

# **Effect of training and familiarity on responsiveness to human cues in domestic dogs (*Canis familiaris*)**

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1 **Effect of training and familiarity on responsiveness to human**  
2 **cues in domestic dogs (*Canis familiaris*)**

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## Abstract

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Domestic dogs (*Canis familiaris*) seem to possess an evolved competency to follow human-given cues, often out-performing their wild progenitor the wolf (*Canis lupus*) on cue-following tasks. However, domestication may not be solely responsible for the socio-cognitive skills of dogs, with ontogenetic experience also playing a role. This research evaluated the effects of intensive training on cue following behaviour using an unreinforced object choice paradigm. The responses' of dogs that were trained to competitive levels were compared to those of pet dogs with only basic training, and dogs living in an animal shelter that demonstrated no or only rudimentary following of basic commands. Using a cue following task where three types of cues were presented by familiar and unfamiliar human partners, the number of cues followed by each training group were recorded. All dogs found cues where gesture was combined with a congruent head and eye movement easier to follow than either gesture or eye gaze alone. Whether the cue-giver was familiar or not had a significant effect on number of cues followed in homed dogs, and the performance of shelter dogs was comparable to the other groups when faced with an unfamiliar cue-giver. Contrary to predictions, level of training did not improve performance on the cue-following task. This work does provide support for the presence of an evolved adaptation to exploit social cues provided by humans that can be augmented by familiarity with the cue giver. However, additional joint activity as experienced in an intensive training regime does not seem to increase accuracy in following human-given cues.

44 Keywords: *Canis familiaris*, familiarity, dog-human interaction, social cognition, cue-  
45 following, training  
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49 **Introduction**

50

51 Social signalling is cognitively complex as it requires an understanding of meaning by  
52 both signaller and receiver for it to be a useful method of communication.

53 Comprehension on the part of the receiver extends from a basic understanding of  
54 conspecific behaviour to the more intricate awareness and interpretation of cues  
55 provided, and how they relate to the senders underlying cognitive state (Whiten and  
56 Byrne 1988; Whiten 1997). Within species, the fitness benefits inherent in being able to  
57 interpret and act on social cues provided by others are clear (exploiting others'  
58 knowledge of food resources, nesting sites or predicting behaviour to minimise risk of  
59 conflict or maximise mating opportunities etc.). However, understanding inter-species  
60 social signals may only be useful to certain populations or individuals in particular  
61 environments. For example, captive animals may benefit from interpreting social cues  
62 provided by human caregivers and change their own behaviour in light of the  
63 information they receive; however, this capacity may not be evident in wild conspecifics  
64 with little or no human contact for which the value of understanding human social cues  
65 is minimal.

66

67 Differences in such socio-cognitive skills that are driven by the environment and  
68 experiences of the individual have been referred to as Developmental Social  
69 Competencies (DSC) (Miklósi and Topal 2013), meaning the individual's ability to  
70 generate social skills that are beneficial *in the group they find themselves in*. This is  
71 differentiated from Evolutionary Social Competencies (ESC) that relate to species-wide  
72 'universal' social skills that have been selected through Darwinian processes to increase

73 genetic fitness through acquisition of survival- or reproduction-relevant resources  
74 (Miklósi and Topál 2013). For most species, understanding social cues provided by  
75 humans could develop through ontogenetic processes in environments where humans  
76 are providers of valuable resources such as food (DSC); however, for domesticated  
77 species whose intimate relationships with humans have been shaped through  
78 evolutionary time, ESCs may emerge.

79

80 Domestic dogs (*Canis familiaris*) are particularly sensitive to human gestures and  
81 attentional states. A burgeoning body of research has demonstrated that dogs are able  
82 to follow human points and/or gaze cues to locate out-of-sight food rewards (see Udell  
83 et al. 2010 for a review; Barrera et al. 2011; Schmidjell et al. 2012), out-performing  
84 higher primates on these tests (Bräuer et al. 2006; Hare and Tomasello 2005). These  
85 abilities are generally assessed using an object-choice paradigm where a human  
86 indicates one of two containers that conceal a food reward by pointing or looking  
87 towards it. Dogs typically follow the human cue and will select the indicated container  
88 in a choice test.

89

90 Why dogs exhibit heightened sensitivity to human social cues has continued to be a  
91 subject of debate. Some researchers have proposed that the process of natural  
92 selection acting on the wild progenitor the wolf (*Canis lupus*), produced individuals who  
93 were more tolerant of humans allowing them to exploit human settlements. These  
94 individuals were then subjected to artificial selection for traits desired by humans,  
95 causing genetic changes that resulted in advanced socio-cognitive skills in domestic  
96 dogs (Hare and Tomasello 2005; Miklósi and Topál 2013). The so-called 'Domestication

97 Hypothesis' has received support in that wild canids often do not perform as well on  
98 human-cued object-choice tasks as their domestic counterparts. For example, Hare et  
99 al. (2002) tested wolves and dogs on their ability to follow three types of human  
100 communicative gesture to locate a hidden reward; human tapping and looking at the  
101 correct container, human pointing and looking at the correct container from a short  
102 distance away and human pointing at the correct container from a short distance while  
103 maintaining eye gaze straight ahead. Collectively, the dogs were able to follow the cues  
104 above chance in all conditions whereas wolves, as a group, were only successful in  
105 following the 'point and gaze' cues, and unlike dogs, no individual performed above  
106 chance in any condition. To address criticisms that the failure of wolves was due to  
107 differential experience with humans, researchers have raised wolves and dogs in  
108 matched rearing conditions but still report dogs consistently perform better than even  
109 highly socialised wolves on social cueing tasks (Miklósi et al. 2003; Kubinyi et al. 2007;  
110 Virányi et al. 2008).

111

112 Udell and colleagues (2010), however, disagree that the enhanced following of human-  
113 given cues in dogs is the result of genetic changes that occurred through the  
114 domestication process. They question the practice of testing wolves at the same  
115 chronological age as domestic dogs due to the protracted critical socialisation period of  
116 the latter (Goodwin et al. 1997). It may be therefore, that exposure to humans is  
117 ineffective at a certain age in wolves as they have moved out of their critical window  
118 whereas dogs of the same age would still respond due to their extended developmental  
119 trajectory. If these factors are not controlled in comparative studies, the assumption  
120 that both species have experienced identical rearing histories is questionable. That data

121 from wolf/dog comparisons are inconsistent lends support to this argument, with Udell  
122 et al. (2008) demonstrating that with extensive socialisation, wolves can follow a  
123 momentary distal point (where arm is extended in a point gesture towards a target,  
124 with tip of finger remaining >50cm away from the object, and then arm is relaxed  
125 before subject makes a choice) as well as pet dogs, with more individual wolves  
126 performing above chance.

127

128 Results such as these have led some researchers to conclude that genetic influences on  
129 social cognition in domestic dogs are negligible, instead proposing a 'Two-Stage  
130 Hypothesis' that suggests willingness to accept humans as social companions acquired  
131 early in ontogeny, and opportunity to learn an association between limbs of human  
132 companions and reinforcement are necessary conditions to produce enhanced socio-  
133 cognitive skills (as measured by cue-following object-choice tasks) in canids generally  
134 (Udell et al. 2010).

135

136 It is plausible that both these explanations are correct. Intense selection, both natural  
137 and artificial, for desirable behaviours in dogs has likely resulted in the emergence of  
138 ESCs (Miklósi and Topal 2013). This makes dogs more adapted to follow social cues  
139 provided by human caregivers that manifests as greater 'preparedness' to exploit  
140 information provided by humans in comparison to wild canids. However, these abilities  
141 are still moderated by individual ontogenetic experiences (DSCs) and can manifest  
142 without the presence of ESCs with sufficient exposure, as in human-socialised wolves  
143 (Udell et al. 2010). This suggests that the cognitive capacity is present in wolves and



144 dogs but in the latter, the threshold of human socialisation may be lower due to the  
145 presence of evolved adaptations to accept humans as social companions.

146

147 Support for this more synergistic approach to understanding domestication comes from  
148 Gácsi et al. (2009) who demonstrate that human-reared wolf pups can perform as well  
149 as domestic dog pups with comparable rearing histories on simple proximate cue-  
150 following tasks (kneeling experimenter points towards a referent with the outstretched  
151 finger approximately 30cm from the cued object). However, their performance is more  
152 sporadic as a group due to the failure of some individuals to cooperate with their  
153 human handler (they struggled against restraint) and for those that could be tested,  
154 longer latencies to establish eye contact with the cue-giver. This lack of engagement  
155 with human cue-givers seemingly persists and accounts for their finding that at 4  
156 months of age, socialised wolves perform significantly worse than same-aged domestic  
157 dogs on more complex momentary distal pointing tasks. In adults, performance across  
158 the two groups is indistinguishable on the cue-following task although adult socialised  
159 wolves continue to struggle against restraint and take longer to focus on the cue-giver.  
160 Gácsi et al. interpret this as support for an evolved adaptation in dogs for attachment  
161 and acceptance of humans as social partners that results in selection for utilising  
162 human-given cues. In wolves, a compensatory developmental experience can also result  
163 in the emergence of similar socio-cognitive abilities despite differences in  
164 responsiveness to socialisation in wild canids.

165

166 That learning and experience moderate socio-cognitive skills in domestic dogs has been  
167 demonstrated in many contexts. Exposure to human partners has been shown to

168 impact their behaviour. Barerra et al. (2011) compared pet dogs and those that were  
169 shelter-housed on duration of looking towards an unfamiliar human. Dogs were firstly  
170 reinforced every time they looked at the human in an acquisition phase, and then the  
171 behaviour was extinguished by removing the reward. It was predicted that shelter dogs,  
172 as they had less experience of humans being the source of reinforcers, would gaze less  
173 at the human than pet animals. Although this did not emerge in the acquisition trials,  
174 much greater durations were evident in pet dogs in the extinction trials indicating that  
175 pets were more persistent in monitoring human behaviour even when reward was not  
176 forthcoming (likely due to the intermittent reward schedule experienced by most pet  
177 dogs during daily interactions with humans - i.e. their behaviour is not always  
178 rewarded).

179

180 The relationship between a dog and human partner also affects performance. Horn et  
181 al. (2013) showed that dogs would attend to the actions of a human (measured by  
182 duration of looking at the model) for significantly longer if they had a close relationship  
183 with them, for example, if the model was their owner. Familiarity also promotes cue  
184 following on an object-choice test (Elgier et al. 2009). Here dogs were exposed to a  
185 pointing gesture given either by their owner or a stranger that led to a food reward  
186 hidden in one of two containers. Once they were reliably following the cue, the reward  
187 was removed in an extinction phase. Dogs in the owner-given condition took longer to  
188 extinguish the cue-following response than those who saw an unfamiliar human giving  
189 the cue. In a second reversal phase, where the indicated container did not contain the  
190 reward, dogs cued by their owners learned significantly faster than those in the  
191 stranger-cued condition. Taken together, these results suggest that information given

192 by a familiar human is more salient to dogs and is attended to more, even in the  
193 absence of a reward. This increased attention seemingly facilitates learning and  
194 augments performance.

195

196 As well as social familiarity, the type of interactions between dog and human may affect  
197 behaviour in a communicative setting. Dogs that are trained to perform particular tasks  
198 in response to human-given cues may interpret human actions differently than those  
199 with no or minimal training, and have more opportunity to learn the relationship  
200 between humans and reinforcement. Highly trained dogs (those trained to compete in a  
201 sporting event or as working dogs), were more successful at a box opening puzzle,  
202 interacting more with the apparatus than untrained (pet) dogs that spent significantly  
203 more time looking back at their owners as if soliciting 'help' with the task (Marshall-  
204 Pescini et al. 2008). This was further confirmed in a follow-up study where highly  
205 trained (agility and search and rescue) dogs were compared to untrained dogs on an  
206 'unsolvable' task. Again, pet dogs looked towards the humans present in the room  
207 (owner and experimenter) more than dogs trained in search and rescue (Marshall-  
208 Pescini et al. 2009); however, agility training significantly increased gaze duration  
209 directed towards human partners over other groups. It therefore seems likely that some  
210 types of training increase 'independence' of dogs and this may reduce the likelihood  
211 they will follow human given cues, particularly if they have better information (such as  
212 when the human cue is deceptive – Scheider et al. 2013), while other types of training  
213 strengthen the reliance on humans to direct behaviour, making human-given cues  
214 potentially more relevant.

215 Regardless of how training influences behavioural style, it is likely that engaging in  
216 training of any kind provides the dog with extended opportunity to learn that humans  
217 are a potential source of reward. When training occurs between dog and primary care-  
218 giver, the increased communicative interaction inherent in any training programme  
219 could make the owners' behaviour more salient and attended to than for pet dogs with  
220 only minimal training or shelter-housed dogs with no regular human contact. These  
221 differences may manifest in a cue-following task with highly trained dogs being more  
222 likely to follow human-given cues than pet or shelter dogs. This variability would be  
223 independent of any ESCs that are derived characteristics common to all dogs, but would  
224 attest to the effects that experience has on socio-cognitive skills in domestic dogs.

225 This study investigates the effect of training on cue-following in human-dog dyads when  
226 the cue-giver is familiar (owner) or unfamiliar (stranger). Responses of dogs that had  
227 increased opportunities to associate human actions with reinforcement due to intensive  
228 training regimes, were compared to dogs that had undergone basic training (pet dogs)  
229 and those that demonstrated only minimal or no following of basic commands with no  
230 bond to a significant human due to residence in an animal shelter, on three cue types;  
231 'point and gaze', 'point only' and 'gaze only'. It was predicted that due to increased  
232 opportunity to learn that humans are a source of reward, dogs that experienced  
233 intensive training would follow more human-given cues than un-trained shelter. We  
234 also expected a difference in the number of cues followed in trained and pet dogs  
235 dependent on familiarity with the cue-giver and that all dogs would follow more cues  
236 where gaze orientation and gesture were combined and congruent, potentially  
237 strengthening the signal compared to when only gesture or gaze were presented alone.

238

239 **Methods**

240 Subjects

241

242 Subjects were 30 adult dogs (*Canis familiaris*) that were living as pets or were resident  
243 in Bandeath Dogs Home in Stirling, Scotland. Six dogs did not take part in all trials as  
244 they failed to attend to the task on multiple occasions or they became too anxious  
245 during testing to respond. They were therefore excluded from the analyses leaving a  
246 sample group of 11 females (mean ( $\pm$ SD) age = 3.5(2.121) yrs) and 13 males (mean  
247 ( $\pm$ SD) age = 3.36(1.737) yrs) (Table 1). Age did not differ significantly between sexes  
248 (Kruskal-Wallis independent samples:  $\chi^2(1) = 0.014, p = 0.905$ ).

249

250 **TABLE 1 ABOUT HERE**

251

252 Subjects were divided according to training background into three groups of eight dogs  
253 (Table 1). Highly Trained (HT) group; subjects had been conditioned for specific activities  
254 such as retrieval in hunting or flyball since an early age by their owner and would  
255 participate in these activities at least once per week. Whereas some training regimes  
256 such as search and rescue seemingly foster independence in dogs, these activities were  
257 assumed to increase reliance on human-given instruction and so should increase  
258 awareness of the owners' behaviour facilitating attendance to potentially  
259 communicative cues. These dogs were given free access to the house but in some cases,  
260 were housed in outdoor kennels overnight. Trained (T) group; subjects were pet dogs  
261 that had lived in the owner's home for the greater part of their lives (since leaving their  
262 mothers). All subjects were kept for companionship and basic training had been given

263 so they could reliably sit and stay, understand 'no' and follow simple commands such as  
264 'fetch', 'come' or 'down'. Shelter (S) group: subjects were abandoned dogs from a  
265 shelter and no specific training was evident during behavioural assessments at the  
266 shelter, although histories of these dogs were not always known.

267

268 All subjects were over one year of age, resident in the shelter for a minimum of four  
269 weeks and in sound health. All shelter dogs were assessed prior to testing; anxious or  
270 aggressive dogs or those with a known history as a working or highly trained dog, even if  
271 this was not evident during the behavioural assessments at the shelter, were not  
272 included in the group. All subjects, with the exception of three dogs, were unfamiliar to  
273 the experimenter (MFR) who acted as the 'stranger' for the highly trained and trained  
274 group (a second experimenter unfamiliar to the three remaining dogs acted as the  
275 stranger for these subjects). The owner was used in all tests as the familiar cue giver.  
276 For the shelter group, only cues from an unfamiliar human (MFR) were presented.

277

278 Experimental set up

279

280 Shelter dogs (S group) were tested in a room at the animal home that was unfurnished  
281 and of sufficient size to accommodate the experimental apparatus. Owned dogs (HT  
282 and T groups) were tested in a contained room at their home that provided adequate  
283 space and as few distractions as possible. In all cases, dogs were given time to  
284 familiarise themselves with the room, apparatus and experimenter before the test  
285 began by allowing them free roam for approximately 5 minutes. Once the dog appeared  
286 comfortable in its surroundings, trials began.

287

288 All trials were recorded on a video camera mounted on a tripod directly behind the cue  
289 giver for later behavioural coding. Two orange plastic cups acted as the referents and  
290 were placed upturned approximately two metres apart on the floor to the fore of the  
291 cue-giver who was positioned equidistant from each cup. No food rewards were placed  
292 in the cups to avoid possible odour cues; however, dog treats were used to gain the  
293 dogs' attention (see procedures below).

294

295 Procedures

296

297 Dogs were brought into the testing area by either the owner or the shelter staff. The  
298 referents and video camera were in position when the dog entered and was given time  
299 to acclimatise to the testing situation. For shelter dogs, the staff member would then  
300 leave the room and only the unfamiliar cue-giver (MFR) remained. The staff resources at  
301 the shelter did not allow for staff to stay throughout testing. Therefore, only one human  
302 was in the room during trials for this group. For homed dogs, the owner and unfamiliar  
303 cue-giver remained during all trials. The dogs were not restrained during any part of the  
304 test. Once the dog had settled in the test area, the cue-giver (either 'owner' or  
305 'stranger') encouraged the dog to the starting position on the opposite side of the room  
306 from where the cues would be presented. For the highly trained and trained groups, the  
307 human not acting as the cue-giver stood silently in a central position behind the dog.  
308 Food rewards were used to attract the dogs' attention and commands such as 'sit' and  
309 'stay' were used to keep the dog in the starting position while the cue-giver moved into  
310 place between the referents on the opposite side from the subject. Once the dog and

311 cue-giver were in their starting positions, ostensive cues such as calling the dogs' name  
312 to attract their attention were used, and when the dog oriented towards them, the cue-  
313 giver produced the cue.

314

315 All subjects received three types of cue. '*Point and gaze*' cues where the human used  
316 momentary distal pointing (ipsilateral arm outstretched in a pointing gesture with the  
317 tip of the finger being >50cm from the referent), accompanied by head turn and eye  
318 gaze directed down towards one of the two referents. The cue was presented for 5  
319 seconds and then the arm was relaxed back to the body and head and eye gaze aligned  
320 forward (see Pongrácz et al. (2013) for a discussion of the effects of different pointing  
321 protocols). '*Point only*' cues were as above except the head and eye gaze remained  
322 straight forward throughout. '*Gaze only*' cues were when head and eye gaze were  
323 directed down towards one of the referents for 5 seconds before returning to a forward  
324 position with no pointing gesture given. To minimise the opportunity for dogs to utilise  
325 additional subconscious cues provided by either the cue-giver or owner, no eye contact  
326 between the dog and the human/s occurred during cue presentation or any vocal  
327 communication between humans or between human and dog. Instructions for the cue-  
328 givers were to keep eyes directed centrally and upwards, and body position facing  
329 forward and still for two seconds before presentation of the cue and to return to this  
330 position afterwards.

331

332 Dogs in the highly trained and trained groups received seven trials of each cue type  
333 given by their owner, and seven of each cue type given by a stranger. Trials were  
334 presented in blocks of seven with the cue type held constant in each block. However,



335 the order or cue types and cue-giver were randomised across subjects. The shelter  
336 group only received cues from a stranger, with seven of each cue type given in three  
337 randomised blocks. Inter-trial interval was a minimum of 5 seconds. If dogs' motivation  
338 remained high, blocks were run consecutively. If the dog became distracted, the cue-  
339 giver used a food reward to attract their attention and led them back to the start  
340 position. If this failed to regain focus, a short break was taken during which time, the  
341 experimenter or owner would interact with the dog, and then trials resumed. All dogs  
342 included in the analyses completed the requisite number of trials.

343

344 Rewards were not used to reinforce cue-following behaviour, nor was food present in  
345 the cued referent or the cue-givers hand at any point during cue presentation, and no  
346 pre-training was given. This was done to minimise the effects of associative learning.  
347 Thus, whether dogs chose to move towards the cued object was not based on the  
348 expectation of finding immediate reinforcement, instead representing their tendency to  
349 attend to, and visually monitor human cues.

350

351 Behavioural scoring

352

353 Dogs' responses were later coded from the video footage by MFR, with approximately  
354 20% of 'point and gaze' cues from highly trained and trained dogs being scored by a  
355 second coder (CLC). A positive response was documented (the dog selectively attended  
356 to the cued referent) if the dog turned its head by at least 45 ° to the right or left (in the  
357 direction of given cue) and down towards the stimulus. This differs from the active  
358 choice response used in most studies of human-given cue following by domestic species

359 as we did not require the dog to act on the signal and move towards the referent. Our  
360 question was whether level of training and/or familiarity with the cue-giver would  
361 increase dogs' attention to human behaviour as demonstrated by them visually  
362 following a social signal provided by a human partner. This does not require the subject  
363 to follow that cue to locate an object, only to show they have attended to it. In addition,  
364 by scoring only the attention to the cued object, we remove the possibility that dogs  
365 were moving to the cued location as an obedient response.

366

367 We did not differentiate between a null-response and an incorrect choice and this was a  
368 potential oversight. However, in cases where no choice was made, the dogs either  
369 continued to look at the cue-giver or moved attention away from both referents and  
370 the cue-giver. As the research question is whether dogs will attend to and follow a  
371 potentially communicative gesture provided by a human partner, only whether they  
372 did, or did not do this is relevant. That we do not know whether they were looking at  
373 the un-cued cup or somewhere else in the room does not detract from the results using  
374 this paradigm. Inter-observer reliability for the head-turning response was 89% with all  
375 disagreements being due to the stricter interpretation by the primary coder (MFR)  
376 whose data are used in all further analyses.

377

378 Data analyses

379

380 Total number of cues followed in both the owner- and stranger-given conditions did not  
381 deviate from normality for any group (Shapiro-Wilk: Owner-given – HT;  $W(8) = 0.833$ ,  $p =$   
382  $0.064$ , T;  $W(8) = 0.973$ ,  $p = 0.921$ : Stranger-given – HT;  $W(8) = 0.911$ ,  $p = 0.362$ , T;

383  $W(8)=0.932, p = 0.533, S; W(8)=0.917, p = 0.408$ ). For 'gaze only' cues given by owner,  
384 and all cue types given by stranger, data were not normally distributed mainly due to  
385 lower numbers of cues followed in these conditions (Fig. 1). We therefore report non-  
386 parametric tests where appropriate. An extension of generalized linear models (GZLM),  
387 generalised estimating equations (GEE) that accommodates correlated within-subjects  
388 data and allows for comparisons between subjects (Garson 2013), determined how  
389 training level influenced performance. Binary regression with 'events in trials' fixed was  
390 specified with number of positive responses to each cue type as the response variable.  
391 Training group was a factor in the model and age, a covariate. We controlled for age in  
392 the model as this may be an indicator of opportunity to learn that humans are a source  
393 of reinforcement, with older animals being more attentive to human given cues by  
394 virtue of this increased ontogenetic experience. Alternatively, younger individuals may  
395 have been more interested and attentive to the objects; young individuals are reported  
396 to engage in more investigatory behaviour with objects than do adults (Glickman and  
397 Sroges 1966; Menzel 1969).

398

399 GEE models were run to compare the total number of cues followed in the owner-given  
400 and stranger-given conditions in the highly trained and trained groups, the number of  
401 each cue type followed in the owner-given condition for the highly trained and trained  
402 groups, and the number of each cue type followed in the stranger-given condition in the  
403 highly trained, trained and shelter groups. All tests were two-tailed and alpha was set  
404 at 0.05.

405

406

407 **Results**

408

409 The number of cues followed by dogs was influenced by the type of cue provided. In the  
410 owner-given condition, significant differences were evident between the number of  
411 positive responses from the highly trained and trained dogs (Fig. 1, Friedmans:  $\chi^2$  (2, N =  
412 16) 27.964,  $p < 0.001$ ), with very few responses (N = 11) being given when the 'gaze  
413 only' cue was provided. In the stranger-given condition, the same pattern was seen with  
414 only eight positive responses scored to the 'gaze only' cue (Fig. 1, Friedmans:  $\chi^2$  (2, N =  
415 24) 34.024,  $p < 0.001$ ). The total number of cues followed in the owner-given and  
416 stranger-given condition in the highly trained and trained group differed significantly,  
417 with dogs more likely to follow signals directed towards the referent when presented by  
418 a familiar individual (B = 0.802,  $\chi^2$  (1) = 10.062,  $p < 0.001$ ). Training group did not  
419 influence performance (B = -0.152,  $\chi^2$  (1) = 0.040,  $p = 0.842$ ), nor was age a significant  
420 covariate (B = -0.72,  $\chi^2$  (1) = 1.286,  $p = 0.257$ ).

421

422 **FIGURE 1 ABOUT HERE**

423

424 In the highly trained and trained groups, significant effects were seen in the number of  
425 each cue type followed. Dogs followed significantly more cues that incorporated a  
426 gesture ('point and gaze and 'point only') than they did cues where only eye direction  
427 signalled the referent (gaze only) (Table 2). Pairwise comparisons revealed no  
428 differences between the number of responses made in the 'point and gaze' and 'point  
429 only' conditions when the cue-giver was familiar ( $p = 0.250$ ) or when the subject did not  
430 know the cue-giver ( $p = 0.296$ ). In the 'point only' condition, there were significant

431 differences in the number of cues followed dependent on whether the cue-giver was  
432 familiar or unfamiliar ( $p < 0.01$ ), with more cues being followed in the owner-given  
433 condition (Fig.1). For the 'gaze only' presentations, no significant effects were revealed  
434 based on familiarity of the cue-giver ( $p = 0.675$ ). Significantly less cues were followed  
435 when only gaze was presented compared to the combined 'point and gaze' or 'point  
436 only' cue in both familiar and unfamiliar cue-giver conditions ( $p < 0.01$  for all  
437 comparisons). Training group had no effect on responses given (Table 2). Age remained  
438 non-significant in these analyses and is therefore dropped from the final model.

439

440 TABLE 2 ABOUT HERE

441

442 Including the shelter dogs in the GEE for the unfamiliar cue-given condition revealed a  
443 similar pattern of results in relation to the effects of cue type. Training group again was  
444 non-significant, with shelter dogs performing as well as the highly trained group ( $B = -$   
445  $0.122$ ,  $\chi^2(1) = 0.069$ ,  $p = 0.793$ ) and the trained group ( $B = 0.166$ ,  $\chi^2(1) = 0.232$ ,  $p =$   
446  $0.630$ ). Significant effects of cue type were evident with dogs responding more to the  
447 cues incorporating a gesture than when gaze direction alone signalled the referent  
448 (Point and gaze;  $B = 3.542$ ,  $\chi^2(1) = 49.059$ ,  $p < 0.001$ ; Point only;  $B = 3.171$ ,  $\chi^2(1) =$   
449  $31.199$ ,  $p < 0.001$ ). Pairwise comparisons revealed no significant differences between  
450 'point and gaze' and 'point only' cue types ( $p = 0.113$ ).

451

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454

455 **Discussion**

456

457 'Point and gaze' and 'point only' cues appeared easier for all dogs to follow than gaze  
458 presented alone. Incorporation of gesture into the signal particularly when combined  
459 with a congruent head and eye direction potentially made the signal easier to detect  
460 and could have strengthened the communicative intent of the cue-giver, facilitating  
461 cue-following. Previous work has shown that dogs are able to follow eye gaze cues  
462 towards a referent that concealed a food reward (Soproni et al. 2001; Call et al. 2003);  
463 however, in the absence of food reinforcement, they do not follow eye alignment of a  
464 human partner (Agnetta et al. 2000). Food rewards were not present in this study and  
465 dogs were not required to move towards the cued location. This, accompanied by a  
466 'weakening' of the signal in the 'gaze only' condition, may have reduced the likelihood  
467 that dogs would direct attention according to the presented cue. Had reinforcement  
468 been available at the cued referent, motivation to look in the cued direction may have  
469 been greater.

470

471 Contrary to predictions, whether the dog was highly trained did not influence the  
472 number of cues followed irrespective of whether the cue-giver was familiar or  
473 unfamiliar. In addition, shelter dogs (S group) showed no detriment in performance in  
474 comparison to pet (T) or highly trained (HT) dogs. Udell et al. (2008) provided evidence  
475 shelter housing was detrimental to dogs' performance on cue-following tasks suggesting  
476 that socio-cognitive skills are dependent on opportunity to learn humans are a source of  
477 reinforcement. However, a reanalysis and follow-up study by Hare et al. (2010)  
478 indicated that shelter dogs were as skilled at using a variety of cue types as pet dogs,

479 supporting their proposition of this being a derived cognitive skill. That the shelter dogs  
480 tested here performed at the same level as pet dogs suggests the presence of an ESC  
481 that emerges with only minimal learning opportunity. However, some caution is  
482 required as the histories of the shelter dogs were not known. It may be that these  
483 animals had lived for prolonged periods in a human home with sufficient ontogenetic  
484 experience to produce cue-following behaviour in line with levels demonstrated by pet  
485 dogs. There were also some differences in methods when testing shelter dogs that  
486 could have impacted their performance. For example, there was only one 'unfamiliar'  
487 human in the room during the test compared to two people present in the highly  
488 trained and trained group. Shelter dogs were also tested in a room where they had not  
489 spent significant amounts of time. However, both these factors were likely to have  
490 impaired performance rather than improved it and as there were no significant  
491 differences in cue following responses compared to the pet and trained dogs, the  
492 effects of these differences were likely minimal. We do however think it would have  
493 been a useful comparison to include a familiar care-giver from the shelter in further  
494 study; this may have elucidated how much familiarity is necessary to promote cue  
495 following behaviour.

496

497 Despite the potential confounds in data from shelter dogs, the relationship between  
498 level of training and cue following behaviour did not emerge in the highly trained and  
499 trained groups. It was predicted participation in an intensive training programme (HT  
500 group) would increase the reliance on human-given cues providing greater  
501 opportunities to learn the association between human cues and reinforcement. That no  
502 differences were evident between the performances of highly trained dogs and those

503 with just basic training implies that these assumptions were at least in part, incorrect.  
504 There were significant differences between the number of cues followed in both the  
505 highly trained and trained group dependent on whether the cue-giver was the owner or  
506 a stranger suggesting that familiarity has an important influence on cue following  
507 behaviour. However, intensive training does not seem to augment this relationship or  
508 provide additional learning opportunities that increase the salience of human-given  
509 cues any more than general exposure and minimal training as experienced by  
510 companion dogs living in the owner's home. The effects of training on socio-cognitive  
511 skills in dogs have been inconsistent in the literature (Marshall-Pescini et al. 2008; 2009)  
512 sometimes increasing dog's attentiveness to human companions and at others,  
513 fostering independent behaviour. To further elucidate the relationship between training  
514 and cue-following, more research is needed on how training experience changes  
515 cognitive functioning and whether increased joint activity between dog and owner  
516 really does augment attention to human-given cues.

517

518 There is still some debate about whether dogs interpret a pointing gesture as an  
519 intentional communicative act, or whether they become conditioned through an  
520 association between human limbs and reinforcement to go towards an out-stretched  
521 hand (Scheider et al. 2013). In this research, we avoided pairing the point gesture with a  
522 food reward to limit the opportunity during the trials to form a stimulus-reward  
523 association. However, dogs may still have been conditioned to make this link in their  
524 previous dealings with humans that they then generalised to the testing situation.  
525 Although we did not require dogs to move to the cued location to try and minimise the  
526 possibility that they would interpret the gesture as a command, they may still have



527 followed the direction of the cue in anticipation of being expected to move to that  
528 location by an authority figure. However, a recent study by Scheider et al. (2013)  
529 demonstrated that dogs do not seem to see pointing as an imperative command  
530 ordering them to a particular place. Although they would follow a point cue that  
531 targeted a location where food was hidden, if the cue gave false information, guiding  
532 them to a location they knew to be empty, dogs were less likely to follow it. They  
533 responded in the same way when the authority of the cue-giver was varied (owner  
534 versus a young child), suggesting they did not interpret the gesture as requiring an  
535 obedient response. As the dogs here were not expected to move to the targeted area,  
536 it is unlikely they saw the cue as an order. Whether or not they were aware of the intent  
537 of the cue giver, it seems likely the movement by the human partner drew their  
538 attention to a particular area that, based on past experience with humans, could be  
539 worthy of at least visual investigation.

540

541 The response we used (head turn) differs from that used in much of the social cognition  
542 research with domestic dogs. We deliberately decided to score only attention to the  
543 cued referent rather than an active choice such as movement towards the signalled  
544 reward. This was because our question asked whether training and familiarity increases  
545 monitoring of human behaviour as demonstrated by visual following of a human-given  
546 cue. Thus, the underlying cognitive processes that produce head orientation towards  
547 the cued location potentially differ from the mental procedures that underpin active  
548 cue following used in previous work. In our study, only comprehension of the  
549 directionality of the human cue and experience that monitoring human cues can be  
550 beneficial are necessary. If the scored response requires the subject to move towards

551 the cued object, there is some inference that the human partner intends to  
552 communicate a location that should be investigated or that the human is 'commanding'  
553 the dog to move to a particular place. This potentially induces an obedient response  
554 from the dog (Elgier et al 2009) rather than representing their ability to exploit human  
555 cues for their own benefit. It is therefore possible that monitoring human cues as in the  
556 current study is a better indicator of dogs' ability to use human cues advantageously.

557

558 One confound that we did not investigate was the possible variability in cue  
559 presentation by the cue-givers. Although we tried to minimise individual differences by  
560 giving clear instructions to owners and keeping the 'stranger' constant across the  
561 majority of trials, Hauser et al. (2011) demonstrate that considerable variation can still  
562 exist that could potentially provide subconscious cues to the subject or bias responses.  
563 In future studies, behavioural coding of human partners should be included to ensure  
564 consistency in human performance and neutrality in behaviours produced during cue  
565 presentation.

566

567 In summary, this research suggests the presence of a derived ability to follow human-  
568 given cues in domestic dogs that can be augmented by familiarity between the human  
569 cue-giver and subject. It is therefore likely that evolutionary processes have resulted in  
570 a certain 'preparedness' to interact with human companions (ESC) that can be affected  
571 by ontogenetic experience to strengthen the relationship between human and dog  
572 (DSC). This manifests in increased socio-cognitive skills in dogs when the human social  
573 companion is familiar. Additional joint activity due to intensive training for competition  
574 however does not seem to further increase these skills over and above those gained by

575 daily exposure to humans as experienced by pet companion dogs living in an owner's  
576 home. Further research is needed to assess if and how training influences cognitive  
577 skills in dogs and the relationships between human-dog dyads.

578

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585

586

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