitant, did walk up once a dark red carpet had been placed over it (Lucas, 1999).  
59 This could possibly be the result of a change in the texture of the ground surface, but  
60 also could relate to the colour.

61 Certain features of the equine visual system may help to explain this sensitivity of the  
62 horse to ground level stimuli. The tapetum lucidum increases retinal sensitivity by  
63 reflecting light back through the photoreceptor layer. In the horse this reflective layer  
64 is located in the upper half of the retina, thus increasing sensitivity to light,  
65 particularly that reflected from the ground (Ollivier *et al.*, 2004). The amount of light  
66 entering the eye from above is further limited by the corpora nigra (projections along  
67 the dorsal margin of the pupil), which shade the lower half of the retina and  
68 accentuate information from the inferior visual field (Davidson, 1991).

69 The results of previous studies of colour vision in the horse (Grzimek, 1952; Pick *et*  
70 *al.*, 1994; Macuda and Timney, 1999; Smith and Goldman, 1999; Ver Hoeve *et al.*,  
71 1999; Yokoyama and Radlwimmer, 1999; Macuda, 2000; Carroll *et al.*, 2001),  
72 suggest that the horse is dichromatic and has the ability to see a limited range of  
73 colours. However, a more extensive study into the ability of the horse to perceive  
74 colours demonstrated their ability to use chromatic information from across the visible  
75 spectrum, yellow and blue being the easiest for them to discriminate from grey  
76 (Wyldes, 2004). These behavioural findings are consistent with the peak sensitivities  
77 of the cone photopigments of the horse (429 and 545 nanometres; Macuda, 2000).  
78 These wavelengths appear in the blue (429 nm) and yellow (545 nm) parts of the  
79 visible spectrum.

80 However, only anecdotal evidence as to their reactions to colours is available, the  
81 majority of which refers to avoidance reactions where the horse moves away from or  
82 refuses to approach. The reaction to a visual stimulus can be assessed by recording the  
83 difference in the time taken for a horse to walk over a given distance when that  
84 stimulus is either present or absent (Mackenzie and Thiboutot, 1997) and by the  
85 observation and scoring of associated behaviour (Wolff *et al.*, 1997). For example,

86 Saslow (1999) trained horses to walk freely down a constructed alleyway and used  
87 changes in their speed of approach as well as behavioural reactions as measures of  
88 their first perception of that stimulus. The time taken to negotiate the alleyway was  
89 found to relate to the visibility of the stimulus, with the widest and most highly  
90 contrasting stimuli causing the greatest slowing of the horses' walk. To assess  
91 whether colour affects the behaviour of the horse, particularly when located on the  
92 ground, a similar methodology was used in the present study.

93 The present study was conducted to test whether individual colours cause different  
94 behavioural reactions in the horse and whether the position and previous experience  
95 of that colour affect the response.

## 96 **2. Method**

### 97 *2.1 Subjects*

98 The subjects used were 16 riding horses, 6 mares and 10 geldings, of various types  
99 from the Brackenhurst Equestrian Centre, Nottingham Trent University. Their ages  
100 ranged from 4-20 years with a mean age of 11.3 years, with heights of 152-172 cm  
101 and a mean height of 159.8 cm. When taking part in the study the horses all wore  
102 head-collars from which the lead ropes had been removed. Two of the subjects were  
103 shod all round, the rest being shod in front only. All horses had been turned out for the  
104 summer but were still handled on a daily basis.

### 105 *2.2 Coloured stimuli*

106 Eight different coloured mats, 1.5 m x 2 m, were produced. They consisted of  
107 identical pieces of cord carpet originally oatmeal in colour and rubber backed. Each  
108 piece was sprayed a different colour using Plasti-kote Super Spray paint

109 (manufactured in the U.S.A. by Plasti-kote Co inc.). Spraying was repeated until a  
110 consistent appearance was obtained. The paint colours used are listed in Table 1.

111 The texture of the carpet produced a consistent matt appearance even though some of  
112 the paints were supposed to result in a gloss finish. An alleyway was constructed  
113 (Figure 1) within which the coloured mats were displayed in one of two positions.

### 114 *2.3 Test design*

115 The coloured stimuli were presented in one of two positions (on the wall or on the  
116 ground) that necessitated the horse either walking past or over the stimulus. The data  
117 analysed in the study by Saslow (1999) were taken from the first trip of a two-way  
118 trial due to less reaction being shown on the return trip. In the present study two  
119 consecutive presentations of each colour/position combination were made. The  
120 reactions shown by the horse on the first and second trips were compared to determine  
121 whether behaviour in response to colour was similarly affected by habituation to the  
122 stimuli.

123 All three studies were conducted in daylight between 10 am and 3 pm. The light  
124 conditions varied throughout the test period but any effect that this may have had on  
125 the reactions of the horses to the mats was randomly distributed across all conditions  
126 and mat colours. This would be similar to the light variation naturally experienced by  
127 the horse and would not have impacted on the results of this study, but would have  
128 increased their relevance when applied to everyday situations.

### 129 *2.4 Test area and apparatus*

130 A 10.5m long and 1.5m wide alleyway was constructed on a level concrete surface  
131 along the back wall of a stable block. The stable wall was 14.5m long and consisted of  
132 a 2.1m high vertical wooden wall, above which was a pitched roof. This formed one

133 wall of the alleyway, the other being constructed of three galvanised wire mesh  
134 barriers, each 3.5m long and 1.2m high, linked together at the base. The barriers were  
135 positioned to leave a 2m length open at either end of the alleyway to allow access for  
136 the subjects. The 1.5 x 2m coloured stimuli were presented in one of two positions,  
137 either hung from the stable wall requiring the subjects to walk past them or on the  
138 ground requiring the subjects to walk over them. Metal hooks were screwed into the  
139 wooden stable wall from which to hang the coloured mats. Square section (10cm<sup>2</sup>)  
140 wooden poles 2.75m long were laid either side of the alley to secure the coloured mats  
141 to the ground. Both fixings were left in place regardless of the position from which  
142 the stimulus was being presented. The fixings were positioned to display the stimuli  
143 halfway down the alleyway, the central point being 7.25m from either end of the  
144 stable wall. The ground surface was roughened concrete and level. The colour of the  
145 background on which the colour was displayed at the two levels (wooden stable wall  
146 or concrete ground) was unavoidably different. All horses were used to walking along  
147 this part of the yard, although without the presence of the metal barriers. See Figure 1  
148 for a plan of the construction of the alleyway (the horse is shown at one end; for  
149 starting at the other end, the position of the horse and the handler with the bucket were  
150 reversed).

### 151 *2.5 The scoring of behaviour*

152 Behaviour was recorded using a Sony Video8 Handycam (Sony, U.K.) video camera  
153 and observations recorded on prepared sheets. The behaviour was scored by two  
154 observers and confirmed by observation of the videotape. A scale of 1-6 (Table 2) was  
155 used to record the behaviour of the subjects as they walked down the alleyway, with a  
156 score of 1 indicating no change in speed or behaviour and a score of 6 indicating the  
157 subject stopped and did not continue despite “encouragement” (encouragement being

158 defined as shaking the feed bucket, calling the name or saying “walk on”; no physical  
159 contact was made). Behavioural scores of 2 and above indicated that the coloured mat  
160 had been noticed, those of 3 and above that an adverse reaction had been recorded.

161 The location in the alleyway where the reaction occurred was also recorded as  
162 follows:

163                   At the start of the alleyway

164                   Before the mat (the last stride before reaching the mat was recorded as  
165                   being directly in front of the mat)

166                   Directly in front of the mat (the last stride before treading on or past  
167                   the mat)

168                   On / adjacent to the mat

169                   After the mat

170

171 The passage through the alleyway was timed using a stopwatch. Timing commenced  
172 when the subject’s first front foot passed the first upright of the metal barrier and  
173 stopped as its first front foot passed the last upright. Timing was thus over a distance  
174 of 10.5 m and was carried out by an observer with a stopwatch. A cut off time of 60  
175 seconds was allocated to trials where the subject refused to proceed, despite the use of  
176 the standardized prompts, to enable this data to be included in the analysis.

### 177 *2.6 Pre-test training*

178 Pre-test training entailed the subjects learning to walk freely and without hesitation  
179 down the alleyway before the addition of the coloured mats. Each subject was led to  
180 the fenced alleyway; eight horses starting at the right end, eight at the left end. A  
181 handler was positioned at each end of the alleyway, the one at the opposite end to the



182 subject holding a bucket containing a handful of commercial feed. The subject was  
183 released and encouraged to walk down the alleyway by the receiving handler shaking  
184 the bucket containing the nuts gently and calling the horse's name. During the first  
185 trial a handler walked alongside the horse but on the outside of the alleyway. Once the  
186 horse had reached the end, it was allowed some feed from the bucket, held stationary  
187 for 5 seconds then led out of the alleyway, turned round and the process repeated from  
188 the opposite end. This process was repeated until the subject would walk without  
189 hesitation directly to the bucket at the end of the alleyway, (ignoring an observer  
190 positioned approximately 10m away outside the alleyway and the video camera  
191 mounted on a tripod). All subjects reached this criterion within four trials. The times  
192 were recorded for each subject during the pre-test training and compared with those  
193 recorded during the test phase.

#### 194 *2.7 Test procedure*

195 The colour and position of the mat (on the wall or on the ground) was constant for  
196 each pair of trials, the first and second presentations being approached from opposite  
197 ends of the alleyway. Each colour / position combination was presented to all 16  
198 subjects. The sequence of presentation and direction from which they were first  
199 approached being randomly allocated to each subject and counterbalanced to control  
200 for any effect of order of presentation or variation in ambient light conditions. At the  
201 start of each trial, the subject was walked to the starting line, released by one handler  
202 and received by a second handler at the other end of the alleyway. After being  
203 allowed some feed from the bucket, the subject was led out of the alleyway, turned  
204 round and the process started again from the opposite end. After completing the pair  
205 of trials, the subject was returned to the stable for a period of least 1 hour before

206 participating in the next trial. Each subject took part in a maximum of four separate  
207 pairs of trials per day. The study was carried out over a four-week period.

## 208 *2.8 Data analysis*

209 The percentage of trials resulting in each of the behaviour scores (1-6), the mean  
210 behaviour scores and mean times were calculated for each condition to allow  
211 comparison of the effect of each variable (colour, position and past experience) on  
212 behaviour. The number of reactions that occurred at each of the designated locations  
213 within the alleyway was recorded, and each was then calculated as a percentage of the  
214 total number of reactions recorded. All statistical analyses were carried out using  
215 SPSS 9.0 for Windows. The Kolmogorov-Smirnov test of normality confirmed that  
216 the data were not normally distributed and that non-parametric tests were appropriate  
217 throughout.

218 The effect of the position of the stimulus (on the wall or on the ground) on the  
219 behaviour scores and times was assessed using the Wilcoxon test. The effect of  
220 previous experience (first compared with second presentation) on these measures was  
221 also assessed using the Wilcoxon test. Mean behaviour scores and times were  
222 calculated for each of the colours and the Friedman test used to assess whether there  
223 was a significant difference in the responses of the subjects to the eight individual  
224 colours (regardless of position or presentation number). The effect of the different  
225 colours was then assessed for each of the different position / presentation number  
226 combinations (first and second presentations on the ground and first and second  
227 presentations on the wall) using the Friedman test. Two-tailed analyses were used  
228 throughout.

229

230 **3. Results**

231 *3.1 Overall performance*

232 In just over half of the trials (51.37%) the subject was recorded as having at least  
233 noticed the mat (behaviour scored at 2 or above). Adverse reactions (scoring 3 or  
234 above) were recorded for 16.02% of the trials. The more extreme avoidance reactions  
235 were uncommon. In only two trials did the horse stop and refuse to continue,  
236 reversing backwards out of the alleyway and scoring six (the same subject during the  
237 first and second presentation of yellow on the ground).

238 The time taken to traverse the alleyway during the training trials (with no mats  
239 displayed) ranged from 4.75 – 25.00 seconds. The speed increased for the first three  
240 training trials, then decreased slightly on the fourth and final training trial when the  
241 performance of the subject appeared to have stabilised. The time taken during the test  
242 trials ranged from 4 – 46 seconds, apart from two of the trials where the cut-off time  
243 of 60 seconds was reached and the subject had failed to traverse the alleyway.

244 The overall percentage of trials that were allocated each behaviour score and the mean  
245 times recorded during these trials are shown in Table 3.

246 *3.2 Location of reactions*

247 The locations within the alleyway at which the reactions occurred are shown in Table  
248 4. Almost all of the reactions occurred at the mat, i.e. just before the subject had to  
249 tread on it or as the subject reached the point on the wall where the mat was  
250 displayed. The next most frequent location for a reaction to occur was on the approach  
251 to the mat. Sixteen out of the eighteen reactions recorded before the mat were in  
252 response to ground level presentations, five to yellow, three each to black and blue,  
253 two to green and one each to brown, white and red. The reactions recorded at the start

254 of the alleyway were associated with two mats on the ground (black and green) and  
255 one on the wall (yellow). All of the reactions on / by the mat were to stimuli on the  
256 ground, two to white and one to red. Only one reaction occurred after the mat,  
257 associated with black on the ground.

### 258 *3.3 Effect of position and previous experience*

259 Higher behaviour scores were recorded when the coloured mats were displayed on the  
260 ground as opposed to on the wall (Wilcoxon signed-ranks test:  $z = 3.07$ ,  $p = 0.002$ ).

261 The mean behaviour score when the mats were presented on the ground was 2.00 ( $\pm$   
262 0.63), compared with 1.55 ( $\pm 0.39$ ) when on the wall. It also took significantly longer  
263 to traverse the alleyway with the mats on the ground ( $z = 3.26$ ,  $p = 0.001$ ). The mean  
264 time when the mats were on the ground was 10.01 ( $\pm 2.27$ ) seconds compared with  
265 8.26 ( $\pm 2.27$ ) seconds when they were on the wall.

266 Regardless of the position or colour of the mat, previous experience of each  
267 combination resulted in a significant reduction in the behavioural reaction recorded  
268 (Wilcoxon signed-ranks test:  $z = 3.53$ ,  $p < 0.001$ ) and in the time it took to traverse  
269 the alleyway ( $z = 2.99$ ,  $p = 0.003$ ). When the effect of previous experience was  
270 assessed separately for the two different stimulus positions only those to the ground  
271 level stimuli were significantly reduced on second presentation. The reaction to the  
272 coloured mats on the ground was significantly greater when they were encountered  
273 for the first time, both in terms of the behaviour scored ( $z = 3.52$ ,  $p < 0.001$ ) and the  
274 times ( $z = 3.21$ ,  $p = 0.001$ ).

275 The combined effect of the position in which the coloured mat was displayed and  
276 whether the subject had previous experience of that position / colour combination was  
277 found to significantly affect the reaction to it, both in the behaviour scored (Friedman

278 test:  $\chi^2_{(3)} = 28.01$ ,  $p < 0.001$ ) and the times ( $\chi^2_{(3)} = 25.28$ ,  $p < 0.001$ ). The differences  
279 between each of these conditions, as shown by the percentage of trials resulting in  
280 behaviour scores of 1 – 6, the mean behaviour scores and the mean times for each  
281 condition are shown in Table 5.

### 282 *3.4 Effect of colour*

283 The overall reactions recorded in response to the eight different colours, regardless of  
284 position or previous experience, were found to vary significantly with respect to both  
285 the behaviour scored (Friedman test:  $\chi^2_{(7)} = 38.12$ ,  $p < 0.0005$ ) and the times ( $\chi^2_{(7)} =$   
286  $20.96$ ,  $p = 0.004$ ). However, when the response to the different colours presented in  
287 the four different conditions (first/ground, second/ground, first/wall, second/wall) was  
288 compared, it was found that there was no significant difference in the reactions shown  
289 to the individual colours when they were displayed on the wall (first or second). The  
290 mats were noticed in this position, but the reactions to them were not affected by their  
291 colour. The colour of the mat only affected behaviour when it was encountered on the  
292 ground.

293 During the first presentations on the ground, colour was found to significantly affect  
294 behaviour, both in the scores ( $\chi^2_{(7)} = 38.23$ ,  $p < 0.01$ ) and in the time taken to  
295 negotiate the alleyway ( $\chi^2_{(7)} = 28.14$ ,  $p < 0.001$ ). This effect was reduced on the  
296 second presentation on the ground, colour having a less significant effect on the  
297 behaviour scored ( $\chi^2_{(7)} = 15.89$ ,  $p = 0.026$ ) and no significant effect on the time ( $\chi^2_{(7)}$   
298  $= 12.14$ ,  $p = 0.096$ ).

299 The initial reactions to the individual colours when presented on the ground are shown  
300 in Table 6. The yellow mat was always noticed, produced the highest mean behaviour  
301 score and mean time, as well as provoking an adverse reaction in 87.5% of the trials

302 that it was presented in. The effect of the yellow mat on the time taken to traverse the  
303 alleyway varied considerably, as shown in the standard deviation of this measure. The  
304 second highest mean behaviour score and mean time was recorded for the black mat  
305 although a higher percentage of adverse reactions were recorded for the white mat  
306 (50% for white, 43.75% for black). Both the white and blue mats were also recorded  
307 as having been noticed more than the black mat. The green and grey mats were  
308 noticed least, with the latter also resulting in both the lowest mean behaviour score  
309 and mean time (which also showed the least individual variation). The grey, brown  
310 and red mats resulted in the lowest percentage of adverse reactions (18.75%).

#### 311 **4. Discussion**

312 The behavioural reaction shown to the coloured mats varied according to both the  
313 position in which they were presented and whether the subject had had previous  
314 experience of that colour / position combination. Although the behavioural response  
315 to the mats was found to relate to their colour when they were on the ground, this was  
316 not the case when they were displayed on the stable wall. The results confirmed that  
317 the visual appearance of flooring, in this case the colour, is important in determining  
318 the behaviour of the horse.

##### 319 *4.1 Effect of position*

320 The attention paid to the ground level stimuli confirmed both the findings of the  
321 visual discrimination study (Hall *et al.*, 2003) and previous studies into the  
322 transportation of livestock, where changes in the colour or texture of ground surfaces  
323 caused animals to hesitate or stop (Grandin, 1989). The increased response to the low  
324 level colours could have been the result of a change in both the texture of the ground  
325 and the sound made by the subjects' hooves. However, as all of the mats were of the

326 same texture differences found between the individual colours was likely to be caused  
327 by the variation in their visual appearance. This is further confirmed by the fact that  
328 the majority of reactions occurred before the mat was trodden on. The sensitivity of  
329 the equine visual system to stimuli in the lower visual field may also have made these  
330 ground level stimuli more noticeable to the horse than those displayed on the wall.

331 The significantly higher behaviour scores recorded when the mats were presented on  
332 the ground could have been partially the result of the necessary lowering of the head  
333 associated with looking at the mat on the ground. When the mat was presented on the  
334 wall no large head or neck movements were required to see it. However, the overall  
335 mean times were found to increase, indicating greater hesitancy in response to the  
336 stimuli on the ground.

#### 337 *4.2 Effect of previous experience*

338 As found by Saslow (1999), the response to the coloured mats on the ground was  
339 greater when the individual colours were encountered for the first time. Once the  
340 subjects had walked over the mat, the second presentation resulted in decreased  
341 hesitation and demonstrated the speed at which horses will habituate to novel stimuli  
342 if no adverse consequences have occurred. The subject that refused to approach the  
343 yellow mat on the ground on either the first or second presentation failed to gain  
344 experience of this particular colour / position combination and the extreme adverse  
345 reaction remained. No effect of colour on the reactions to the mats displayed on the  
346 wall was found either initially or when encountered for the second time.

347 These results show that colour only mattered, or was only noticed when on the  
348 ground. In addition, novel experiences of such ground level colours produced the  
349 most adverse reactions. This suggests that in training situations in particular (where

350 novel stimuli are often encountered) the colour of flooring could be controlled to  
351 minimise adverse behavioural reactions.

352 The initial reaction shown to the different colours varied with individual subjects,  
353 certain colours producing adverse reactions in some, but not all. Differences in  
354 temperament may account in part for this variation, but the past experience of  
355 individuals varies. Some of the subjects will have had a greater experience of different  
356 colours, particularly in relation to changes in the visual appearance of the ground.  
357 Given the effect of previous experience found in the present study and the effect of  
358 previous experience on various aspects of behavioural reactivity shown in other  
359 studies (Jeziarski *et al.*, 1999), this is a probable cause of the individual differences  
360 found.

#### 361 *4.3 Effect of colour on the ground*

362 Adverse behavioural reactions to the mats on the ground occurred more frequently  
363 with certain colours. Those that were highly contrasting (such as the black and white  
364 mats), or were perceived as the most colourful (blue and yellow), were found to  
365 consistently affect behaviour. The green, red, brown and grey mats were noticed less.  
366 By far the strongest and most adverse reactions were shown to the yellow mat. This  
367 colour was noticed by all of the subjects the first time it was presented on the ground  
368 and resulted in adverse reactions in 87.5% of the trials. Although blue was noticed in  
369 81.25% of the trials when on the ground, adverse reactions were only recorded in  
370 31.25% of them, less than with the black or white mats.

371 It is likely that the reactions shown to the white and black mats resulted from their  
372 strong contrast with the background. Adverse reactions to the white mat were more  
373 prevalent than to the black mat. Black flooring is more common in horse management



374 than white and therefore would have been experienced more frequently. Grey, brown  
375 and green are all common ground colours which may have accounted for the lack of  
376 reaction shown to them. Although red is not a common ground colour for the horse it  
377 failed to elicit adverse reactions. This confirms the findings of a previous study into  
378 the ability of the horse to discriminate colours from greys; red does not appear as  
379 colourful to the horse as to the human trichromat (Wyldes, 2004). This may explain  
380 the preference for red matting over black by the horse described by Lucas (1999).

381 The contrast between the individual colours of the mats and the different background  
382 colours against which they were displayed may have resulted in certain colours being  
383 more noticeable. To the trichromatic human observer, for example, some contrasted  
384 less with the stable wall than with the concrete of the floor (e.g. red and brown), or  
385 vice versa (e.g. grey and white). However, as there was no significant effect of colour  
386 on behaviour when the colours, regardless of their contrast, were displayed on the  
387 wall in the high position, whether or not they were encountered on the floor was  
388 evidently the most important factor in determining the reaction to them.

389

## 390 **5. Conclusion**

391 These findings demonstrate that visual stimuli at ground level are more salient to the  
392 horse than those at other levels. This is in agreement with the findings of a previous  
393 study into the ability of horses to perform a task of visual discrimination. The task  
394 was made easier for the horse by presenting the stimuli on the ground as opposed to at  
395 a higher level (Hall *et al.*, 2003). In the present study, the colour of stimuli on the  
396 ground, but not of the same stimuli in the higher position on the wall, was found to  
397 affect the behaviour of the horse. Although the level of the reaction diminished in

398 most cases once no negative consequences had occurred, the response to the colour of  
399 the ground level stimuli continued throughout each pair of trials. Although colour  
400 seems to matter most to the horse when associated with a novel situation, its effect  
401 continues despite previous experience.

402 These findings provide evidence that, over and above the effects of stimulus  
403 familiarity (that generally reduces adverse reactions), controlling the visual  
404 appearance of stimuli can further reduce the incidence of adverse behavioural  
405 reactions. Specifically, colour should be considered when selecting floor surfaces for  
406 equine areas. This is of particular importance during initial training and when small,  
407 contrasting areas are involved, such as the loading ramps for transportation vehicles.

408

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448 **Table 1:** The paints used to produce the coloured mats (Plasti-kote Super Spray paint,  
449 manufactured in the U.S.A. by Plasti-kote Co Inc.)

450

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<b>Mat colour</b>	<b>Name of paint colour</b>	<b>Colour number</b>
Black	Gloss black	1100
White	Gloss white	1109
Grey	Medium grey	1105
Brown	Chestnut brown	1123
Blue	Royal blue	1134
Green	Lawn green	1126
Yellow	Yellow	1115
Red	Bright red	1120

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451

452 **Table 2:** Behaviour of subjects walking down the alleyway and the related scores

453

<b>Behaviour</b>	<b>Score</b>
Walks over/past mat without hesitation (or trots)	1
Looks but does not hesitate	2
Slows, looking at floor/wall/mat (or shies) but does not stop	3
Stops at some point (<10 seconds) but continues without encouragement	4
Stops (>10 seconds or steps back) but continues with encouragement	5
Stops and does not continue despite encouragement (or U-turn/reversing)	6

454

455 **Table 3:** The overall percentage of trials that resulted in each behaviour score and the  
 456 mean times recorded for each score

457

<b>Behaviour scored</b>		<b>Percentage of trials</b>	<b>Mean times (<math>\pm</math> SD)</b>
<b>1</b>		<b>48.63</b>	<b>7.87 (<math>\pm</math> 1.59)</b>
<b>2</b>		<b>35.35</b>	<b>8.15 (<math>\pm</math> 0.95)</b>
<b>3</b>	<b>Noticed the mat</b>	<b>8.79</b>	<b>9.72 (<math>\pm</math> 3.27)</b>
<b>4</b>		<b>4.69</b>	<b>17.91 (<math>\pm</math> 8.32)</b>
<b>5</b>		<b>2.15</b>	<b>24.70 (<math>\pm</math> 9.00)</b>
<b>6</b>		<b>0.39</b>	<b>60.00 (<math>\pm</math> 0.00)</b>
			<b>(cut-off time reached)</b>

458

459 **Table 4:** The number of trials that resulted in a reaction being recorded for each  
460 location within the alleyway

461

<b>Location of the reaction</b>	<b>Number of trials</b>	<b>Percentage of reactions</b>
At the start	3	1.14 %
Before the mat	18	6.85 %
At the mat	238	90.49 %
On / adjacent to the mat	3	1.14 %
After the mat	1	0.38 %

462



463 **Table 5:** Percentage of trials resulting in behaviour scores of 1 – 6, mean behaviour  
 464 scores and the mean times for each condition

465

MEASURES		HIGH POSITION (Wall)		LOW POSITION (Ground)	
BEHAVIOUR SCORES		First presentation	Second presentation	First presentation	Second presentation
		(% of trials)	(% of trials)	(% of trials)	(% of trials)
1		50.78	60.94	31.25	53.13
2	N	41.41	35.16	32.03	32.03
3	O	3.91	3.12	16.41	11.72
4	T	2.34	0.78	14.06	0.78
5	I	1.56	0.00	5.47	1.56
6	C	0.00	0.00	0.78	0.78
	E				
	D				
MEAN BEHAVIOUR SCORES (± SD)		1.63 (± 0.54)	1.47 (± 0.31)	2.33 (± 0.70)	1.68 (± 0.60)
MEAN TIMES (± SD) (seconds)		8.37 (± 2.58)	8.16 (± 1.90)	10.80 (± 7.45)	9.23 (± 6.22)

466

467 **Table 6:** Percentage of trials resulting in behaviour scores of 1 – 6, mean behaviour  
 468 scores and the mean times for each colour when presented for the first time on the  
 469 ground  
 470

MEASURES		COLOURED MATS							
BEHAVIOUR SCORES		Black	White	Grey	Brown	Blue	Green	Yellow	Red
		(% of trials)	(% of trials)	(% of trials)	(% of trials)	(% of trials)	(% of trials)	(% of trials)	(% of trials)
1		25	12.5	56.25	31.25	18.75	56.25	0	50
2	N	31.25	37.5	25	50	50	18.75	12.5	31.25
3	O								
4	A	12.5	31.25	12.5	12.5	6.25	12.5	37.5	6.25
5	D	18.75	18.75	6.25	6.25	12.5	6.25	37.5	6.25
6	I								
	V								
	E	12.5	0	0	0	12.5	6.25	6.25	6.25
	R								
	E	0	0	0	0	0	0	6.25	0
	D								
	S								
	E								
<b>MEAN BEHAVIOUR SCORES</b> (±SD)		<b>2.63</b> (± 1.41)	<b>2.56</b> (± 0.96)	<b>1.69</b> (± 0.95)	<b>1.94</b> (± 0.85)	<b>2.50</b> (± 1.32)	<b>1.88</b> (± 1.26)	<b>3.56</b> (± 1.03)	<b>1.88</b> (± 1.20)
<b>MEAN TIMES (SECONDS)</b> (±SD)		<b>11.54</b> (± 6.42)	<b>9.75</b> (± 4.97)	<b>8.87</b> (± 3.54)	<b>9.26</b> (± 4.35)	<b>10.4</b> (± 5.57)	<b>9.56</b> (± 4.79)	<b>18.27</b> (± 14.64)	<b>9.71</b> (± 6.18)

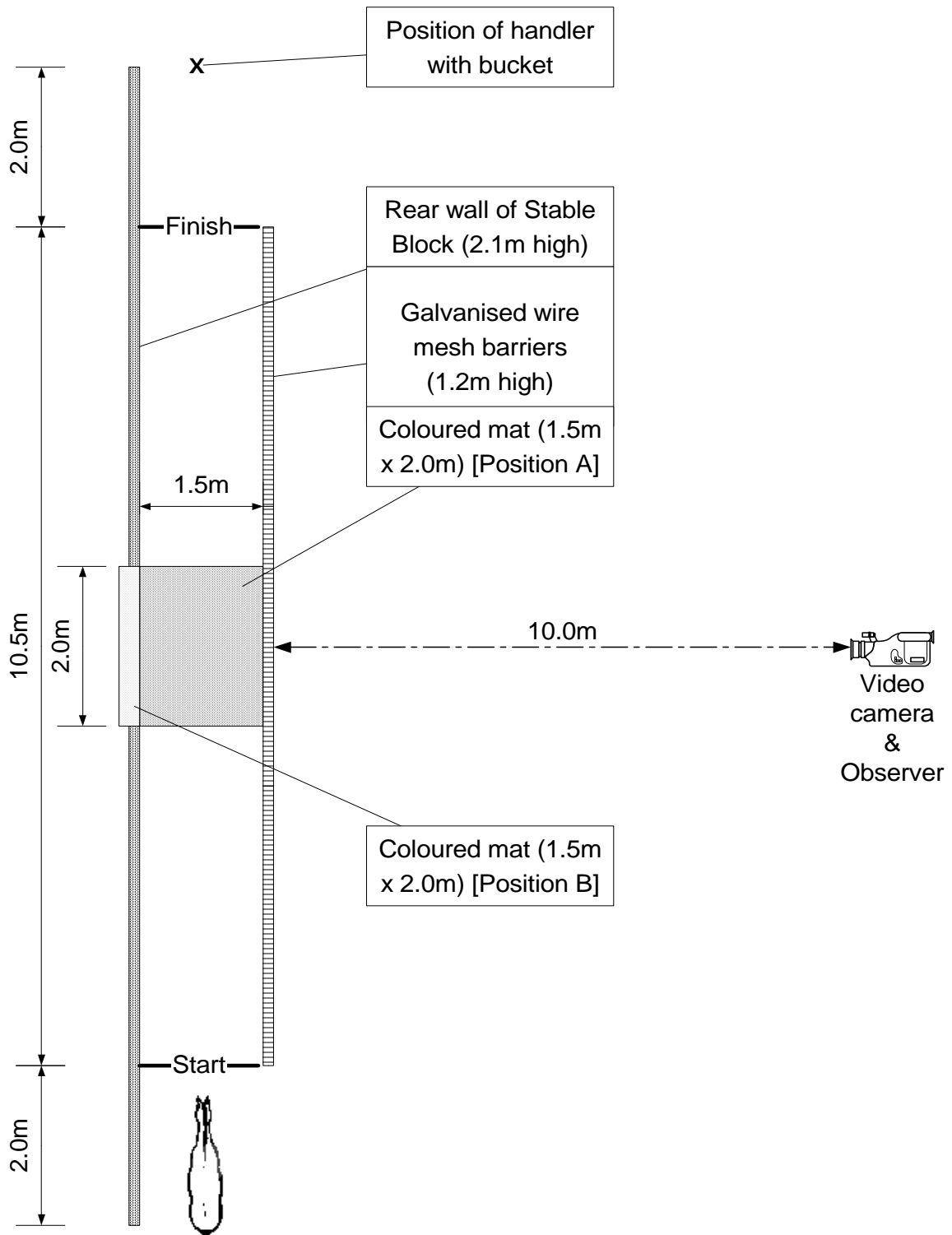
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475 **Figure 1:** Plan of the alleyway used to present the stimuli (referred to as coloured  
476 mats) either on the ground (position A) or on the stable wall (position B). The horse is  
477 shown at one end; for starting at the other end, the position of the horse, start and  
478 finish lines were reversed. All dimensions are shown in metres.

479

480

481



482

483 Figure 1.