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A preliminary investigation into personality and pain in dogs

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1 ABSTRACT

2 Adherence to basic animal welfare standards involves effective monitoring and
3 control of pain, especially in a veterinary setting. Assessment relies on behavioural
4 and physiological indicators. However, individual differences in physiology mediate
5 consistent individual differences in behaviour, referred to as personality (Koolhaas et
6 al., 1999). Therefore, personality may confound measurements of pain (Ijichi et al.,
7 2014). The current work is a preliminary investigation into whether Extraversion and
8 Neuroticism are associated with differences in individual behavioural and
9 physiological responses to pain. Twenty dogs were observed during recovery from
10 routine castration in a clinical setting. Core temperature was recorded using Infrared
11 Thermography (IRT) (Stewart et al., 2008) upon admission, 15 minutes post-
12 extubation and every 30 minutes thereafter, until the subject was collected by their
13 owner. Behaviour during recovery was scored using Short Form Glasgow
14 Composite Measure Pain Scale (Reid et al., 2007) at the same intervals as IRT
15 readings. Personality was measured using Monash Canine Personality
16 Questionnaire-Revised (Ley et al., 2009) and owners rated their dog's tolerance to
17 pain on a five-point Likert scale. Pain score did not have an association with eye
18 temperature discrepancy or core temperature changes from control, indicating it may
19 not predict affective response to pain. More highly extravert subjects had
20 significantly higher pain scores ($p = 0.031$), despite experiencing similar tissue
21 damage. More extravert subjects showed significantly greater right eye temperature
22 ($p = 0.035$), suggesting hemispheric dominance. Neuroticism had no association
23 with physiological or behavioural responses to pain. Finally, owners were not able to
24 predict their dog's behavioural or physiological response to pain. These results
25 indicate that personality may be a useful clinical tool for assessing individual
26 differences in response to pain, whilst owner ratings of their dog's response is not
27 reliable.

28 KEYWORDS: personality, pain, extroversion, neuroticism, dogs, castration

29 INTRODUCTION

30 Animals are unable to verbally convey their emotions to human care-givers, which
31 makes the measurement of pain difficult (Reid et al., 2013). Therefore, behaviour-
32 based scales are utilised to quantify pain levels in animals, assisting the
33 administration of the correct dosage of analgesic drugs and informing decisions on
34 humane end-points (Ashley et al., 2005). Consequently, it is vital that these scales
35 are both sensitive and valid, to reduce the welfare implications that could occur
36 through the incorrect assessment of pain (Rutherford, 2002). However, personality -
37 defined as individual differences in behaviour which are stable over time and across
38 contexts (Koolhaas et al., 1999) - may confound this. For example, human subjects
39 scoring more highly for Extraversion express their experiences of pain more clearly
40 (Harkins et al., 1989), though they may experience pain less intensively (Ramírez-
41 Maestre et al., 2004; Soriano et al., 2012). Extraversion is characterised by traits
42 such as energetic behaviour, assertiveness and the tendency to seek stimulation
43 (Costa and McCrae, 1985). Further, highly neurotic people have a higher emotional
44 stress response to pain when compared to those who have a low score for
45 neuroticism (Goubert et al., 2004; Koenig et al., 2015). Neuroticism is associated
46 with the tendency to experience unpleasant emotions easily and a low degree of
47 emotional stability (Costa and McCrae, 1985).

48 The association between personality and pain response has recently been
49 investigated in animals in a clinical setting (Ijichi et al., 2014). This study provides
50 preliminary evidence that extraversion correlates with behavioural expressions of
51 pain in horses, whilst neuroticism is associated with reduced tolerance to pain.
52 However, it is not known whether personality affects the emotional experience of
53 pain, as well as its behavioural expression in animals, as it does in humans (e.g.

54 Asghari & Nicholas 2006). Further, this study used a variety of naturally occurring
55 tissue damage, making comparison across individuals more complex. In addition, it
56 is not known whether the link between personality and pain is a species-specific
57 phenomenon or whether it is seen in other non-human mammals.

58 In dogs, personality and pain can be measured using validated questionnaires. The
59 Monash Canine Personality Questionnaire-Revised (MCPQ-R) has been validated
60 as having good inter-rater and test-retest reliability for five factors which include
61 Extraversion and Neuroticism (Ley et al., 2009b). On this scale, extravert dogs are
62 typically active, excitable and restless, whilst neurotic dogs are characterised as
63 fearful, submissive and timid. Canine pain can be measured using the Short Form
64 Glasgow Composite Measure Pain Scale (CMPS-SF) (Reid et al., 2007) as it has
65 been shown to be both more sensitive and have less inter-observer variability when
66 compared to other tests (Guillot et al., 2011). It is designed as a clinical tool for
67 dogs in acute pain and uses 30 descriptors within six categories to inform decisions
68 about pain management (Reid et al., 2007).

69 The current investigation aims to investigate whether personality affects emotional
70 and behavioural response to pain in dogs in a clinical setting. Castration was
71 selected as it is a common routine procedure which causes moderate post-operative
72 pain (Wagner et al., 2008) and is often conducted on healthy, young animals. In
73 addition, the ability of owners to predict their dog's response to pain was measured,
74 as horse owner ratings have been shown to have high predictive accuracy (Ijichi et
75 al., 2014). Canine Extraversion and Neuroticism was measured using the MCPQ-R
76 (Ley et al., 2009a) and compared with pain behaviour using the CMPS-SF (Reid et
77 al., 2007). Emotional response to pain was measured using Infrared Thermography
78 (IRT) as core temperature increases with arousal (Stewart et al., 2005; Travain et
79 al., 2015) and decreases with pain in cattle (Stewart et al., 2008). Tympanic
80 differences in temperature relate to lateralised cerebral blood flow (Riemer et al.,

81 2016), reflecting emotional valence. Therefore, discrepancy between the right and
82 left eye was explored as this may indicate lateralised cerebral blood flow.

83 Based on human and equine research, it was hypothesised that 1) Extraversion will
84 correlate positively with behavioural indicators of pain and may correlate with
85 changes in physiology; 2) Neuroticism will correlate negatively with owner rating of
86 the subject's tolerance and positively with emotional response to pain; 3) Owner
87 Tolerance ratings will correlate negatively with behavioural indicators of pain and
88 emotional response. In addition, the association between behavioural and emotional
89 response to castration will be investigated to determine if behaviour is an accurate
90 indicators of the emotional state of subjects.

91 MATERIALS AND METHODS

92 Subjects were assessed between 24th October 2016 and 17th January 2017 at two
93 veterinary surgeries based in Gloucester and Surrey (UK). Subjects were admitted
94 and treated as per standard protocol for each veterinary practice. Patients were pre-
95 medicated with acepromazine and sub-cutaneous buprenorphine. General
96 anaesthesia was induced by intravenous propofol and maintained using inhaled
97 isoflurane. Subjects were observed whilst pain was caused by a routine, voluntary
98 procedure conducted in normal veterinary practices. This procedure would cause
99 dogs' moderate pain regardless if the dogs were part of this study, allowing for an
100 ethical means of testing the aims of this study, as additional pain infliction is not
101 needed. Where the subject's medical needs conflicted with those of the study,
102 medical needs were prioritised and the subject withdrawn from data analysis.

103 Twenty dogs of mixed breed were assessed as limiting subjects to a single breed
104 would reduce personality variance to an unacceptable degree, as personality is
105 known to differ between breeds (Starling et al., 2013). The age of subjects could not
106 be specified as the sample included re-homed dogs without clear histories. To

107 reduce confounding effects, subjects were not included in the study if they: had pre-
108 existing conditions that might cause pain; underwent any additional treatment;
109 required a different anaesthetic drug or had recently been administered pain
110 relieving medicine for a separate condition.

111 Of 20 original subjects, three dogs were excluded. One dog received a different
112 anaesthetic drug and one slept throughout the study, preventing ocular
113 temperatures and behavioural pain scores from being measured. An additional dog
114 was excluded due to the subject being paired with another dog, which was likely to
115 confound results. Two dogs were removed from part of the study, as tissue damage
116 and analgesic drug dosage were not controlled. One of these dogs was
117 administered a lower dose of the pre-operative drugs due to their older age. The
118 other subject had juvenile teeth and two dew claws removed, which was elected
119 during the castration operation. Data from these dogs was used only when
120 assessing whether eye temperatures correlates with behavioural pain scores, as
121 different treatment would not affect within-individual correlations.

122 *Personality and Owner Ratings*

123 Upon admission, owners were informed of the nature and purpose of the study and
124 written consent to use their dog was obtained. Subsequently, owners were asked to
125 complete the Monash Canine Personality Questionnaire-Revised (MCPQ-R) (Ley et
126 al., 2009a). This ensured owners were blind to the subject's post-operative pain
127 response when they completed the questionnaire. Extraversion and Neuroticism
128 were the only personality factors used for further analysis, as these relate to the
129 hypothesis of the study, based on previous literature. An additional five-point Likert
130 scale was added to the MCPQ-R to assess the owner's rating of subject's tolerance
131 to pain (Ijichi et al., 2014). This score will be referred to as "Tolerance".

132 *Pain Scores*

133 Behavioural expression of pain was assessed using the Short Form Glasgow
134 Composite Measure Pain Scale (CMPS-SF) (Reid et al., 2007). Section B (analysis
135 of mobility) and section C (pain on palpitation of wound) of the CMPS-SF were
136 deemed unethical for the purposes of this study, potentially causing dogs
137 unnecessary pain and stress, and so were omitted from the current study procedure.

138 Post-extubation, veterinary nurses were asked to orientate the subjects' face
139 towards the video camera during recovery. This allowed for easier observations of
140 the dogs' behaviour without disturbing the subject during recovery. Scoring was
141 conducted retrospectively from 3-minute video recordings of the subjects taken
142 using a Canon 60D® with a Canon® 28-105mm EF-S lens, to reduce the effect of
143 observer presence. The first minute was disregarded due to the influence the
144 observer may have had on entering the room. Pain scores were taken 15 minutes
145 post-extubation and every 30 minutes thereafter, totalling a maximum of twelve
146 recordings of two minutes per dog, dependant on how long the subject remained in
147 recovery. These timings were recommended and used by previous studies looking
148 at post-operative pain in dogs (e.g. Wagner et al., 2008). The scoring observer (J.L.)
149 was blind to subject's personality scores at the time of scoring. For each subject, the
150 peak pain score recorded from the first four recordings was used for analysis of
151 individual differences. This is referred to as Peak Pain Score. Four recordings were
152 used because dogs remained in the recovery kennel for different amounts of time
153 but all subjects were present during at least the first four time periods. Recordings of
154 behaviour between the 5th and 12th observation were discarded for comparison
155 across individuals. These reading were use to explore how pain changed over time.

156 *Infrared Thermography*

157 Eye temperature readings were taken with an infrared camera (FLIR® One™ for
158 android). A mobile device was used as it is considerably smaller than hand-held
159 devices with a similar specification, which have been shown to causes stress in
160 canine subjects (Travain et al., 2015). Images were taken from a distance of 0.5m -
161 1.0m and an angle of 90° from each eye (Stewart et al., 2007), calibrating the
162 camera after each photo was taken. A control measurement was taken 15 minutes
163 after the dogs were placed into the recovery cage prior to surgery or the
164 administration of medication to measure the stress caused by being in a veterinary
165 practice, as opposed to that caused by pain. This will be referred to as Control
166 Temperature. During recovery, images were taken immediately after video recording
167 stopped (15 minutes post-extubation and every 30 minutes thereafter) for each
168 behaviour assessment time point. This was to prevent IRT recording altering the
169 subject's behaviour and confounding CMPS-SF behavioural results.

170 Temperatures were analysed retrospectively using the FLIR® One™ app by
171 identifying the palpebral fissure, including the lacrimal caruncle and taking the
172 maximum temperature from this area (Yarnell et al., 2013). This reduced the stress-
173 inducing effects of prolonged IRT measurement required to take accurate readings
174 of such a small area (Travain et al., 2015). The observer (J.L) was blind to
175 personality scores at the time of taking and assessing IRT images.

176 The mean for both eyes at each time point was calculated to indicate Core
177 Temperature. Core temperature at each time point was subtracted from Control
178 Temperature, separating the stress inducing effects of being in a veterinary practice
179 from pain-induced stress post-castration. This gave a score for how much core
180 temperature had changed at each time point and whether it had increased or
181 decreased. This is referred to as Temperature Change from Control.

182 Only recordings from the first four time periods were used for analysis of individual
183 differences, as per pain scoring. The maximum increase from Control Temperature
184 was used for analysis of individual differences as previous research used peak
185 temperature (Stewart et al., 2008). This is referred to as Peak Temperature
186 Increase. The discrepancy between eyes was calculated by subtracting the left eye
187 temperature from the right to indicate the extent of right hemispheric dominance.
188 This is referred to as Eye Temperature Discrepancy. A positive score indicates the
189 right eye was hotter, and a negative score indicates the left was. The greatest
190 discrepancy recorded from the four measurements was used for analysis of
191 individual differences. This is referred to as Peak Discrepancy.

192 *Analysis*

193 Analysis was conducted using “R” (R Development Core Team, 2017) and IBM®
194 SPSS® Statistics 23. Shapiro-Wilks tests were used to test for normality of variables
195 and residuals for tests of difference (Field, 2009). Paired T-tests were used to
196 analyse for differences in core temperature between the control measurement and
197 each observation post-castration. Paired T-test and Wilcoxon Signed-Rank tests
198 were used, as appropriate for normality, to analyse whether eye temperature
199 discrepancy was significantly different between control and post-castration readings.
200 Shapiro-Wilks tests were used to determine the normality of variables. Where each
201 variable was normally distributed, a Levene test (Fox and Wiesberg, 2011)
202 assessed the homogeneity of variance on paired variables (Field, 2009). To
203 determine whether behaviour correlated with emotional response, pain scores were
204 compared with matched Temperature Change from Control and eye temperature
205 discrepancy, using Pearson or Spearman-Rank correlations as appropriate for
206 normality and homoscedasticity. Relationships between personality factors and
207 Peak Pain Score, Peak Discrepancy and Peak Temperature Increase were explored
208 using Pearson or Spearman-Rank correlations, as appropriate. Correlations were

209 stated as weak where the coefficient was less than ± 0.1 , moderate for ± 0.3 and
210 strong for ± 0.5 (Field, 2009).

211 RESULTS

212 *Post-castration behaviour and changes in physiology*

213 Paired T-Tests indicated significant differences in core temperature from control in
214 observations 1,2,3,5,6 and 7 (Table 1; Figure 1). Paired T-tests and Wilcoxon
215 Signed-Rank tests did not detect significant differences from control for eye
216 temperature discrepancy (Table 2). The change in pain scores across observations
217 can be seen in Figure 2.

218 *Relationship between behavioural and physiological responses to pain*

219 Spearman's correlation revealed Pain Score did not have an association with Eye
220 Temperature Discrepancy ($r_s = -0.091$, $N = 164$, $P = 0.246$) or Temperature Change
221 from Control ($r_s = 0.131$, $N = 164$, $P = 0.095$).

222 *Personality and response to pain*

223 Extraversion had a strong positive correlation with Peak Pain Score (Spearman: $r_s =$
224 0.558 , $n = 15$, $p = 0.031$). Control Temperature did not correlate with Extraversion
225 (Pearson: $r_s = -0.390$, $n = 17$, $p = 0.15$). Post-surgery, Extraversion had a moderate
226 positive relationship with Peak Temperature Increase which can be seen through
227 visual inspection (Figure 3). However, this was not statistically significant
228 (Spearman: $r_s = 0.438$, $n = 15$, $p = 0.101$). Extraversion correlated strongly and
229 positively with Peak Discrepancy post-surgery (Pearson: $r_s = 0.546$, $n = 14$, $p =$
230 0.035 ; Figure 4).

231 Control Temperature did not correlate with Neuroticism (Pearson: $r_s = -0.078$, $n = 17$,
232 $p = 0.78$). There was no significant correlation between Neuroticism and Peak

233 Discrepancy (Spearman: $r_s = -0.401$, $n = 15$, $p = 0.138$), Peak Pain Score
234 (Spearman: $r_s = 0.107$, $n = 15$, $p = 0.703$), Peak Temperature Increase (Pearson: r_s
235 $= -0.124$, $n = 15$, $p = 0.660$), or Peak Discrepancy ($r_s = -0.011$, $n = 15$, $p = 0.970$).

236 *Owner Predictions*

237 There was no significant correlation between Tolerance and Peak Pain Score
238 (Spearman: $r_s = 0.372$, $n = 15$, $p = 0.172$), Peak Temperature Increase (Spearman:
239 $r_s = 0.029$, $n = 15$, $p = 0.917$), Peak Discrepancy (Spearman: $r_s = 0.101$, $n = 15$, $p =$
240 0.720), Extraversion (Spearman: $r_s = 0.431$, $n = 15$, $p = 0.109$) or Neuroticism
241 (Spearman: $r_s = -0.016$, $n = 15$, $p = 0.956$).

242 DISCUSSION

243 Accurate pain assessment is essential for animal welfare and vital for correct pain
244 management (Rutherford, 2002). Ijichi et al. (2014) provided preliminary evidence to
245 suggest behavioural indicators of pain in horses may not accurately indicate the
246 level of damage sustained. Instead, this study found the behavioural response to
247 damage is associated with personality. This indicates behaviour based pain
248 assessment tools may not be accurate and the subsequent management of pain
249 among animals may not be appropriate. The over estimation of pain could increase
250 analgesic drug dosage - causing adverse pharmaceutical effects - or contribute to
251 an unnecessary euthanasia (Ashley et al., 2005). Underestimation could result in
252 inadequate pain relief and subsequent suffering (Reid et al., 2007). Both of these
253 result in welfare implications, highlighting the need for accuracy in these
254 assessment tools. In the present study, post-operative behaviour was assessed
255 after castration and compared with personality and core temperature. The results
256 provide further evidence that there may be a relationship between personality and
257 behavioural pain scores, as well as physiological measures.

258 The second observation post-castration showed a peak in mean pain score across
259 subjects of 3.13 out of a possible 15 and this steadily declined throughout the
260 observation period. This indicates that, on average, adequate pain relief was
261 administered and pain was successfully managed during recovery (Reid et al.,
262 2007). However, core temperature was significantly lower than control readings from
263 the first observation and this was still seen in observation seven, more than three
264 hours after surgery. Lowered core temperature is associated with pain in cattle
265 (Stewart et al., 2008), however, it may also have been influenced by general
266 anaesthetic and post-castration medication (Raffe et al., 1980). Unlike the study by
267 Stewart et al. (2008), temperature did not rapidly increase after an initial drop. This
268 may be due to differences between the species, procedure, pain-relief or context
269 between the two studies and requires further investigation.

270 The discrepancy in temperature between left and right eye did not change
271 significantly from control in any observation post-castration and this may indicate
272 that eye temperature discrepancy does not reflect response to pain as originally
273 suggested. This supports the findings of Riemer et al. (2016), which did not indicate
274 a lateralised cerebral blood-flow as a result of separation anxiety. Interestingly, there
275 was noticeable individual variation in both behavioural and physiological responses
276 to pain triggered by the same procedure. Further, behavioural indicators did not
277 correlate with physiological responses. Yarnell et al. (2013) also found ocular
278 temperatures and behavioural measures of stress also did not correlate in horses
279 when exposed to a stressor. Taken together, this indicates behaviour may not
280 accurately indicate when an animal was experiencing poor welfare and that
281 individuals respond differently to the same procedure, supporting previous findings
282 in horses (Ijichi et al., 2014).

283 Subjects scoring more highly for Extraversion had higher Peak Pain Scores, despite
284 experiencing relatively standardised tissue damage. This indicates behavioural

285 response may differ between subjects due to specific personality factors. This
286 supports Ijichi et al. (2014) in their finding that extravert animals score more highly
287 for behavioural expression of pain, regardless of the severity of their injury. In this
288 previous study, tissue damage was not standardised for severity and constituted
289 both skeletal and soft tissue damage. The current study goes some way to correct
290 this by using pain caused by a standardised procedure under more controlled
291 conditions. The relationship between Peak Pain Score and Extraversion suggests
292 that more introvert subjects are less likely to exhibit pain related behaviours.
293 Intriguingly, human introverts are less physically active and less likely to adopt
294 active coping responses (Soriano Pastor et al., 2010), a behavioural pattern similar
295 to that seen here and supported by evidence that Extraversion may be associated
296 with passive strategies with less apparent behaviour indicators of stress (Ijichi et al.,
297 2013). It is therefore important to investigate whether more introvert animals
298 express fewer behavioural indicators of pain because they have a lower emotional
299 response to pain or because they experience pain to the same degree as extraverts
300 but have inhibited expression, as is the case in human subjects (Harkins et al.,
301 1989).

302 To investigate whether personality may be associated with differing emotional
303 responses to pain, core temperature was measured using IRT (Stewart et al., 2008).
304 A moderate positive correlation between Extraversion and Peak Temperature
305 Increase was noted in the current study (Figure 3). However, this was not
306 statistically significant, possibly due to the modest sample here. Therefore, the
307 relationship between Extroversion and core temperature should be investigated
308 further. This relationship was not observed before surgery, which may mean that
309 personality correlates with core temperature under painful conditions. It appears that
310 subjects scoring more highly for Extraversion had an increase in core temperature,
311 whilst those with a low score for Extraversion had a decrease in temperature. If

312 arousal results in an increase (dogs: Travain et al., 2015), and pain results in a
313 decrease (cattle: Stewart et al., 2008) in temperature, this may suggest more
314 extravert individuals have increased arousal in response to the same tissue damage
315 whilst introvert individuals experience pain induced depression of core temperature.
316 In human studies, more introvert people have stronger emotional responses to injury
317 (Paine et al., 2009), and have reduced quality of life associated with poor coping
318 mechanisms (Soriano Pastor et al., 2010). However, different species may have
319 differing core temperature responses to pain. Further research will be needed to
320 confirm or reject this novel finding using veterinary practices with larger caseloads of
321 castration.

322 It is possible that differences in core temperature are the result of variation in
323 hypothermic response to medication. However, it was also observed that the
324 personality extraversion was associated with discrepancy in eye temperature, which
325 might suggest hemispheric dominance. For peak discrepancy readings, more
326 extravert individuals displayed higher temperatures in the right eye, whilst more
327 introvert subjects displayed greater temperature in the left eye. If eye temperature
328 reflects lateralised cerebral blood flow, this suggests that more extravert subjects
329 had increased activity in the right hemisphere and more introvert subjects had
330 increased activity in the left. Whilst this subject is complex, there is evidence to
331 suggest that the right hemisphere processes emotional responses (Borod et al.,
332 1998) and is associated with the tendency to express emotions (Nestor and Safer,
333 1990). This may explain the higher scores for behavioural expression of pain in
334 these subjects. However, it is suggested that right hemispheric activity is an
335 indicator of increased pain sensitivity and negative affect in humans (Pauli et al.,
336 1999). If this were the case, it would suggest that more extravert subjects expressed
337 more pain due to increased sensitivity, in which case, behavioural indicators may
338 provide valuable information on the affective state of subjects. Further validation of

339 core temperature as an indicator of pain, and ocular temperature discrepancy as an
340 indicator of lateralised cerebral blood flow, is required to fully understand these
341 findings. Heart Rate Variability (Rietmann et al., 2004) and salivary cortisol (Hekman
342 et al., 2012) in a larger sample may clarify this relationship.

343 Neuroticism did not correlate with Peak Pain Scores. This is not unexpected if this
344 personality factor is more associated with the experience of pain, rather than its
345 expression (Ijichi et al., 2014; Paine et al., 2009). However, in the current study,
346 Neuroticism did not correlate with any physiological indicators taken, which suggests
347 it was not associated with the subjective experience of pain. There are several
348 reasons this may be the case. First, there are species-specific responses to pain
349 (Anil et al., 2002), which may affect behaviour and emotional processing. Second,
350 personality factors measured by different subjective questionnaires may be similar
351 constructs but not identical due to either species or trait differences. Therefore, what
352 is referred to as “Neuroticism” by one assessment method may not be identical to
353 that measured by another. The traits measured by the original equine questionnaire
354 (Ijichi et al., 2013) are not species-specific and may be appropriate for application to
355 canine subjects. Further work on canine pain using this questionnaire could identify
356 whether the differences seen here are the result of species specific responses to
357 pain or differences in the measurement of Neuroticism.

358 Owner ratings of Tolerance did not correlate with Neuroticism or behavioural and
359 physiological indicators of pain. Ijichi et al. (2014) found that horse owner’s
360 subjective opinion accurately predicted their horses objectively scored response to
361 pain. Owner rated Tolerance also closely correlated with Neuroticism in the previous
362 study. The distinct uses of dogs and horses may have caused this unexpected
363 difference in results. Horses are regularly worked or ridden, which may be
364 negatively impacted upon if the animal is in pain. Typically, the animals are also of
365 much higher financial, though not necessarily sentimental, value. Therefore, horse

366 owners may be more attuned to behavioural indicators of pain. Function may be
367 much less important with companion dogs, as they are mainly household pets, and
368 therefore the same attentiveness to pain might not exist. By contrast, dog owners
369 have the benefit of increased contact time due to sharing their home with their pets
370 which should promote sensitivity to changes in behaviour.

371 It was noted during collection that owners regularly commenting on the difficulty of
372 remembering a time their dog was in pain. Results by Brown et al. (2013) showed
373 that behavioural pain scales conducted by owners did not correlate with vertical
374 force produced by arthritic dogs. This indicates dog owners may not be good at
375 detecting when their pet is in pain. Hielm-Björkman et al. (2011) discovered owners
376 were only accurate with pain scales when they were 'self-trained'. In this previous
377 study, once owners had seen the difference in their dogs' expression of pain after
378 pain medication, they were able to recognise behaviours caused by pain. Taken
379 together, this suggests that dog owners may not offer the same clinical opportunities
380 in understanding individual differences in pain response, as compared to equine
381 owners.

382 CONCLUSION

383 The current study provides preliminary evidence for individual variation in
384 behavioural and physiological response to a moderately painful procedure. Further,
385 these individual differences were associated with personality. As predicted,
386 Extraversion was associated with differences in response to pain post-castration as
387 those scoring more highly for this factor presented with more prominent behavioural
388 indicators of pain. The relationship between Extroversion and emotional response to
389 pain was more complex. More extrovert subjects had possible greater increases in
390 core temperature and increased temperature in the right eye compared to the left.
391 To understand the association between extraversion and emotional responses to

392 pain, further physiological tests beyond the scope of the current study should be
393 investigated. Neuroticism was not associated with behavioural or physiological
394 response to pain. This contradicts the prediction of the current study that more
395 neurotic subjects would show more pronounced changes in core temperature.
396 Owner ratings of Tolerance were not associated with any indicator of pain, which
397 suggests that limited value should be placed on using this information in assessing
398 canine pain.

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408 ETHICAL CONSIDERATIONS

409 No ethical permission is needed for non-invasive observations of dogs within a
410 clinical setting in the United Kingdom. The veterinary practices and all individual
411 owners were informed about the nature and intent of the research and their written
412 consent was obtained prior to any data collection. Participants were permitted to
413 withdraw up until the point of data analysis, which was conducted using anonymised
414 data.

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