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8 **TITLE: Empathic-like responding by domestic dogs (*Canis familiaris*) to distress in**

9 **humans: An exploratory study**

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15 Abstract

16

17 Empathy covers a range of phenomena from cognitive empathy involving
18 metarepresentation to emotional contagion stemming from automatically triggered
19 reflexes. An experimental protocol first used with human infants was adapted to
20 investigate empathy in domestic dogs. Dogs oriented toward their owner or a stranger
21 more often when the person was pretending to cry than when they were talking or
22 humming. Observers, unaware of experimental hypotheses and the condition under which
23 dogs were responding, more often categorized dogs' approaches as submissive as
24 opposed to alert, playful or calm during the crying condition. When the stranger
25 pretended to cry, rather than approaching their usual source of comfort, their owner, dogs
26 sniffed, nuzzled and licked the stranger instead. The dogs' pattern of response was
27 behaviorally consistent with an expression of empathic concern, but is most
28 parsimoniously interpreted as emotional contagion coupled with a previous learning
29 history in which they have been rewarded for approaching distressed human companions.

30

31 **Key words:** empathy, emotional contagion, domestic dogs

32

33 Dogs and humans have shared a symbiotic bond for at least 15,000 years (Miklósi 2008;
34 Savolainen *et al.* 2002). Over that period dogs have been subject to intense selective
35 breeding that has not only produced breeds with markedly different body shapes and
36 sizes but also differing behavioral dispositions (Scott & Fuller 1974). Hare *et al.* (2002)
37 have argued that the process of domestication has also conveyed advanced socio-
38 cognitive abilities to dogs (e.g., Hare & Tomasello 2006; Tópal *et al.* 2006; Kaminski *et*
39 *al.* 2009). In addition, it has been suggested that domestication has led to a strong
40 predisposition in dogs to form close affectional bonds with humans (Tópal *et al.* 1998;
41 Prato-Previde *et al.* 2003; Palmer & Custance 2008). The genetic basis of this process has
42 been well established in silver foxes (*Vulpes vulpes*) which over the course of 30 years of
43 selective breeding not only became increasingly tame and friendly toward humans, but
44 also developed a dog-like appearance with floppy ears, spotty coats and curly tails
45 (Belyaev *et al.* 1981; Trut *et al.* 2002).

46 One aspect of the dog-human affectional bond, often cited by pet-owners, is the
47 fact that dogs seem empathically well-tuned to human emotions (Vitulli 2006). They
48 appear to celebrate our joy and commiserate our sorrow. Although owners readily report
49 empathic-like responding in their pets, systematic empirical confirmation remains elusive
50 (Silva & de Sousa 2011). Although it has been found that dogs will contagiously yawn in
51 response to a human yawning (Joly-Mascheroni *et al.* 2008) such behavior seems very
52 different from empathically responding to human emotional displays such as distress.
53 Zahn-Waxler *et al.* (1984) in a study on empathy in human infants noted that some
54 household dogs appeared to respond empathically when their owner pretended to cry.
55 However, the report of this behavior constituted little more than an anecdotal observation.

56 Despite over a century of interest, no consensus exists over a proper definition of
57 empathy. Although its linguistic roots are in ancient Greek, the word empathy was first
58 introduced relatively recently into modern usage in the context of the philosophy of
59 aesthetics. It was originally used to refer to “feeling into” works of art or nature
60 (Titchener 1909). However, from the mid 20th century onwards, empathy became a focus
61 of psychological research in the context of social communication and pro-sociality (Silva
62 & de Sousa 2011). Although there seem to be as many definitions of the term as
63 researchers interested in it, empathy has broadly been defined as, “the naturally occurring
64 subjective experience of similarity between the feelings expressed by self and others
65 without losing (*sic.*) sight of whose feelings belong to whom” (Decety & Jackson 2004,
66 p. 71).

67 Developmental and comparative psychologists have identified a number of
68 empathy-related phenomena involving varying degrees of cognitive complexity (e.g.,
69 Eisenberg 2009, Preston & de Waal 2002). Batson *et al.* (1981) were among the first to
70 distinguish *empathy* from *personal distress*. Both processes are underpinned by
71 emotional contagion in which perceiving another’s emotional state triggers a similar
72 emotional response in an observer. Yet, whilst personal distress is self-oriented, empathy
73 is other-oriented (Batson 1991). Eisenberg (2009) defined personal distress as, “self-
74 focused, aversive emotional reaction to the vicarious experiencing of another’s emotion
75 ... that is associated with the egoistic motivation of making oneself feel better” (p. 126).
76 Thus, upon witnessing another infant cry an observing infant may also start to cry, but
77 instead of offering aid to the initially distressed individual the observing infant seeks
78 comfort for her own vicariously triggered distress.

79 In contrast to personal distress, whilst empathizing individuals still experience a
80 vicarious emotional reaction to the emotional state displayed by others, they do not
81 become entirely focused upon their own emotional response. As such, empathy requires a
82 capacity for self-other differentiation (Preston & de Waal 2002; de Waal 2008). The
83 empathizer's response to the other's emotional state is primarily focused upon or oriented
84 toward the other rather than themselves. Hence, a behavioral indicator of empathy may
85 be comfort-offering or helping behavior in response to another's distress.

86 Some theorists have also discussed another highly cognitively complex category
87 of empathy-related processing, sometimes labeled *sympathy* (e.g., Eisenberg 2009) or
88 *cognitive empathy* (e.g., Preston and de Waal 2002). Eisenberg (2009) defined it as, "an
89 affective response that frequently stems from empathy, but can derive solely (or partly)
90 from perspective taking or other cognitive processing, including retrieval of information
91 from memory. It consists of feelings of sorrow or concern for the distressed or needy
92 other rather than feeling the emotion as the other person is experiencing or expected to
93 experience it" (p. 126). Such a highly complex category of empathic responding would
94 be extremely difficult to establish empirically without the aid of verbal self-report. Thus,
95 it seems unlikely that one could provide convincing evidence of sympathy in non-verbal
96 participants such as very young human infants or non-human animals.

97 Although it would be very difficult to establish a capacity for sympathy in non-
98 human animals, there is growing evidence that many species are nevertheless sensitive to
99 distress in others. Rats (Church 1959) and monkeys (Wechkin *et al.* 1964) have been
100 found to forgo food in order to avoid delivering electric shocks to conspecifics. Mice
101 have shown increased sensitivity to their own pain when paired with familiar mice

102 experiencing a different type of pain (Langford *et al.* 2006). Additionally, there is
103 evidence of empathic concern in chimpanzees, cats and dogs (Zahn-Waxler *et al.* 1984;
104 Yerkes 1925; Ladygina-Kohts 1935/2001), yet this is largely anecdotal. There is,
105 however, systematic observational data on post-conflict “consolation” in apes (de Waal &
106 van Roosmalen 1979), rooks (Seed *et al.* 2007) and domestic dogs (Cools *et al.* 2008).
107 Such consolatory behavior involves a third party approaching and often making physical
108 contact with either the winner or loser of a former altercation. Yet the degree to which
109 this functions as comfort-offering is not clear, since there is little evidence of stress
110 alleviation as a result of such post-conflict affiliation (Koski & Sterck 2007).

111 As indicated above, most evidence of empathy related behavior in non-human
112 animals involves intraspecies responding. The anecdotal observations of dogs are of
113 particular interest since they often involve interspecies (i.e., dog to human) empathic-like
114 behavior. The distress signals of humans are very different to those of dogs. Nevertheless,
115 one might expect a predator/scavenger, such as a dog, to be predisposed to respond to the
116 distress signals of other species. However, rather than provoking empathic-like
117 responding, it seems just as likely that distress in an interspecific would provoke alert or
118 predatory related behavior in dogs. It is not immediately clear how one might expect a
119 dog to respond to distress in humans.

120 There has been some experimental study of empathically motivated help-seeking
121 in dogs. Macpherson and Roberts (2006) found that pet dogs failed to seek the help of a
122 human bystander when their owner feigned a heart attack or was pinned by a bookcase.
123 The authors concluded that the “dogs did not understand the nature of the emergency or
124 the need to obtain help” (p. 113). But, seeking help from a bystander is a rather complex

125 type of empathic responding. We set out to investigate a slightly less complex scenario.
126 How do dogs respond when humans suddenly begin to cry for no readily apparent
127 reason?

128 It has been found that when typically-developing human infants are faced with
129 suddenly crying individuals, they will often hug, pat, make appropriate verbal utterances
130 (e.g., “there, there”, “it’s okay”), offer toys, and sometimes recruit assistance (Zahn-
131 Waxler *et al.* 1979; Zahn-Waxler *et al.* 1984). The behavior of dogs under similar
132 circumstances is harder to interpret. Dogs can whine, nuzzle, lick, lay their head in the
133 person’s lap or fetch toys. Yet, such behavior could be an expression of contagious
134 distress and egoistic comfort-seeking rather than empathically motivated comfort-
135 offering. Alternatively, such behavior could be motivated by curiosity. Hence, the
136 primary challenge in investigating possible empathy in dogs is devising an experimental
137 procedure that can elucidate the distinction between curiosity, egoistic attention- or
138 comfort-seeking and expressions of genuine empathic concern.

139 In an attempt to solve this conundrum, we modified Zahn-Waxler *et al.*’s (1984)
140 procedure to include a condition in which an unfamiliar person also pretended to cry. If
141 the dogs were principally seeking comfort for themselves, we predicted that they would
142 avoid the crying stranger and approach their owner instead. If the dogs’ approach was
143 principally motivated by curiosity, we predicted that any relatively uncommon behavior,
144 of a similar intensity to crying, would elicit approach. Therefore, we included a condition
145 in which the owner and stranger took turns humming in a strange staccato manner. We
146 also compared the dogs’ behavior in response to crying and humming with periods in
147 which the humans were talking. Talking is a very common human activity for dogs to

148 witness and thus it served as a baseline condition with which to compare their responses
149 to the rather strange or uncommon crying and humming behavior. Finally, we also
150 evaluated the emotional tone of the dogs' approaches during the different conditions (i.e.,
151 crying, humming and talking). If the dogs were exhibiting contagiously triggered
152 personal distress or empathy one would expect them to behave in a subdued, submissive
153 manner rather than being playful, neutrally calm or alert.

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155

156

Method

157

158 Participants

159 Eighteen medium-sized domestic dogs (*Canis familiaris*) from the North West
160 USA participated in the study. There were 9 females and 9 males of various breeds (10
161 mongrels, three Labradors, two Golden Retrievers, one Vizsla, one Belgian Shepherd and
162 one Beagle) with a mean age of 9 years and 9 months ranging from 8 months to 12 years.
163 Twelve dogs had been adopted by their current owners from a canine rescue centre. The
164 remaining six were acquired either from a breeder or the litter of a personal acquaintance.
165 All were household pets with no specialist training beyond basic obedience.

166 Eighteen owners (one per dog) comprising 14 women and 4 men ranging from 34
167 to 72 years of age also participated in the study. Length of ownership ranged from two
168 months to twelve years. When owners were asked how responsive their dog had been to
169 emotions in humans previously, 15 dogs were anecdotally reported to have responded (11
170 to sadness, seven to pain, eight to anger, and nine to celebration).

171

172 Testing Conditions and Materials

173 In order to ensure that the dogs remained relatively unstressed during the
174 experiment, and were thus more likely to behave in a natural manner, they were tested in
175 the living-room of their own home. The owner and stranger remained seated at least two
176 meters apart throughout the procedure, whilst a third person stood discreetly in one
177 corner of the room and recorded the dog's behavior on a Sony Handicam® camcorder.

178

179 Procedure

180 Each dog was exposed to four separate 20 second long experimental conditions in
181 which: 1) their owner cried; 2) a stranger cried; 3) their owner hummed; 4) the stranger
182 hummed. The order of who performed first (i.e. stranger or owner) and whether they
183 cried or hummed was counterbalanced. In addition, each crying or humming condition
184 was preceded by two minutes during which the owner and stranger talked.

185 The same person played the role of stranger throughout (i.e., the second author, J.
186 Mayer). She was entirely unfamiliar to the dogs prior to testing. From the moment of
187 entering their house, the stranger ignored the dogs: she did not look directly at them or
188 make any friendly overtures. By the time testing began, all dogs showed little interest in
189 the stranger. As a result, when 20 seconds of the dogs' behavior was sampled one minute
190 into the procedure (during which the owner and stranger were talking), 15 dogs were
191 passive, two were walking and one was playing. Thus, the dogs were not overly fixated
192 upon the stranger nor did they show any aggressive territoriality.

193 The owners were given the following instructions concerning their role during
194 each condition: *Crying*: When you are asked to cry, please pretend to cry to the best of
195 your ability for 20 seconds; you will be told when you can stop. The only gestures you
196 should make while you are pretending to cry are either leaning forward or covering your
197 face. *Humming*: When you are asked to hum, please loudly hum the nursery rhyme
198 “Mary Had a Little Lamb” to the best of your ability for 20 seconds; you will be told
199 when you can stop. Please hum at approximately the same volume and perform the same
200 gestures as you did or will do during the crying condition. The owners were also asked
201 not to refer to their dog by name, look directly at him or her or initiate physical contact
202 during testing.

203 Once the owner had been briefed, the video-camera was turned on and the testing
204 session began. For the first two minutes the stranger asked the owner questions from a
205 previously prepared list about the dog’s biographical details along with soliciting
206 anecdotal reports regarding the dog’s previous reactions to various emotional displays in
207 humans. When two minutes had elapsed, the first bout of crying or humming was
208 performed. Immediately following this bout, the owner and stranger returned to talking
209 thereby allowing the dog’s behavior to normalize. Thus, a total of two bouts of crying
210 and two of humming were performed, each separated by two minutes of talking.

211

212 **Behavioral Analysis**

213 The 20-second humming and crying conditions from the digital video recordings
214 of the testing sessions were analyzed using 5-second point and time sampling (Martin &
215 Bateson 2007). Because we also wished to compare the dogs’ responses to humming and

216 crying with that of talking, we sampled two 20-second phases during which the owner
217 and stranger talked. The first sample commenced one minute after the start of the
218 experiment and the second sample was taken 30 seconds after the second
219 crying/humming phase.

220 Six different behaviors, divided into two categories, were scored via 5-second
221 point-sampling. The category “person-oriented” included “look at”, “approach” and
222 “contact” whilst “non-person-oriented” included “passive”, “walking”, and “solitary
223 play” (Table 1). Thus, after every 5-second interval the behavior displayed by the dog at
224 that precise moment was recorded.

225

226 INSERT TABLE 1 ABOUT HERE

227

228 Since vocalizing was not a mutually exclusive behavior (i.e., it could co-occur
229 with any of the other behaviors) and it was a rare and transient event, it was scored
230 differently using 5-second time- rather than point-sampling. Thus, if the dog made any
231 vocalization during each 5-second interval, this was scored as one and the type of the
232 vocalization was noted.

233 The second author (J. Mayer) scored all of the testing sessions and a naïve
234 observer, who was unaware of the study’s hypotheses, scored a random selection of four
235 sessions (i.e., 4 out of 18 dogs or 22% of the sample). During naïve scoring, a DVD
236 without sound or labels was used so that the naïve observer remained as far as possible
237 unaware of the experimental conditions or hypotheses. Inter-observer agreement was
238 very good: Cohen’s $\kappa = 0.83$.

239 In addition to the basic behaviors outlined above, we also wished to evaluate the
240 emotional tone of the dogs' approaches to the stranger and owner to see if they
241 approached in a different manner when the humans were crying, humming or talking.
242 Four emotional states in dogs were considered: submissive, calm, playful and alert. These
243 four relatively mild emotional displays were chosen because the other more extreme
244 emotional signals described in dogs such as fearfulness or aggression were not evident in
245 any of the subjects. (For reasons of welfare, the procedure would have been curtailed if
246 any of the dogs had displayed strong fear or aggression.). Three exemplars of each
247 emotion (two photographs and a line drawing) were selected from a Google© image
248 search. An opportunity sample of 10 experienced dog-owners, who were unaware of the
249 experimental hypotheses, were asked to identify which of the four emotional states the
250 dogs in the pictures were displaying. There was 100% agreement between the observers
251 on all but three of the 12 images. These three pictures were discarded and the remaining
252 images were used to develop pen drawings of each of the relevant emotional state
253 postures (Figure 1).

254

255 INSERT FIGURE 1 ABOUT HERE

256

257 Three other independent observers, all of whom were experienced dog-owners
258 and unaware the study's hypotheses, were shown the four pen drawings along with short
259 descriptions of each emotional display.

260 *Calm (relaxed or neutral)*: The dog's ears are held down but not laid flat and back (or if
261 it is a breed that holds its ear up all the time, such as a Doberman pincher or German

262 Shepherd, the ears are not pricked forward). The mouth is often open and the tongue is
263 out or in view. The tail is held in a neutral position (not between the legs, but not held up
264 toward horizontal or higher).

265 *Submissive (mildly worried or concerned)*: The dog's body and head is slightly lowered.
266 They hold their ears flat and back. Their tail is held low and sometimes slightly between
267 their legs. They will also sometimes wag their tail with a rapid side to side motion. They
268 will sometimes protrude their tongue slightly and raise one leg in a hesitant placating
269 manner.

270 *Alert*: The dog's ears are pricked and forward (some breeds cannot prick their ears, but if
271 possible they hold them up slightly). The body is slightly raised and the legs stiff. The
272 dog stares in a fixed manner and its tail is held up so that it is horizontal or higher.

273 *Playful*: The dog moves in an exuberant, excited manner, the tail is held up (often
274 wagging) and the dog's face assumes a happy or excited expression with the mouth often
275 held slightly open. When requesting play dogs will sometimes assume a "bow" posture:
276 they lower their front legs and raise their hind quarters with their tail held up.

277 The three observers watched silent footage of all the dogs' approaches in the
278 crying and humming conditions (none of the dogs approached during talking). They were
279 asked to select which emotional category best fitted the nature of the dog's approach. The
280 agreement between observers was moderate to good: observer A to B Cohen's $\kappa = 0.685$,
281 observer A to C Cohen's $\kappa = 0.463$, and observer B to C Cohen's $\kappa = 0.618$. In 18 out of
282 the 29 (67%) crying and humming bouts in which approaches occurred, all three
283 observers agreed on the nature of the dogs' approaches. In the remaining nine bouts
284 (33%) at least two observers agreed on the nature of the approach. Therefore, the

285 emotional tone of the dogs' approaches during each bout of crying or humming was taken
286 to be that category upon which two or more of the observers agreed.

287

288 **Results**

289

290 Table 2 presents a summary of the point and time sample data. According to the
291 time sample data, significantly more dogs approached during crying ($N = 15$) than
292 humming ($N = 6$) (McNemar test $X^2(1, N = 18) = 7.11, p = .008$). None of the dogs
293 approached during talking. Only two dogs vocalized during testing. One dog whined
294 when its owner pretended to cry, the other produced a trilled-whimpering in response to
295 the crying bouts of both the owner and stranger.

296

297 INSERT TABLE 2 ABOUT HERE

298

299 There was a significant main effect for the degree of person-oriented behaviors
300 (i.e., the combined point sample scores for look at, approach and contact) performed
301 during the crying, humming and talking conditions (repeated measures ANOVA, $F(1.36,$
302 $23.03) = 51.29, p < .001$, Fig. 2). Bonferroni corrected post hoc tests showed that dogs
303 were significantly more person-oriented during crying compared to humming ($p < .001$)
304 or talking ($p < .001$). Despite responding more strongly to crying, the dogs still
305 differentiated between humming and talking, since there was a significantly higher rate of
306 person-oriented behaviors performed during humming versus talking ($p = .045$ one-
307 tailed).

308

309 INSERT FIGURE 2 ABOUT HERE

310

311 As mentioned earlier, it was hypothesized that if the dogs were behaving in a
312 manner consistent with empathy, they would direct more behavior toward the person who
313 was crying than the silent witness. If, however, they approached their owner when the
314 stranger was crying, this might suggest they were comfort-seeking. To test these
315 hypotheses, a 2X2 repeated measures ANOVA was conducted on the dependent variable
316 of number of person-oriented behaviors performed by dogs during the crying condition.
317 The independent variables were identity of person performing (owner/stranger) and
318 behavior being responded to (crying/sitting silently). There was no significant main effect
319 of identify of person performing ($F(1,17) = .04, p = .843$). Thus, dogs did not perform
320 significantly more person-oriented behavior toward the owner versus the stranger or vice
321 versa. However, there was a significant main effect for behavior being responded to
322 ($F(1,17) = 79.12, p < .001$). Dogs directed significantly more person-oriented behaviors
323 toward the person crying than the silent companion ($p < .001$, Fig. 3). There was no
324 significant interaction between the identity of the person performing and the behavior
325 being responded to ($F(1,17) = .054, p = .819$).

326

327 INSERT FIGURE 3 ABOUT HERE

328

329 Although the point sample data indicated that the dogs oriented more to the
330 humans when they were crying versus humming or talking, this does not automatically

354 apparently weakened individual; they could become curious or playful; or they could
355 approach and touch the distressed person in a gentle or submissive manner thereby
356 providing reassurance or comfort. The majority of dogs in the present study behaved in a
357 manner that was consistent with empathic concern and comfort-offering. The dogs
358 responded to their owner and the stranger when they were crying in a markedly
359 differently manner compared to when they were humming or talking. They oriented
360 toward the person (i.e., looking at, approaching and touching them) significantly more
361 during the crying condition than the humming or talking conditions. Of the 15 dogs that
362 approached during the crying condition, the majority of them did so in a submissive
363 rather than playful, calm or alert manner.

364 The fact that the dogs differentiated between crying and humming indicates that
365 their response to crying was not purely driven by curiosity. The humming was designed
366 to be a relatively novel behavior, which might be likely to pique the dogs' curiosity.
367 However, it was somewhat similar to talking and one might suspect that the dogs did not
368 respond to it because they treated it as equivalent to talking. Although humming did not
369 provoke approach or contact, the dogs nevertheless looked at the humming person
370 significantly more often than they looked during talking. Thus, they seemed to notice that
371 humming was different from talking, but they did not become sufficiently interested or
372 aroused during humming to approach or touch the person performing the behavior. In
373 addition, the two dogs who produced mild distress vocalizations during the procedure
374 only did so during the crying condition. Thus, it seemed that crying carried greater
375 emotional valence for the dogs and provoked a stronger overall response than either
376 humming or talking.

377 It is possible that the dogs' response to crying was driven principally by
378 emotional contagion. The crying could have triggered personal distress in the dogs so that
379 their approaches were driven by a desire to gain comfort for themselves rather than to
380 offer comfort to the human. However, if the dogs' approaches during the crying condition
381 were entirely motivated by egoistic comfort-seeking, one might expect them to be more
382 likely to approach their usual source of comfort (i.e. their owner) in preference to the
383 stranger. Yet, no such preference was found. The dogs approached whoever was crying
384 regardless of their identity. In addition, when the person who was crying ignored them (as
385 they were instructed to do), if the dogs were egoistically motivated, one might expect
386 them to turn to the other available non-crying person for comfort, particularly if that
387 person were their owner. However, only two dogs approached both people during the
388 crying condition (one approached the crying stranger first and then her owner, the other
389 approached the calm stranger prior to going over to his crying owner and then when the
390 stranger was crying approached the stranger prior to his owner). Thus, the dogs' behavior
391 was not strongly consistent with what one would expect if they were only egoistically
392 comfort-seeking.

393 Even if the dogs' pattern of response exceeded what one would expect of personal
394 distress and egotistic comfort-seeking, it does not automatically follow that they were
395 empathizing in the sense of making a self-other differentiation. A more parsimonious
396 explanation of their behavior is that they may have previously received positive
397 reinforcement for approaching crying individuals. Any household dog who approaches a
398 distressed human family member is likely to be positively reinforced by receiving
399 affection. Through the process of generalization, any human who then cries in the

400 presence of that dog is likely to initiate a conditioned approach response. Since the dog is
401 nonetheless affected by emotional contagion the response will still tend to be submissive
402 in its emotional tone. Thus, the behavioral outcome is a response to human distress that is
403 consistent with an expression of empathic concern, but which may not actually involve
404 the requisite self-other differentiation needed for it to count as true empathy.

405 Similarly, there is no compelling evidence to suggest that the dogs' behavior
406 indicated sympathy or cognitive empathy. Cognitive empathy would require them to
407 exhibit some understanding of the mental perspective of the crying humans. Sympathetic
408 humans can produce verbal utterances such as, "Are you okay?" or, "What is the matter?"
409 which indicate that they are engaging with or asking after the mental perspective of the
410 crying person. Without the benefit of such verbal responses, it is difficult to imagine what
411 behavior a dog could produce under such circumstances which could convincingly
412 indicate mental perspective-taking.

413 In conclusion, we in no way claim that the present study provides definitive
414 answers to the question of empathy in dogs. Nevertheless, we believe it sets out a
415 profitable direction for further study. There are many more possible avenues of inquiry.
416 For example, what is the effect of breed? Nearly all the dogs in our sample were
417 medium-sized mongrels or hunting breeds. How would toy breeds respond? If learning
418 history is important, a developmental study with puppies might reveal important trends.
419 In addition, contrasting dogs with different rearing histories, such as shelter dogs or
420 highly trained working dogs, might reveal systematic differences. It might be profitable
421 to study other emotions in contrast to crying. It is possible, as mentioned earlier, that
422 humming was too similar to talking to provoke a strong response. On reflection, it might

423 have been better to have contrasted crying with laughing. Laughing is a human emotional
424 display that has a similar auditory intensity to crying, but one might expect it to provoke
425 a playful rather than submissive approach. The crying behavior in the present study was
426 devoid of context. Future studies could provide a context for the emotion being
427 displayed, such as fear caused by a snake or pain caused by stubbing one's toe. The
428 experimental paradigm we have developed offers a powerful new way to address many of
429 these questions.

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510

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516 **Figure Legends**

517

518 Figure 1: Emotional postures in dogs. a) calm, b) submissive; c) alert; d) playful

519

520 Figure 2: Rate of person-oriented behaviors performed during the crying, humming and
521 talking conditions

522

523 Figure 3: A dog approaches the “stranger” as she pretends to cry

524

525 Table 1: Behavior scored by point and time sampling

526

Behavior	Definition	Grouping
Passive	Sitting, standing or lying down without paying any obvious attention to the physical or social environment	NPO
Walking	Walking around the room without orienting to either the owner or researcher	NPO
Solitary Play	Playful behavior not associated with either the owner or researcher (e.g., chewing a toy)	NPO
Look at person	Sitting, standing or lying still whilst looking directly toward either the owner or stranger	PO
Contact person	Sniffing, licking, pawing, jumping up on or leaning against the owner or stranger	PO
Approach	Walking toward whilst clearly visually oriented to the owner or stranger	PO
Vocalizing	Any vocalization made by the dog (the nature of the vocalization was noted e.g., whining or barking)	
Transition	Ambiguous, transitional actions	

527 Key: PO = person oriented; NPO = non person oriented

528 Table 1: Mean (s.d.) number of point and time samples in which dogs responded in each
 529 condition

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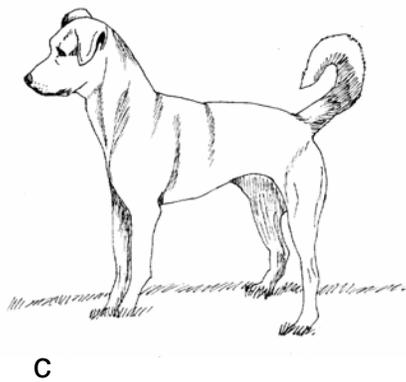
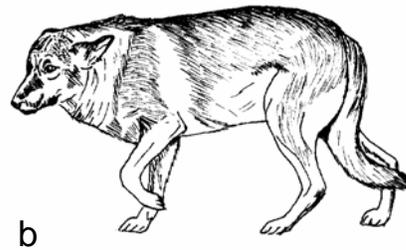
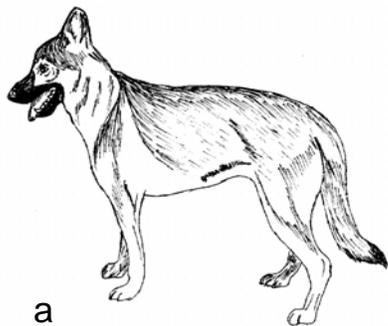
RESPONSE	CRY	HUM	TALK
Look PS	3.78 (2.16)	1.39 (2.17)	.06 (.24)
Approach PS	.06 (.24)	.11 (.47)	0 (0)
Approach TS	1.11 (1.32)	.22 (.55)	0 (0)
Contact PS	1.61 (1.69)	0 (0)	.06 (.26)
Person-oriented PS	5.44 (2.31)	1.5 (2.36)	.11 (.47)
Non-person-oriented PS	2.56 (2.31)	6.5 (1.91)	7.89 (.47)

531

532 Standard deviations (s.d.) are in parentheses after means. PS = point-samples, TS = time-samples. Look,
 533 approach and contact were combined to form person-oriented. Although 5-sec. point-sampling captured
 534 very few approaches, when approach data were collected using 5-sec. time-sampling and analysed
 535 separately the results followed the same pattern as person-oriented. Looking and contact point-sample data,
 536 when analysed separately, also followed the same pattern, except that dogs looked significantly more
 537 during humming than talking.

538 Figure 1

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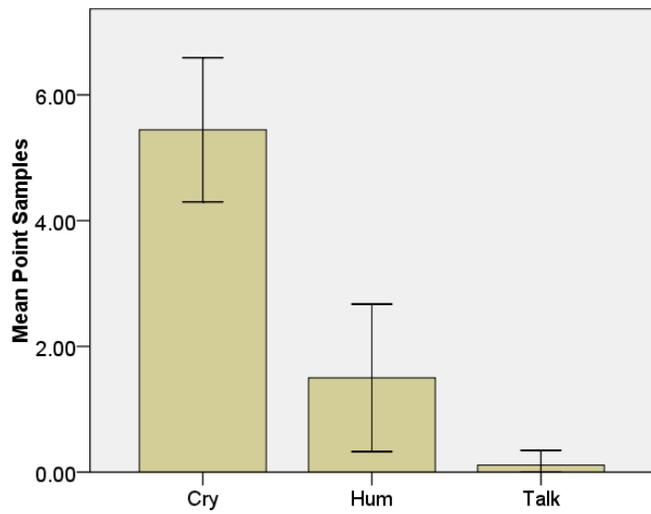
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550 Figure 2

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553 Figure 3

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