

The performance of domestic dogs (*Canis lupus familiaris*) on two versions of the Object Choice Task

Article (Accepted Version)

Clark, Hannah and Leavens, David A (2021) The performance of domestic dogs (*Canis lupus familiaris*) on two versions of the Object Choice Task. *Animal Cognition*. ISSN 1435-9448

This version is available from Sussex Research Online: <http://sro.sussex.ac.uk/id/eprint/97560/>

This document is made available in accordance with publisher policies and may differ from the published version or from the version of record. If you wish to cite this item you are advised to consult the publisher's version. Please see the URL above for details on accessing the published version.

Copyright and reuse:

Sussex Research Online is a digital repository of the research output of the University.

Copyright and all moral rights to the version of the paper presented here belong to the individual author(s) and/or other copyright owners. To the extent reasonable and practicable, the material made available in SRO has been checked for eligibility before being made available.

Copies of full text items generally can be reproduced, displayed or performed and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

The Performance of Domestic Dogs (*Canis lupus familiaris*) on Two Versions of the Object
Choice Task

Hannah Clark and David A. Leavens

School of Psychology, University of Sussex, Falmer, East Sussex, BN1 9QH

*Corresponding author: David A. Leavens, School of Psychology, University of Sussex,
Falmer, East Sussex, BN1 9QH; davidl@sussex.ac.uk

ORCID:

Hannah Clark: 0000-0002-6653-115X

David A. Leavens: 0000-0001-6538-4891

Keywords: object choice task; dogs; comparative cognition; domestication hypothesis

Acknowledgements

We thank the School of Psychology and the Doctoral School, University of Sussex for funding these studies. Dan Hyndman and Martha Casey provided technical support. We also thank the many pets and owners who volunteered their time for this study. We thank Kassandra Giragosian for assistance with reliability coding. Finally, we thank the Milton Village Community Association for generous and helpful access to their facilities.

Declarations

Funding: Hannah Clark was funded by the University of Sussex School of Psychology and Doctoral School.

Conflicts of interest/Competing interests: N/A

26 Availability of data and material (data transparency): Data is available on request from the
27 corresponding author.

28 Code availability: N/A

29 Authors' contributions: HC and DAL designed the experiment, HC collected the data,
30 conducted the analyses and wrote the manuscript. DAL edited the manuscript and advised on
31 analyses.

32

Abstract

33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56

Object Choice Task (OCT) studies are widely used to assess the phylogenetic and ontogenetic distribution of the understanding of communicative cues, with this understanding serving as a proxy for the discernment of communicative intentions. Recent reviews have found systematic procedural and methodological differences in studies which compare performances across species on the OCT. One such difference concerns the spatial configuration of the test set-up, specifically the distances between the two containers (inter-object distance) and the subject-experimenter distance. Here, we tested dogs on two versions of the task: a central version in which the containers were in the subjects' direct line of vision, and a peripheral version in which the position of the containers was distal to the subject. Half of the subjects were tested with a barrier in the testing environment (as nonhuman primates are tested) and the other half without. We found that dogs tested with a barrier performed significantly better in the central version and were more likely to fail to make a choice in the peripheral version. Dogs tested without a barrier showed comparable performance on the two versions. We thus failed to find support for the distraction hypothesis in dogs. We discuss potential explanations for this, highlighting how methodological differences in the presentation of the OCT can influence outcomes in studies using this paradigm.

57 Object Choice Task (OCT) studies are frequently used as evidence in support of
58 theories that appeal to evolutionarily derived socio-cognitive competencies in the
59 comprehension of deictic, referential gestures and the discernment of communicative
60 intentions, in a range of vertebrate species (e.g., Povinelli et al. 1997, 1999; Tomasello et al.
61 1997). The OCT is designed to assess an individual's ability to comprehend deictic cues, such
62 as pointing, and involves an experimenter baiting one of two or more containers and then
63 indicating the location of the hidden reward to the subject using a directive cue, such as
64 pointing or direct gaze. Over multiple trials, above-chance performance in selecting the
65 baited container constitutes evidence of subjects' comprehension of the communicative cue.
66 Interest in pointing comprehension abilities stems from gestural origins theories of language,
67 which assert that spoken language evolved from complex gestural communication developed
68 as an adaptive response to life on the savannah, after humans (*Homo sapiens*) separated from
69 the rest of the hominid lineage (Arbib et al. 2008; Corballis 1999). Specific focus is given to
70 declarative points, which are defined as points intended to direct attention (Bates et al. 1978),
71 distinguished from imperative points, which function to obtain a desired object; declarative
72 points have been linked to the emergence of joint attentional skills and language (Dawson et
73 al. 2004). The relative abilities of nonhuman primates, therefore, in comprehending pointing
74 cues have been widely studied, and their apparently poor performance (Herrmann et al. 2007;
75 Itakura et al. 1999; Kirchhofer et al. 2012; Povinelli et al. 1997, 1999; Tomasello et al. 1997)
76 used to suggest that the understanding of declarative points is, among primates, a human-
77 unique ability and, further, that it entails a suite of socio-cognitive skills such as theory of
78 mind (Baron-Cohen 1995), shared intentionality (Tomasello and Carpenter 2007) and
79 cooperation (Moll and Tomasello 2007) that other primates do not possess.

80 In contrast, domestic dogs' apparently consistently good performance on the OCT
81 (e.g. Riedel et al. 2007; Viranyi et al. 2008) has been used to promote domestication theories,

82 built on the premise that, through years of domestication, dogs have evolved specialised
83 socio-cognitive skills which endow them with the ability to comprehend human gestural and
84 other deictic cues (Hare and Tomasello 2005). Recent reviews draw into question both the
85 domestication hypothesis and the claims for human uniqueness in declarative cue
86 comprehension. They assert that a number of procedural confounds that are prevalent in the
87 comparative literature prohibit group-to-species generalisations which form the evidence base
88 for claims of species differences. For example, Lyn (2010) highlighted the importance of
89 rearing history in apes to their understanding of human communicative conventions.
90 Moreover, Lyn et al. (2010) demonstrated the importance of pre-experimental exposure to
91 humans in the development of pointing comprehension, finding that enculturated apes, who
92 have backgrounds rich in exposure to humans, display significantly higher success rates in
93 point-following than institutionalised apes with less pre-experimental history with humans.
94 Russell et al. (2011), whose ape samples were matched for age, sex and species, reported
95 similar results, with the enculturated sample performing at similar levels to those reported for
96 2.5-year-old human children in previous studies. Similar effects have been found for dogs:
97 those with less experience of human interaction than the typically tested pet dogs (e.g.,
98 kennel-raised or shelter dogs) demonstrate lower success rates on the OCT (D’Aniello et al.
99 2017; Lazarowski and Dorman 2015; Osborne and Mulcahy 2019; Udell et al. 2010).

100 Whilst ontogenetic factors have been shown to affect performance on the OCT,
101 Mulcahy and Hedge (2012) suggested that it may be methodological differences which better
102 account for the ape-dog disparities in performance compared with phylogenetic explanations.
103 They defined two versions of the OCT, the central version and the peripheral version. The
104 central version involves the subject, experimenter and containers being positioned such that
105 they are in close proximity, usually with subject and experimenter facing each other at a
106 small table on which the containers are placed. In the peripheral version, in contrast, the

107 subject and experimenter face each other at a distance of around 2m, both equidistant to the
108 containers which are placed on the floor, around 2m apart. They outlined two ways in which
109 the differential positioning of the testing apparatus may impact an individual's performance.
110 First, in the central version of the task, the subject has both the experimenter and the
111 containers in their direct line of vision. Thus, the salience of the containers, one of which
112 contains food (as the subject is aware), may distract the subject's attention away from the cue
113 being given. Second, in the peripheral version, the containers are placed at such a distance
114 that the subject must locomote to the container in order to retrieve the hidden reward. Such
115 extra effort required to obtain the hidden food may result in the subject paying increased
116 attention to the cue being given by the experimenter. In a review of OCT studies, Mulcahy
117 and Hedge (2012) argued that there is a tendency to test apes with the central version of the
118 task, and dogs with the peripheral, and this was supported by Clark et al. (2019), who, in a
119 review of 71 dog and ape OCT studies, found that dogs were tested with significantly greater
120 inter-container distances than nonhuman primates. Mulcahy and Call (2009) and Mulcahy
121 and Suddendorf (2011) both found increased performance by great apes when tested with a
122 peripheral rather than central version of the task, providing support for Mulcahy and Call's
123 (2009) assertion that this methodological difference can affect individuals' performance on
124 the OCT. Similarly, Clark et al. (2019) found inter-object distance to be positively correlated
125 with performance for both dogs and apes on a number of pointing cues on the OCT (differing
126 in duration, laterality and distance, as outlined by Miklósi & Soproni 2006), such that as
127 inter-object distance increased so did performance.

128 In the one study, to date, that has directly compared dogs' performances with the two
129 configurations of the OCT, Kraus et al. (2014) found that dogs performed above chance in
130 both versions, but that performance was significantly lower in the central version of the task.
131 Specifically, they found a success rate difference of 15% between the two conditions and

132 they noted the similarity with Mulcahy and Call's (2009) ape subjects whose performance in
133 the two conditions differed by 17%. Kraus et al. (2014) therefore argued that their results
134 provided support for the distraction hypothesis in dogs. Whilst Kraus et al. (2014) aimed to
135 match their study design as closely as possible to that of Mulcahy and Call (2009), it differed
136 in a number of ways, namely in the absence of test cages, the inter-object distances in the test
137 set-up, and in the point type presented. With regard to the first of these differences, in
138 Mulcahy and Call's (2009) study, the apes were tested from within a test cage, thus imposing
139 a barrier between the subject and the experimenter, and the subject and the containers. In
140 Kraus et al.'s (2014) study, dogs were not tested within test cages, a systematic cross-species
141 confound in testing environment that Leavens et al. (2019) and Clark et al. (2019) note is
142 prevalent in much of the comparative OCT literature. Clark and Leavens (2019) and
143 Kirchhofer et al. (2012) found that the imposition of a barrier into an OCT protocol can have
144 a detrimental effect on dogs' performances.

145 With regard to the configuration of the test set-up, the two studies differed in that
146 Kraus et al. (2014) used a peripheral inter-object distance of 140cm and a central inter-object
147 distance of 45cm, whereas Mulcahy and Call (2009) used distances of 250cm and 60cm,
148 respectively. This is a difference of more than a metre in the peripheral version, an important
149 factor to consider given previously mentioned findings that an increase in inter-object
150 distance was associated with an increase in performance on the OCT (Clark et al., 2019).

151 Finally, Kraus et al. (2014) presented subjects with an ipsilateral momentary proximal
152 point in both conditions, which involves presenting the pointing cue for three seconds before
153 retracting the hand (as per Miklósi and Soproni, 2006), with the distance between the
154 experimenter's finger and the container being around 20cm in the central condition and 30cm
155 in the peripheral condition. In comparison, Mulcahy and Call (2009) used a cross-lateral
156 dynamic pointing cue, which involves pointing across the body with the hand contralateral to

157 the correct container and maintaining the position until the subject makes a choice. The
158 distance between the experimenter's finger was approximately 100cm in the peripheral
159 condition (a distal point according to Miklósi and Soproni 2006) and 40cm in the central
160 condition (a proximal point). Miklósi and Soproni (2006) and Udell et al. (2013) have shown
161 that the laterality, duration of presentation, and the finger-tip-to-container distance can all
162 differentially affect performance on the OCT.

163 Given that the use of barriers in the testing environment in the form of cages, inter-
164 object distance, and point type have all been shown to differentially affect an individual's
165 performance, direct comparison between Kraus et al.'s (2014) dogs and Mulcahy and Call's
166 (2009) apes is subject to the effects of a number of confounds in the test setups. In the current
167 study, therefore, we aimed to replicate as closely as possible the testing conditions used by
168 Mulcahy and Call (2009) with a sample of pet dogs, in order to investigate further whether
169 differences in spatial configuration might affect the behavioural responses of dogs on the
170 OCT, with the additional manipulation of the presence of a barrier between dogs and targets.
171 We matched the spatial configuration and the point cue presented with those of Mulcahy and
172 Call (2009), and half of the dogs were tested within a child's playpen, designed to emulate a
173 cage following Clark and Leavens (2019). For control purposes, we also tested half of the
174 dogs without the playpen. This would allow us to distinguish between effects of the two
175 manipulations: to ascertain effects of the two configurations and effects of the imposition of
176 the barrier. As such, the study used a 2x2 design, with configuration as a within-subjects
177 variable and barrier as a between-subjects variable. We expect that, following Mulcahy and
178 Call's (2009) and Kraus et al.'s (2014) findings, the dogs' performance to be lower in the
179 central version of the task than in the peripheral version, and that performance in both
180 conditions will be lower in the presence of a barrier, in line with Clark and Leavens (2019)
181 and Kirchofer et al. (2012).

182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206

Method

Subjects

Twenty-six pet dogs (14 male, 12 female) took part in the study. Dogs ranged in age from four months to 12 years ($M = 4.0$ years, $SD = 3.1$) and comprised a variety of breeds (see Table 1 for individual subject and performance data). Dogs were recruited through advertisements placed on social media and face-to-face recruitment in a local park. None of the dogs had ever taken part in any studies before, however given that all of the subjects were pets, and thus exposed to rich human interaction on a daily basis, it is likely that all subjects were somewhat familiar with pointing gestures. The extent of individual subjects' familiarity with such cues or indeed with human interaction was a factor we were unable to control for. Subjects were tested individually by an unfamiliar experimenter, and testing took place in a local community hall. Subjects were randomly assigned to conditions prior to testing. Two dogs were excluded from the final analysis; one because she failed to complete testing due to being apparently highly anxious within the playpen, and the other because the video-recording of the test session was lost due to a technical error.

Materials and Set-up

The playpens used in the barrier condition were two Dreambaby Royal Converta 3-in-1 Playpen Gates, measuring 380 x 4 x 74cm (Dreambaby, Unit 53, Rosyth Business Centre, 16 Cromarty Campus, Rosyth, KY11 2WX, Scotland). The containers used to hide the bait were two opaque plastic cups. A premium commercial dry dog food was used for baiting the cups. All dogs were tested on a 1m long lead. All testing sessions were recorded on a Sony Handycam HDR-PJ410 video-camera (Sony, 1-7-1 Konan Minato-ku, Tokyo, 108-0075 Japan). In the central version of the task, the experimenter knelt at a distance of approximately 60cm from the subject and the distance between the two containers was 60cm; in the peripheral version, the subject-experimenter distance was approximately 110cm and

207 the inter-object distance was 250cm (see Figure 1). Because we exactly matched the relevant
208 distances to those in Mulcahy and Call (2009), therefore, by the Pythagorean theorem, all
209 angles between elements that were under experimental control would be identical to those in
210 their study.

211 **Procedure**

212 **Pre-test.**

213 On arrival at the hall, dogs were given time to explore the room, off lead, and the
214 experimenter interacted with the dog and offered them treats, in order for them to become
215 familiar with both the testing environment and the experimenter. The experimenter then
216 showed the dogs the cups, allowing them to sniff them, and then, in sight of the dog, hid a
217 treat under one of the cups, then showed it to the dog and gave it to them. This was repeated
218 twice to show the dog that the experimenter had treats, and that these could be found under
219 the test cups.

220 **Test.**

221 The owner was then asked to put the dog on a 1m lead and to stand with the subject
222 on a marked point in the test room (this was inside a playpen for dogs tested with a barrier;
223 for those tested without, it was the same location in the room but without the barrier
224 present—see Fig 1). The experimenter then baited both cups in view of the dog, saying
225 “*name... look*” as she hid a treat under each cup. The order of baiting was counterbalanced
226 across trials. She then returned to a point equidistant between the two cups, called the dog’s
227 name and established eye contact, then pointed to one of the cups using a cross-lateral,
228 dynamic pointing cue. In the central version, the distance between the experimenter’s finger
229 and the cup was approximately 40cm; in the peripheral version it was approximately 100cm
230 (Fig 1). The owner held the subject on the lead while the baiting took place and released the
231 lead when the experimenter pointed. The experimenter maintained the pointing cue until

232 either the subject made a choice (described below) or the trial timed out. If the subject made a
233 correct choice, the experimenter gave the subject the piece of food (if they had not already
234 retrieved it). Both dogs tested from within the playpen and those tested without were able to
235 retrieve the food reward- the gap between the bars was such that dogs were able to either
236 insert their snout and lift the cup or reach through with the paw to knock the container over
237 and retrieve the reward. If the subject made an incorrect choice, both pieces of food were
238 removed from the containers and the trial ended. If the subject failed to make a choice, the
239 trial ended after one minute. The beginning of the trial was counted from when the pointing
240 cue was presented and the subject was released to make a choice (after Udell et al. 2010b).
241 Subjects were given 4 trials per condition, with the order of conditions counterbalanced prior
242 to testing. The cued (correct) container was on the left or the right an equal number of times
243 and the order was pseudorandomised such that it never appeared on the same side for more
244 than two consecutive trials.

245 **Data Scoring**

246 All testing sessions were video recorded and coded at a later date. Trials were coded
247 for correct/incorrect response and response latency. Following Udell et al.'s (2010b)
248 recommendations, a correct response was categorised as one in which the subject first
249 touched or came within 10cm with their snout of the correct container. Any other response
250 was categorised as incorrect. Incorrect responses were further categorised into incorrect
251 choices, in which the subject first touched or came within 10cm with their snout of the
252 incorrect cup, and no choice, in which the subject failed to choose one of the cups before the
253 end of 1 minute.

254 **Reliability**

255 All trials were coded by the first author, and a second coder, who was blind to the
256 purposes of the study, coded a random sample of 20% of subjects' testing sessions; that is,

257 five dogs' testing sessions constituting 40 trials. For correct choices, there was 100%
258 agreement between the two coders, $\kappa = 1.00$, $p < .001$. There was excellent agreement for
259 whether or not the subject made a choice, $\kappa = .81$, $p < .001$, and for response latency, $r_s = .99$,
260 $p < .001$.

261 **Data Analyses**

262 Due to a lack of normal distribution in the data, all analyses used nonparametric tests.
263 Binomial tests were used to test for above-chance performance, Wilcoxon signed-ranks test
264 was used for the within-subjects comparisons and Mann-Whitney U tests were used for the
265 between-subject comparisons.

266 **Results**

267 **Age and Sex**

268 We found no relationship between age and performance (Spearman's $\rho = -.04$, $N =$
269 24, $p = .852$). In addition, we found no relationship between dogs' sex and performance
270 (Mann-Whitney $U = 51.00$, $p = .210$). Therefore, we do not further consider age or sex.

271 **Dogs Tested with a Barrier**

272 **Correct choices.**

273 As a group, dogs performed above chance in the central version of the task, (binomial
274 test, $p < .001$) but not in the peripheral version (binomial test, $p = .665$). Dogs chose the
275 correct container on a significantly higher proportion of trials in the central version ($Mdn =$
276 $.88$) than in the peripheral version ($Mdn = .50$) of the task, $Z = -2.46$, $p = .014$. This shows
277 that dogs tested with a barrier were more accurate in their responses in the central version
278 than in the peripheral version. Figure 2 shows the percentage of trials on which the dogs
279 tested with a barrier (a) chose the correct cup, (b) chose the incorrect cup, and (c) failed to
280 make a choice.

281 **Incorrect choice and no choice responses.**

282 There was no significant difference in the proportion of responses that were incorrect
283 choices between the central version ($Mdn = 0.00$) and the peripheral version ($Mdn = 0.00$) of
284 the task, $Z = -1.00$, $p = .317$. The proportion of trials on which the dogs failed to make a
285 choice was significantly lower in the central version ($Mdn = .00$) than in the peripheral
286 version ($Mdn = .50$), $Z = -2.27$, $p = .023$. This shows that the dogs were similarly likely to
287 make an incorrect choice in the two versions of the task, but that they were more likely to fail
288 to respond when the cups were placed further apart.

289 **Dogs Tested without a Barrier**

290 **Correct choices.**

291 As a group, the dogs performed above chance in both the central version
292 (binomial test, $p = .002$) and the peripheral version (binomial test, $p = .013$) of the task. There
293 was no significant difference in the proportion of trials on which the dogs chose the correct
294 cup between the central version ($Mdn = .75$) and the peripheral version ($Mdn = .75$) of the
295 task, $Z = -0.29$, $p = .774$. This shows the dogs tested without a barrier performed equally well
296 on both versions of the task. Figure 3 shows the percentage of trials on which dogs tested
297 without a barrier (a) chose the correct cup, (b) chose the incorrect cup, and (c) failed to make
298 a choice.

299 **Incorrect and no choice responses.**

300 There was no significant difference between the proportion of trials on which the dogs
301 made an incorrect choice between the central ($Mdn = .25$) and the peripheral version ($Mdn =$
302 $.13$), $Z = -0.14$, $p = .890$. There was also no significant difference between the proportion of
303 trials in which the dogs failed to make a choice between the central ($Mdn = .00$) and the
304 peripheral version ($Mdn = .00$), $Z = -378$, $p = .705$. This shows that there was no difference
305 between the type of incorrect responses the dogs exhibited between the central and peripheral
306 versions of the task, in the absence of a barrier.

307 **Barrier vs. No Barrier Comparisons**

308 **Correct Choices.**

309 On the central version of the task, there was no significant difference in the proportion
310 of trials in which the dogs chose the correct cup between those tested with a barrier ($Mdn =$
311 $.75$) and those tested without ($Mdn = .88$), Mann-Whitney $U = 58.5$, $p = .411$. Nor was there a
312 significant difference between those tested with a barrier ($Mdn = .50$) and those tested
313 without ($Mdn = .75$) on the peripheral version, Mann-Whitney $U = 42.00$, $p = .073$. This
314 shows that the dogs tested with and without a barrier chose the correct cups on a comparable
315 number of trials in the two versions of the task.

316 **Incorrect choice and no choice responses**

317 There was no significant difference in the proportion of trials in which dogs made
318 incorrect choices in the central version of the task between dogs tested with a barrier ($Mdn =$
319 $.00$) and dogs tested without a barrier ($Mdn = .25$), Mann-Whitney $U = 45.00$, $p = .075$. There
320 was also no difference in the proportion of incorrect choices on the peripheral version
321 between dogs tested with a barrier ($Mdn = .00$) and dogs tested without ($Mdn = .13$), Mann-
322 Whitney $U = 60.00$, $p = .434$. On the central version of the task, there was no difference in
323 the proportion of trials on which the dogs failed to make a choice between dogs tested with a
324 barrier ($Mdn = .00$) and dogs tested without a barrier ($Mdn = .00$), Mann-Whitney $U = 67.00$,
325 $p = .719$. On the peripheral version of the task, dogs tested with a barrier failed to make a
326 choice on a significantly higher proportion of trials ($Mdn = .50$) than dogs tested without a
327 barrier ($Mdn = .00$), Mann-Whitney $U = -2.41$, $p = .016$. This shows that the dogs tested with
328 and without a barrier exhibited comparable types of incorrect responses on the central version
329 of the task, but that dogs tested with a barrier showed an increased tendency to fail to make a
330 choice on the peripheral version.

331 **Order of Administration**

332 For dogs tested with a barrier, there were no effects of order of administration on the
333 proportion of correct choices in the central version (central first $Mdn = 1.00$; peripheral first
334 $Mdn = .75$), Mann-Whitney $U = 17.00$, $p = .930$, nor in the peripheral version (central first
335 $Mdn = .50$; peripheral first $Mdn = .50$), Mann-Whitney $U = 17.50$, $p = 1.00$.

336 For dogs tested without a barrier, there were no effects of order of administration on
337 the proportion of correct choices in the central version (central first $Mdn = .88$, peripheral
338 first $Mdn = .75$), Mann-Whitney $U = 14.50$, $p = .560$, nor in the peripheral version (central
339 first $Mdn = .63$; peripheral first $Mdn = .88$), Mann-Whitney $U = 12.00$, $p = .312$. This shows
340 that there were no order of administration effects for dogs tested with or without a barrier. .

341 **Trial by Trial Analyses**

342 For dogs tested with a barrier, there was no difference in the number of correct
343 choices across trials in the central version, Cochran's $Q = 3.00$, $p = .392$, nor in the peripheral
344 version, Cochran's $Q = 0.55$, $p = .909$.

345 For dogs tested without a barrier, there was no difference in the number of correct
346 choices across trials in the central version, Cochran's $Q = 1.44$, $p = .697$, or in the peripheral
347 version, Cochran's $Q = 6.14$, $p = .105$. This shows that both for dogs tested with and dogs
348 tested without a barrier, there was no effect of successive administrations on their tendency to
349 choose the correct container.

350 **Discussion**

351 We tested dogs on a central and peripheral version of the OCT, attempting to replicate
352 as closely as possible Mulcahy and Call's configurational manipulations in their study of 19
353 juvenile and adult apes (comprised of chimpanzees, bonobos and an orangutan). Here, we
354 failed to replicate their results with regard to configurational effects, finding that dogs tested
355 with a barrier (akin to the apes tested in cages in Mulcahy and Call's study) only performed

356 above chance in the central version of the task, in which performance was significantly
357 higher than in the peripheral version, and no effects of configuration for those tested without
358 a barrier, with dogs performing above chance in both configurational conditions. This
359 contrasts both with Mulcahy and Call's (2009) study with apes and with Kraus et al.'s (2014)
360 study with dogs, in which apes and dogs, respectively, demonstrated increased performance
361 in the peripheral version of the task. Whilst our aim in the current study, which was also the
362 aim of Kraus et al. (2014), was to replicate as closely as possible Mulcahy and Call's (2009)
363 testing conditions, there remain some differences in methodology between the three studies,
364 which could serve as explanations for the lack of replication of the configurational effects.
365 First, the scoring procedures used with apes and dogs differ as a function of species-specific
366 capabilities. With their ape subjects, Mulcahy and Call (2009) scored a correct choice when
367 the subject inserted their finger through a hole in the plexiglass window to touch the
368 container, whereas in both our study and Kraus et al.'s (2014) study, scoring procedures
369 followed those of Udell et al. (2010) in which a correct choice was deemed to be such when a
370 subject first touched or came within 10cm of the container. Given that in both the dog studies
371 the same scoring procedure was used, and that Kraus et al. (2014), using this scoring
372 procedure, replicated the configurational effects found by Mulcahy and Call (2009), we do
373 not think that this difference in scoring procedure between the present study and that of
374 Mulcahy and Call explains our failure to replicate their results.

375 A further difference between the studies is the reward that was offered to subjects
376 upon selecting the correct container- Mulcahy and Call (2009) used a flattened grape, Kraus
377 et al. (2014, p. 174) used "small pieces of commercial dog treat", and in the current study, we
378 used a premium commercial dry dog food. It may be that subjects were differentially
379 motivated to work for the different food stuffs offered, however, given that in all three

380 studies, subjects selected a container significantly more than they failed to make a choice, we
381 argue that subjects were motivated to work for the foods on offer.

382 A third difference between the studies is the baiting procedure used in each. In the
383 current study, the experimenter baited both cups in view of the subject, then presented a
384 pointing cue from an equidistant point. This differs from both Mulcahy and Call's (2009) and
385 Kraus et al.'s (2014) baiting procedures. In the former, one container was baited in view of
386 the subject, placed behind an occluder, followed by the second empty container being shown
387 to the subject, and then also being placed behind the occluder, before the experimenter either
388 switched or pretended to switch the position of the containers. In Kraus et al.'s (2014) study,
389 the experimenter baited the two containers "invisibly for test subjects" (p.175) covering the
390 baiting process with her body, then turned and simultaneously placed both pots on the test
391 table. Thus, the studies differ both in terms of the number of containers which were actually
392 baited and the visibility of the baiting procedure for the subjects. This could be a possible
393 explanation for why we failed to replicate the distraction effects of the central configuration,
394 however, given that subjects viewed both containers being baited in the current study, it could
395 be argued that having the containers at a closer proximity would thus then be more
396 distracting- two pieces of food easily within reach from which the subject must avert their
397 attention to attend to the cue, rather than one. We would expect then, if dogs were being
398 distracted by the salience of the containers, to see an increase in incorrect responses in the
399 central condition when both containers were baited in full view, but in the current study, we
400 found that, in fact, correct choices were more prevalent. An alternative explanation is that the
401 presence of two pieces of food heightened the dogs' focus on the cue- the salience of the food
402 reward may have been increased due to there being two pieces and therefore dogs may have
403 been more motivated to work for the reward. This possibility is one that could be explored in

404 future studies by using an alternative baiting method in which either baiting is occluded or
405 there is no food reward in either of the containers.

406 A further difference in the methodologies used in the studies is in the test set-up,
407 specifically the use of raised platforms to present the stimuli. In Mulcahy and Call's (2009)
408 study, ape subjects were tested sitting at a table, whereas in the studies with dogs, Kraus et al.
409 (2014) placed the containers on two raised platforms (stacked boxes), and in the current
410 study, the containers were placed on the floor. This means that the containers in the current
411 study were more easily within reach of most of the subjects, and thus, we would expect the
412 central version to be more distracting, which again contrasts with our findings.

413 Furthermore, the dogs in the current study were tested in the presence of their owner,
414 contrasting with Mulcahy and Call's (2009) subjects who were tested individually. Although
415 the presence of the owner could potentially influence the dogs' behaviour, we do not think
416 that this can explain the difference in findings reported between our study and those of
417 Mulcahy and Call (2009) and Kraus et al. (2014) because the dogs tested by Kraus et al.
418 (2014) were also tested in the presence of the owner, and also because previous studies have
419 found the presence of the owner, and even inadvertent cuing, to have little effect on dogs'
420 performance on the OCT (Hegedüs et al 2013; Schmidjell et al 2012).

421 In addition, the number of trials presented to subjects differs between the three
422 studies- Mulcahy and Call's (2009) ape subjects completed 24 trials per condition, Kraus et
423 al.'s (2014) dog subjects completed 12 trials per condition, and, in the current study, subjects
424 completed four trials per condition. This was following Clark and Leavens (2019) who found
425 significant differences in dogs behaviour and performance on an OCT when comparing dogs
426 tested with and without a barrier using four trials per condition also. Whilst testing subjects
427 on a greater number of trials per condition would result in more data on which to base our

428 analyses, given that Clark and Leavens (2019), and in the current study our trial-by-trial
429 analyses showed no differences across trials in dogs' responses, we do not believe this would
430 have a substantial impact on our findings.

431 Finally, the studies differ in the type of pointing cue presented to subjects. In the
432 current study, and in Mulcahy and Call (2009), a cross-lateral, dynamic pointing cue was
433 used, meaning the cue was in place until a subject made a choice, or the trial timed out,
434 whereas Kraus et al. (2014) presented their subjects with an ipsilateral, momentary proximal
435 pointing cue, meaning subjects were presented with the cue for just three seconds. As Miklósi
436 and Soproni (2006) highlight momentary and dynamic cues differ in terms of the memory
437 demands on subjects- with a momentary cue, the subject must attend to and remember the
438 direction of the cue, whereas with a dynamic cue, no such memory demands exist. It may be,
439 then, that dogs presented with a momentary cue are more likely to be subject to distraction if
440 the containers are in their direct line of vision, because not only must they attend to the cue
441 over the highly salient containers, they must also remember the direction of the cue and use
442 this to inform their response.

443 When comparing dogs tested with and without a barrier, we found no significant
444 differences in performance across the two versions of the task. This was surprising, given that
445 Kirchhofer et al. (2012) and Clark and Leavens (2019) found suppressive effects on
446 performance associated with the imposition of a barrier. On the central version of the task,
447 dogs tested with a barrier actually had a higher success rate, choosing the correct cup on 75%
448 of trials, than those tested without, who had a success rate of 69%. One explanation for this is
449 that the barrier perhaps reduces dogs' susceptibility to distraction- having the barrier between
450 the subject and the containers may decrease the salience of the cups and promote attention to
451 the cue. In contrast, in the peripheral version of the task, although there was no significant
452 difference, there was a trend towards poorer performance associated with the presence of a

453 barrier, and dogs both failed to perform above chance in the barrier condition, and failed to
454 make a choice on a significantly greater number of trials. This echoes the findings of Clark
455 and Leavens (2019) who found a similar increase in no choice responses when dogs were
456 tested with a barrier. Clark and Leavens (2019) suggested that this may be explained by the
457 Referential Problem Space (Leavens et al. 2005), that is, the barrier may increase perceptions
458 of the reward as being unobtainable (even though, it is, in fact obtainable). This perception
459 coupled with the extra effort associated with obtaining a reward which is placed far away
460 from the subject in the peripheral condition, may explain, in the current study, why the dogs
461 tested with a barrier failed to make a choice on 42% of peripheral trials. A related potential
462 future avenue for investigation would be to compare the performance of dogs raised in
463 alternative environments to pet dogs, specifically shelter or kennel dogs, who arguably would
464 have more experience with barriers (in the form of cages). Whilst previous research shows
465 that such groups typically perform more poorly on point-following tasks than pet dogs (e.g.
466 Lazarowski & Dorman 2015; Osborne & Mulcahy 2019; Udell et al. 2010), it would be of
467 interest to see what effects, if any, the imposition of a barrier in the testing environment
468 would have on their behaviour and performance.

469 Another possible factor to consider is the visual acuity of the individual and the extent
470 to which they may be able to see either the structure of the barrier (be that bars or wire mesh)
471 and the objects behind it, with this being influenced by the distance between the subject and
472 the apparatus as well as variables such as age and species (see Bard et al. 1995 for a
473 discussion of the development of visual acuity in chimpanzees, and Miller and Murphy 1995,
474 for a discussion of visual acuity in dogs).

475 There are some limitations to the current research, the first of which is our modest
476 sample size of 24 subjects. Although a sample size greater than this may be preferable, here
477 our objective was to investigate the generalisability of the configuration effects found by

478 Mulcahy and Call (2009) whose sample consisted of 19 subjects. Given that Mulcahy and
479 Call (2009) found an effect with this size sample, we think that our use of 24 subjects is
480 comparable in power to that of the original study. Our intention in this study was not to
481 demonstrate a species proclivity, but to investigate the effect of an experimental manipulation
482 on a sample of comparable size, but a different species, to that studied by Mulcahy and Call
483 (2009). We do, however, acknowledge that an interesting future direction would be to study
484 the effect of this manipulation with a greater sample of dogs.

485 In addition, as an anonymous reviewer helpfully pointed out, the dogs tested were of a
486 wide range of ages, thus representing various life history stages. In their original study,
487 Mulcahy and Call (2009) found an effect of configuration on performance on the OCT with a
488 sample of apes which included both juveniles and adults (specific ages were not specified).
489 We therefore reasoned that if this effect of configuration generalises to dogs, we should be
490 able to find a comparable effect with a comparable sample, which also includes both juvenile
491 and adult subjects. Furthermore, our sampling of dogs is in line with Dorey, Udell & Wynne
492 (2010) and Udell et al.'s (2013) assertions that there is no detriment to performance
493 associated with age for dogs aged four months and over. It is consistent with age sampling in
494 other dog OCT studies in the literature (e.g. Clark & Leavens, 2019; Hare & Tomasello,
495 1999; Udell, Dorey & Wynne, 2008; Udell et al., 2010). Notwithstanding, we do
496 acknowledge that this is a legitimate point which warrants further investigation. As noted by
497 Leavens et al. (2019), a lack consideration of a subject's life history stage when comparing
498 across species is a prevailing issue in the animal cognition literature, and it may well be that
499 puppies and seniors perform in systematically different ways to adult dogs. Whilst our
500 objective in the current study was to investigate the generalisability of the configurational
501 effects found by Mulcahy and Call (2009), and therefore our sampling was consistent with

502 their ape sampling, we recognise that an interesting future direction would be to investigate
503 the potential effects of life-history stage.

504 A final limitation of the current study is our baiting method, specifically the choice to
505 bait both containers prior to presenting the cue. This method was used in order to control for
506 possible olfactory cues associated with baiting one container only. A drawback of this
507 method is that some dogs were able to retrieve the food reward even when an incorrect choice
508 was made. We do not believe, however, that this has had a substantial effect on our results,
509 first because dogs tested without a barrier, and thus with easier access to the containers to
510 retrieve the rewards, performed above chance in both the central and peripheral versions of
511 the task demonstrating that they were attentive and responsive to the cue being given.
512 However, we recognise that this method of baiting may have influenced dogs' behaviour, and
513 as such we would recommend a method more akin to that used by Udell et al. (2013) in
514 which food was not contained within or on the containers used until the subject made a
515 choice. This allows olfactory cues to be controlled for whilst also eliminating the possibility
516 of inadvertent reinforcement of incorrect choices.

517 We did not find support for the distraction hypothesis in dogs tested either with or
518 without a barrier, for the former, in fact, the central version facilitated performance, and for
519 the latter, that performance was comparable. This contrasts with Kraus et al.'s (2014)
520 findings and further highlights the effects that cue types may have on performance, as noted
521 by Miklósi and Soproni (2006) and Udell et al. (2013). Indeed, an interesting future direction
522 would be to further investigate how configuration and cue type may interact to affect
523 subjects' performance. This could be done by testing dogs across a range of cue types
524 differing in their distance and temporal properties, similarly to Udell et al. (2013), using both
525 a central and a peripheral configuration.

526 We found the presence of a barrier to affect behavioural responses in the peripheral
527 version, and a statistically non-significant trend towards this finding in the central version
528 which echoes Clark & Leavens' (2019) findings in which greater sample sizes were used.
529 In conclusion, here we found a complex interaction between two environmental influences
530 on performance in dogs, with responses to central and peripheral versions of the OCT
531 differing as a function of the presence of a barrier. This builds on previous studies (e.g. Clark
532 & Leavens 2019; Clark et al 2019; Clark et al 2020, Miklósi & Soproni 2006; Mulcahy &
533 Hedge 2012; Mulcahy & Suddendorf 2011; Udell et al. 2013) showing that methodological
534 differences in the presentation of the OCT can impact on individual performance and
535 behaviour, and shows the importance of ensuring comparable testing conditions before
536 generalising from individuals to a species as a group, and before making cross-species
537 comparisons. This study adds to the growing OCT literature which emphasises the necessity
538 of addressing systematic methodological confounds prior to speculating about the
539 evolutionary roots of socio-cognitive skills based on apparent species difference in
540 performance. Without consideration of the effects of these confounding variables, it is
541 premature to attribute subjects' responses to their selective histories.

542

543

544

545

Ethical Note

546 All applicable international, national, and/or institutional guidelines for the care and use of
547 animals were followed. All procedures performed in studies involving animals were in
548 accordance with the ethical approval of the Animal Welfare and Ethical Review Board at the
549 University of Sussex, United Kingdom.

550

551

552

References

- 553
- 554 Arbib MA, Liebel K, Pika S (2008) Primate vocalisation, gesture, and the evolution of human
555 language. *Curr Anthropol.* <https://doi.org/10.1086/593015>
- 556 Bard KA, Street EA, McCrary C, Boothe RG (1995) Development of visual acuity in infant
557 chimpanzees. *Infant Behav Dev.*, 18(2): 225-232.
- 558 Baron-Cohen S. (1995) *Mindblindness: An essay on autism and theory of mind.* Cambridge,
559 MA, US: The MIT Press.
- 560 Bates E, Camaioni L, Volterra V (1975) The acquisition of performatives prior to speech.
561 *Merrill-Palmer Q.* 21(3):205-226.
- 562 Clark H, Elsherif MM, Leavens DA (2019) Ontogeny vs. phylogeny in primate/ canid
563 comparisons: A meta-analysis of the object-choice task. *Neurosci Biobehav Rev.*
564 <https://dx.doi.org/10.1016/j.neubiorev.2019.06.001>
- 565 Clark H, Leavens DA (2019) Testing dogs in ape-like conditions: the effect of a barrier on
566 dogs' performance on the object-choice task. *Anim Cogn.*
567 <https://doi.org/10.1007/s10071-019-01297-8>
- 568 Corballis MC (1999) The gestural origins of language: Human language may have evolved
569 from manual gestures, which survive today as a "behavioural fossil" coupled to
570 speech. *Am Sci.* <https://doi.org/10.1511/1999.20.810>
- 571 D'Aniello B, Alterisio A, Scandurra A, Petremolo E, Iommelli MR, Aria M (2017) What's
572 the point? Golden and Labrador retrievers living in kennels do not understand human
573 pointing gestures. *Anim Cogn.* <https://doi.org/10.1007/s10071-017-1098-2>
- 574 Dawson G, Toth K, Abbott R, Osterling J, Munson J, Estes A & Liaw J (2004) Early social
575 attention impairments in autism: social orienting, joint attention, and attention to
576 distress. *Dev Psychol.* <https://doi.org/10.1037/0012-1649.40.2.271>.

577 Dorey NR, Udell MAR, Wynne CDL (2010) When do domestic dogs, *Canis familiaris*, start
578 to understand human pointing? The role of ontogeny in the development of
579 interspecies communication. Anim Behav.
580 <https://doi.org/10.1016/j.anbehav.2009.09.032>.

581 Hare B, Tomasello, M (1999) Domestic dogs (*Canis familiaris*) use human and conspecific
582 social cues to locate hidden food. J Comp Psychol. [https://doi.org/10.1037/0735-](https://doi.org/10.1037/0735-7036.113.2.173)
583 [7036.113.2.173](https://doi.org/10.1037/0735-7036.113.2.173).

584 Hare B, Tomasello M. (2005). Human-like social skills in dogs? TRENDS Cogn Sci.
585 <https://doi.org/10.1016/j.tics.2005.07.003>

586 Hegedüs D, Bálint A, Miklósi A, Pongrácz P. (2013). Owners fail to influence the choices of
587 dogs in a two-choice, visual pointing task. Behav. 150:427-443.

588 Herrmann E, Call J, Hernandez-Lloreda MV, Hare B, Tomasello, M. (2007). Humans have
589 evolved specialized skills of social cognition: The cultural intelligence hypothesis.
590 Science. <https://doi.org/10.1126/science.1146282>

591 Itakura S, Agnetta B, Hare B, Tomasello M (1999). Chimpanzee use of human and
592 conspecific cues to locate hidden food. Dev Sci. [https://doi.org/10.1111/1467-](https://doi.org/10.1111/1467-7687.00089)
593 [7687.00089](https://doi.org/10.1111/1467-7687.00089)

594 Kirchhofer KC, Zimmermann F, Kaminski J, Tomasello M (2012). Dogs (*Canis familiaris*),
595 but not chimpanzees (*Pan troglodytes*), understand imperative pointing. PLoS ONE.
596 <https://doi.org/10.1371/journal.pone.0030913>

597 Kraus C, van Waveren C, Huebner F (2014) Distractible dogs, constant cats? A test of the
598 distraction hypothesis in two domestic species. Anim Behav.
599 <https://doi.org/10.1016/j.anbehav.2014.04.026>

600 Lazarowski L, Dorman DC (2015) A comparison of pet and purpose-bred research dog
601 (*Canis Familiaris*) performance on human-guided object-choice tasks. Behav
602 Processes. <https://doi.org/10.1016/j.beproc.2014.09.021>

603 Leavens DA, Bard KA, Hopkins WD (2019). The mismeasure of ape social cognition. Anim
604 Cogn. <https://doi.org/10.1007/s10071-017-1119-1>

605 Leavens DA, Hopkins WD, Bard KA (2005) Understanding the point of chimpanzee
606 pointing: Epigenesis and ecological validity. Curr Dir Psychol Sci.
607 <https://doi.org/10.1111/j.0963-7214.2005.00361.x>

608 Lyn H (2010) Environment, methodology, and the object choice task in apes: Evidence for
609 declarative comprehension and implications for the evolution of language. J Evol
610 Psychol. <https://doi.org/10.1556/JEP.8.2010.4.3>

611 Lyn H, Russell JL, Hopkins WD (2010) The impact of environment on the comprehension of
612 declarative gestures in apes. Psychol Sci <https://doi.org/10.1177/0956797610362218>

613 Miklósi A, Soproni K (2006) A comparative analysis of animals' understanding of the human
614 pointing gesture. Anim Cogn. <https://doi.org/10.1007/s10071-005-0008-1>

615 Miller PE, Murphy CJ (1995) Vision in dogs. J Am Vet Med Assoc 207(12):1623-1634.

616 Moll H, Tomasello M (2007) Cooperation and human cognition; The Vygotskyan
617 intelligence hypothesis. Philos Trans Royal Soc. [https://doi.org/](https://doi.org/10.1098/rstb.2006.2000)
618 [10.1098/rstb.2006.2000](https://doi.org/10.1098/rstb.2006.2000)

619 Mulcahy NJ, Call J (2009) The performance of bonobos (*Pan paniscus*), chimpanzees (*pan*
620 *troglydytes*) and orangutans (*Pongo pygmaeus*) in two versions of an object-choice
621 task. J Comp Psychol. <http://dx.doi.org/10.1037/a0016222>

622 Mulcahy NJ, Hedge V (2012) Are great apes tested with an abject object-choice task? Anim
623 Behav. <http://dx.doi.org/10.1016/j.anbehav.2011.11.019>

624 Mulcahy NJ, Suddendorf T (2011) An obedient orangutan (*Pongo abelii*) performs perfectly
625 in peripheral object-choice tasks but fails the standard centrally presented versions. J
626 Comp Psychol. <http://dx.doi.org/10.1037/a0020905>

627 Osborne T, Mulcahy NJ (2019) Reassessing shelter dogs' use of human communicative cues
628 in the standard object-choice task. PLoS ONE.
629 <https://doi.org/10.1371/journal.pone.0213166>

630 Povinelli DJ, Bierschwale DT, Čech CG (1999) Comprehension of seeing as a referential act
631 in young children, but not juvenile chimpanzees. Brit J Dev Psychol 17:37–60

632 Povinelli DJ, Reaux JE, Bierschwale DT, Allain AD, Simon BB (1997) Exploitation of
633 pointing as a referential gesture in young children, but not adolescent chimpanzees.
634 Cogn Dev 12:423–461

635 Riedel J, Schumann K, Kaminski J, Call J, Tomasello M (2008). The early ontogeny of
636 human-dog communication. Anim Behav.
637 <https://doi.org/10.1016/j.anbehav.2007.08.010>

638 Russell JL, Lyn H, Schaeffer JA, Hopkins WD (2011). The role of sociocommunicative
639 rearing environments in the development of social and physical cognition in apes.
640 Dev Sci. <https://doi.org/10.1111/j.1467-7687.2011.01090.x>

641 Schmidjell T, Range F, Huber L, Virányi Z (2012) Do owners have a Clever Hans effect on
642 dogs? Results of a pointing study. Front. Psychol.
643 <https://doi.org/10.3389/fpsyg.2012.00558>.

644 Tomasello M, Call J, Gluckman A (1997) Comprehension of novel communicative signs by
645 apes and human children. Child Dev. [https://doi.org/10.1111/j.1467-](https://doi.org/10.1111/j.1467-8624.1997.tb01985.x)
646 [8624.1997.tb01985.x](https://doi.org/10.1111/j.1467-8624.1997.tb01985.x)

647 Tomasello M, Carpenter M (2007) Shared intentionality. Dev Sci.
648 <https://doi.org/10.1111/j.1467-7687.2007.00573.x>

649 Udell MAR, Dorey NR, Wynne, CDL (2008) Wolves outperform dogs in following human
650 social cues. Anim Behav. <https://doi.org/10.1016/j.anbehav.2008.07.028>.

651 Udell MAR, Dorey NR, Wynne CDL (2010). The performance of stray dogs (*Canis*
652 *familiaris*) living in a shelter on human-guided object-choice tasks. Anim Behav.
653 <https://doi.org/10.1016/j.anbehav.2009.12.027>

654 Udell, MAR, Dorey NR, Wynne CDL (2010b) What did domestication do to dogs? A new
655 account of dogs' sensitivity to human actions. Biol Rev. [https://doi.org/](https://doi.org/10.1111/j.1469-185X.2009.00104.x)
656 [10.1111/j.1469-185X.2009.00104.x](https://doi.org/10.1111/j.1469-185X.2009.00104.x)

657 Udell MAR, Hall NJ, Morrison J, Dorey NR, Wynne, CDL (2013). Point topography and
658 within-session learning are important predictors of pet dogs' (*Canis lupus familiaris*)
659 performance on human-guided tasks. Revista Argentina de Ciencias de
660 Comportamiento 5(2):3-20.

661 Virányi Z, Gácsi M, Kubinyi E, Topál, J, Belényi, B, Ujfalussy D, Miklósi A (2008)
662 Comprehension of human pointing gestures in young human-reared wolves (*Canis*
663 *lupus*) and dogs (*Canis familiaris*). Anim Cogn. [https://doi.org/10.1007/s10071-007-](https://doi.org/10.1007/s10071-007-0127-y)
664 [0127-y](https://doi.org/10.1007/s10071-007-0127-y)

665

666

667

668

669 Table 1

670 *Subject and performance data*

Name	Breed	Sex	Age (years)	Barrier	First condition	Central trials correct	Peripheral trials correct
Hendrix	Shih Tzu x Chihuahua	M	7	Barrier	Central	1	0
Evie	Lurcher	F	3	Barrier	Central	4	2
Abbie	Cavalier King Charles Spaniel	F	0.75	Barrier	Central	2	2
Theo	Cocker Spaniel x Poodle	M	4	Barrier	Peripheral	4	4
Marnie	Yorkshire Terrier x Jack Russell	F	4	Barrier	Peripheral	4	1
Bruce	Manchester Terrier x Jack Russell	M	6	Barrier	Central	4	4
Dudley	Springer Spaniel	M	12	Barrier	Peripheral	4	2
Stanley	Cocker Spaniel x Poodle	M	0.33	Barrier	Central	4	1
Olly	Cocker Spaniel	M	0.83	Barrier	Peripheral	3	0
Eva	Red Fox Labrador	F	6	Barrier	Peripheral	3	4
Axie	Mongrel	F	4	Barrier	Peripheral	3	2
Bob	Jack Russell	M	4	Barrier	Peripheral	2	0
Jake	Springer Spaniel x Poodle	M	1	No Barrier	Peripheral	4	4
Gary	English Mastiff	M	2	No Barrier	Peripheral	3	4
Floki	Border Collie	F	3	No Barrier	Peripheral	3	3
Leyla	Cavalier King Charles Spaniel x Poodle	F	4	No Barrier	Central	0	3

Watson	Border Collie	M	5	No Barrier	Central	4	4
Tallulah	Jack Russell x Poodle	F	3	No Barrier	Peripheral	3	4
Bruce	Border Collie	M	12	No Barrier	Peripheral	2	3
Tilly	Border Collie	F	1	No Barrier	Central	2	0
Ruby	Jack Russell	M	4	No Barrier	Peripheral	1	2
Elvis	Cocker Spaniel	M	7	No Barrier	Central	4	4
Cookie	French Bulldog x Pug	F	1	No Barrier	Central	3	2
Penny	Boston Terrier	F	2	No Barrier	Central	4	2

671

672

673

674

675

Figure captions

676

677 **Fig. 1** The configurational set-up of the central and the peripheral conditions. O = Owner; E
678 = experimenter. Dashed line indicates playpen. Figure not to scale, distances involving agents
679 are approximate.

680

681 **Fig. 2** The percentage of trials in which dogs tested with a barrier made a correct choice, an
682 incorrect choice and no choice in the central and peripheral versions of the task. Total number
683 of trials per condition = 48. * denotes significant at $p < .05$.

684

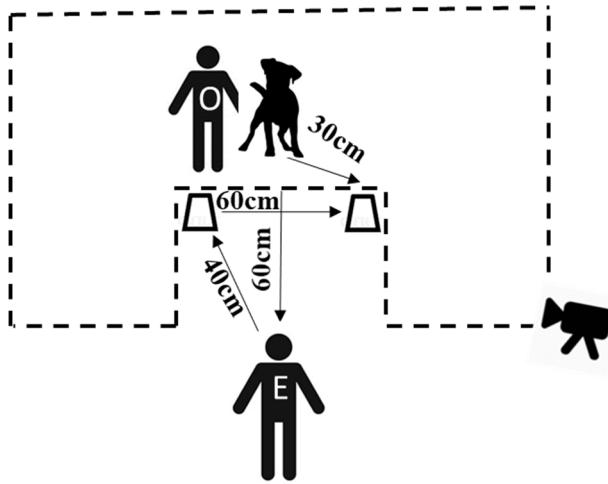
685 **Fig. 3** The percentage of trials in which dogs tested without a barrier made a correct choice,
686 an incorrect choice and no choice in the central and peripheral versions of the task. Total
687 number of trials per condition = 48. * denotes significant at $p < .05$.

688

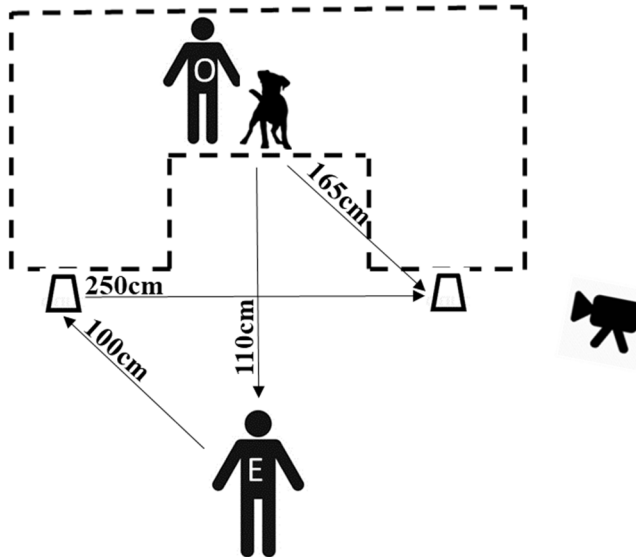
689

690 Figure 1

Central Condition



Peripheral Condition



691

692

693

694

695

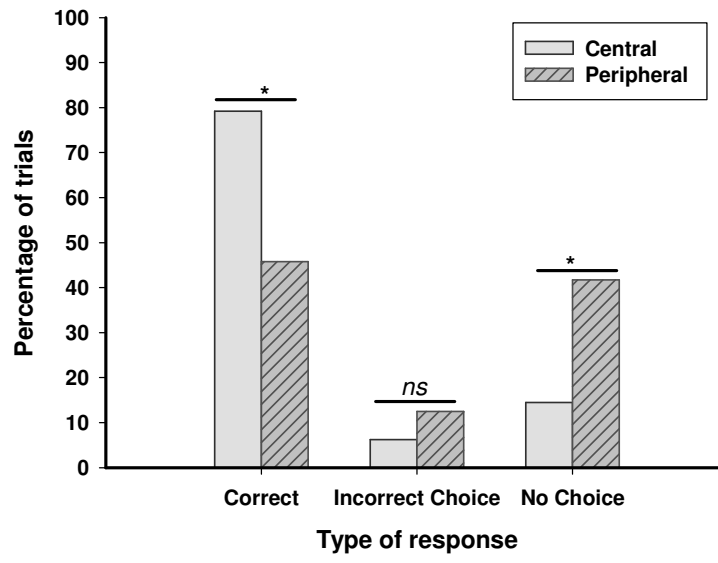
696

697

698

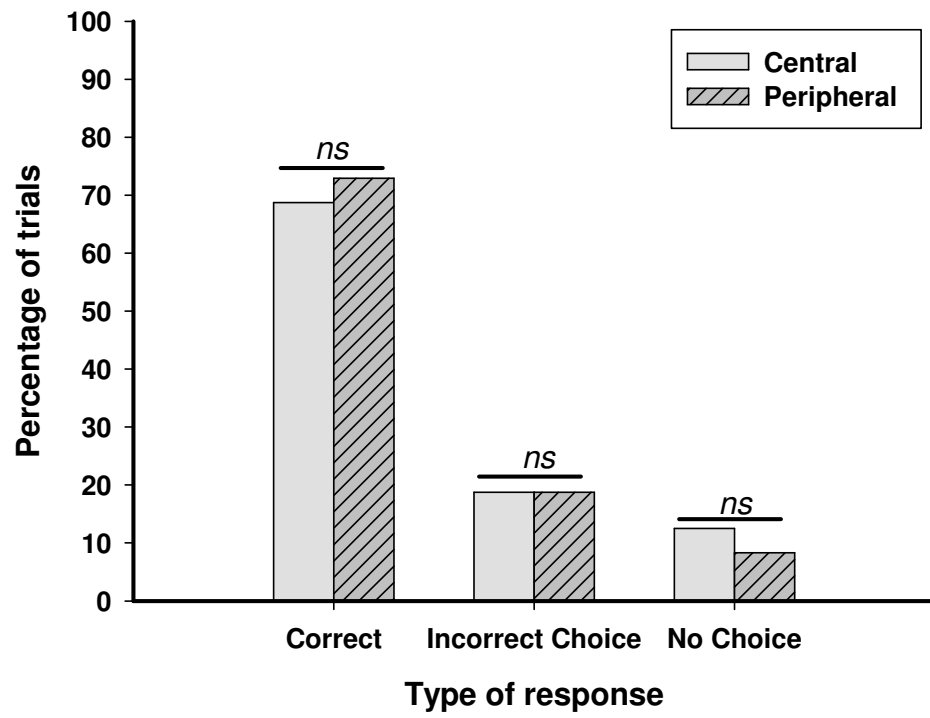
699

700 **Figure 2**



701

702 **Figure 3**



703

704 **Figure 4**

705