

1 ONTOGENY'S IMPACTS ON HUMAN-DOG COMMUNICATION

2 **Running head:** Wynne et al. Ontogeny of human-dog communication

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19 **Abstract:**

20 Riedel et al. (2008) present evidence of the ability of dogs (*Canis familiaris*) ranging in
21 age from six to 24 weeks to find hidden food by following human pointing gestures. They
22 argue that their data offer no evidence of an ontogenetic impact on this performance.
23 Specifically their analyses revealed no differences in the performance of the dogs at
24 different ages on the experimental conditions, and no evidence of improvement within
25 the experimental sessions. We argue that these failures to reject the null hypotheses were
26 due to insufficient statistical power in the data. In a reanalysis we show that the older
27 dogs perform significantly better than the younger ones, and that the youngest dogs show
28 improvements within the experimental sessions. We suggest future directions for the
29 study of the ontogeny of this complex behavior.

30 **Keywords:**

31 *Canis familiaris*; dog; evolution; ontogeny; object choice task; social cognition.

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34 Several authors have argued recently that domestication has led to a special sensitivity to
35 human social cues in domestic dogs (*Canis familiaris*). This sensitivity is not present in
36 dogs' closest wild relatives and progenitors, wolves (*C. lupus*: Hare et al. 2002; Kubinyi
37 et al. 2007). Furthermore, even puppies too young to have had extensive exposure to
38 humans are able to follow human social cues. Consequently this ability must have a
39 largely innate basis (Hare et al. 2005; Hare and Tomasello 2005). Various forms of cuing
40 the location of hidden food by a human pointing with her limbs have been extensively
41 used as tests of canid comprehension of human intentions (e.g., Miklósi et al. 1998; Hare
42 & Tomasello 1999; Udell, et al. 2008; see Udell & Wynne 2008, for a review).

43 In a recent paper Riedel, et al. (2008) present data from four age groups of
44 puppies, ranging from six to 24 weeks, which, they claim, indicate that "dogs as young as
45 6 weeks old can use a variety of human communicative gestures to locate hidden food"
46 (p. 5). They believe this "suggests that dogs do not acquire these skills mainly because of
47 their experiences in ontogeny." (p. 5).

48 We believe that the results presented by Riedel et al. do not justify their
49 conclusions.

50 Results

51 We concentrate our analysis on experiment 1 because it is the only experiment that tested
52 several different juvenile groups (experiments 2 and 3 only compared young dogs to
53 adults), and it included three different types of point (experiments 2 and 3 only presented
54 one type of point each) and thus three times as many trials as the other two experiments.

55 In experiment 1, 16 puppies at each of four different ages (i.e., 64 dogs in total)
56 were tested on three different types of point and a control condition. The ages tested were
57 6, 8, 16 and 24 weeks, and the points were Dynamic cross point move (DCPM:
58 experimenter pointed to baited cup with index finger of contra-lateral hand four times,
59 leaving her hand indicating the cup), Dynamic cross point (DCP: as DCPM but only
60 pointing once) and Marker (M: experimenter placed a piece of wood on top of the baited
61 cup in full view of the dog). In addition, all dogs were tested on control trials in which a
62 cup was baited but no cue was offered.

63 In each case, the oldest dogs performed better on each point type than the
64 youngest dogs. The oldest dogs scored 0.63, 0.81 and 1.19 points better than the youngest
65 on an eight point scale on the three conditions, DCPM, DCP and M respectively. Since
66 chance was 50%, the portion of the range over which the dogs' performance might vary
67 is only four points: thus these improvements are from 16 to 30% of the portion of the
68 scale over which they might plausibly vary. Riedel et al. reported however that this
69 improvement with age was not in general statistically significant. They analyzed the
70 results with a mixed-model ANOVA with condition (point type) as a within-subjects
71 factor and age group as a between subjects factor. Although the main effect of age was
72 significant ($F_{3,60} = 2.85$, $P = 0.045$) Riedel et al. do not consider this evidence of an effect
73 of age on the experimental performance because their analysis included the control
74 condition. Since there are no cues offered in the control condition, performance on it
75 should not improve with age and thus, in this analysis, an effect of age in the
76 experimental conditions would show itself in the interaction of age with condition. This
77 analysis, Riedel et al. report, is not significant ($F_{3,180} = 1.59$, $P = 0.12$). Follow-up

78 Bonferroni corrected one-way ANOVAs on the performance on each condition separately
79 revealed a significant effect of age for the Marker condition ($F_{3,60} = 4.23$, $P = 0.0009$),
80 but not for the other two experimental conditions.

81 We propose that the lack of statistical significance for the other two conditions is
82 due to a lack of power in the ANOVAs. Since there is no expectation or evidence that
83 the dogs improved on the control trials on which no point was offered, that condition can
84 be omitted from the analysis. In this way, the sought after effect becomes a main effect
85 (of age) instead of an interaction (of age and condition) and thus has greater statistical
86 power. We repeated the analysis, using the data in Riedel et al.'s Table 1, with within-
87 subjects factor experimental condition and between subjects factor age. We found that
88 there was a significant effect of age ($F_{3,60} = 3.73$, $P = 0.0158$), as well as of experimental
89 condition ($F_{2,120} = 21.50$, $P = 0.000001$). The interaction of these two factors was not
90 significant. ($F_{6,120} = 1.15$, $P = 0.338$). Thus it is safe to reject the null hypothesis that
91 there is no difference in the performance of the subjects of different ages in following
92 human points.

93 ----Figure 1 About Here:----

94 We also considered the performance of the individual dogs. In their Table 1,
95 Riedel et al. included those occasions on which individual dogs reached a criterion of
96 seven out of eight trials correct for a given condition. Seven out of eight trials correct has
97 a binomial $P = 0.0352$. Figure 1 shows the number of trials on which dogs at the four
98 different ages reached this criterion level performance. The figure clearly shows that the
99 number of individuals reaching a statistically significant level of performance increased
100 monotonically with age. At six weeks, dogs performed significantly above chance on

101 fewer than half the tests: at the oldest age they were above chance on more than three
102 quarters of the tests.

103 Riedel et al. also claim that the dogs did not improve in performance over the
104 course of each session of testing. They support this argument with a mixed-model
105 ANOVA comparing the first and last four trials of each experimental condition (within
106 subjects) with age as a between-subjects factor. Again we propose that the failure of this
107 analysis to produce a statistically significant result is due to insufficient power. To
108 increase power (and to avoid an analysis of binary data, which do not fulfill the
109 prerequisites for an ANOVA) we summed across experimental conditions. Riedel et al.
110 refer to the three conditions as interchangeable tests of the ability to follow human cues,
111 thus pooling their results seems reasonable. We compared the first half to the second half
112 of each dog's testing. This split-half analysis showed no main effect of session half ($F_{1,252}$
113 $= 1.17$, $P = 0.281$) but a significant main effect of age ($F_{3,252} = 6.84$, $P = 0.001$) and a
114 significant interaction of session half with age ($F_{3,252} = 3.16$, $P = 0.025$). As shown in Fig.
115 2, performance increased across the session halves for the youngest age group, but not for
116 the older age groups. This indicates that the older age groups had fully learned to use the
117 cues prior to the experiment, but that the youngest age group was still learning to respond
118 to the human cues during experimental testing.

119 -----Figure 2 about here:-----

120 Discussion

121 Our reanalysis of the data clearly shows that performance of the puppies on the tests
122 involving human cues improved with age from 6 to 24 weeks. Furthermore, the youngest

123 age group of dogs improved in performance from the first to the last half of each testing
124 session.

125 Riedel et al. state that, in order to test whether the responsiveness of dogs to
126 human social cues is due to domestication or socialization, it is necessary to test puppies,
127 "with limited or no human contact" (p. 2). They point out that, "Freedman et al. (1961)
128 showed that at 7 weeks of age puppies are most receptive to socialization with humans"
129 (p. 2), and thereby justify their choice of puppies "from 6 weeks on" (p. 2) as a suitable
130 group in which to demonstrate a minimal impact of ontogeny.

131 The argument that the youngest dogs they tested had not reached their "most
132 sensitive period of socialization with humans [and] thus... human interaction and
133 influence on their behaviour was reduced to a minimum" (p. 5) is weak. Riedel et al. fail
134 to take into consideration that when Freedman et al. (1961) identified seven weeks as the
135 point of maximal responsiveness to humans, they were studying minimally socialized
136 pups that only experienced human contact for three half-hour periods a day during a
137 single week of their lives. This week took place between two and nine weeks of age. It is
138 under those highly constrained conditions that the seventh week proved to be the period
139 of maximal receptiveness to humans. In fact, the most plastic portion of social
140 development for the dog is between four and eight weeks (Scott and Marston 1950; Scott
141 1958; Freedman et al. 1961) – the time period when dogs' sensory systems are fully
142 developed but fear does not yet inhibit exploration (Fox 1965; Freedman et al. 1961;
143 Rosenblatt, 1976; Scott and Fuller, 1965).

144 In order to be considered as a group of dogs with minimal exposure to humans
145 Riedel et al. would have to offer evidence that the pups under test had indeed had

146 minimal human social interaction. The dogs are described as privately owned in an urban
147 environment.

148 Furthermore, pups raised by a breeder usually begin to receive supplemental gruel
149 feeding by hand at four weeks of age. Thus, by six weeks, even though they have not yet
150 been weaned, most pups reared in a home have had two weeks experience of hands being
151 associated with food. Given standard practice when breeding dogs as pets, we think the
152 burden of proof is on Riedel et al. to show that these puppies had not received repeated
153 interaction with humans, such as might make human limbs into stimuli predictive of the
154 location of food, toys and other significant stimuli.

155 Many studies assume that if they only use a small number of trials (in Riedel et
156 al.'s case, eight on each of three point types), then learning to follow the cues during the
157 testing sessions is unlikely. This assumption overlooks how readily pet dogs can be
158 trained. Each 'test' trial in experiments of this kind is rewarded if correct and
159 nonrewarded if incorrect and thus constitutes an operant training trial. Udell et al. (2008),
160 in a study of dogs' following of human points, found evidence of learning within ten
161 trials. Several reports indicate very rapid learning of other human signals in domestic
162 dogs. McKinley & Young (2003) found that pet dogs could be taught a new vocal label
163 in around eight minutes. Mariana, et al. (in press) reported that just three training trials
164 were sufficient to increase pet dogs' rate of gazing towards an unfamiliar human's face.

165 We contend that a behavior as complex as extrapolating the angle formed by the
166 limbs of an individual of a different species to locate hidden food cannot possibly
167 develop essentially independently of experiences in ontogeny as Riedel et al. and others
168 have claimed. For the performance to develop, certainly an individual must possess the

169 appropriate genetic substrates. Equally clear however, is that appropriate ontogenetic
170 conditions must be fulfilled. These include accepting humans as social companions –
171 which is a product of exposure to humans during a critical developmental window
172 (Coppinger & Coppinger 2002). No test has been published on the response to human
173 points of non-human-habituated dogs for the simple reason that no experimenter could
174 get close enough to such a dog to carry out the test.

175 Acceptance of humans as social companions, however, is not sufficient to
176 “spontaneously” follow human limb points. Udell et al. (submitted) have found that dogs
177 at an animal shelter do not follow points – even though the dogs they tested readily
178 accepted humans as social companions. A dog must have experience with desired objects
179 becoming available from human limbs if it is to follow those limbs to find such objects.

180 To isolate the different kinds of experience that are necessary for a dog to show
181 responsiveness to human social cues, a study of the ontogenesis of dogs’ ability to follow
182 human points needs to differ in several ways from Riedel et al.’s experiment. First, in
183 order to test the importance of exposure to humans as social companions, it needs to
184 include a group raised in isolation from humans until the time of test. Second, to test the
185 impact of experience with human hands delivering important consequences, a group
186 needs to be raised such that, although they accept humans as social companions, they
187 have no (or minimal) experience of human hands delivering consequences. This might be
188 difficult to implement, but the fact that pound dogs do not follow points (Udell et al.,
189 submitted) suggests that it may not be essential that the dogs have absolutely no
190 experience of human limbs offering food for them to fail to follow points. Finally, a study

191 of this type should use a more difficult form of pointing, such as the momentary distal
192 point, so that improvement within sessions, if present, is more obvious.

193 Such a study, delineating the specific ontogenetic factors that contribute to the
194 dog's ability to follow human social cues such as points, would be a very valuable
195 contribution to our understanding of the human-dog relationship.

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243

244

FIGURE LEGENDS

245 Figure 1: Number of tests on which individual dogs scored more than 7 out of 8

246 trials correct (binomial $P = 0.0352$). Data from Riedel et al., Table 1.

247 Figure 2: Mean performance of dogs over three experimental conditions at four

248 ages during the first 12 and last 12 trials on experimental conditions of Riedel et al. Error

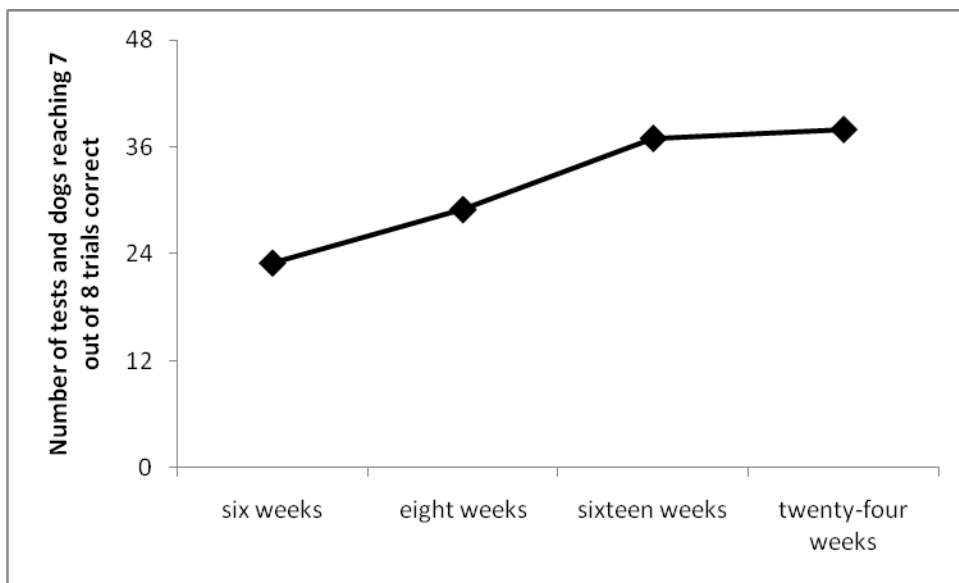
249 bars show one s.e. Asterisk indicates significant difference ($P = 0.025$).

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251

FIGURES

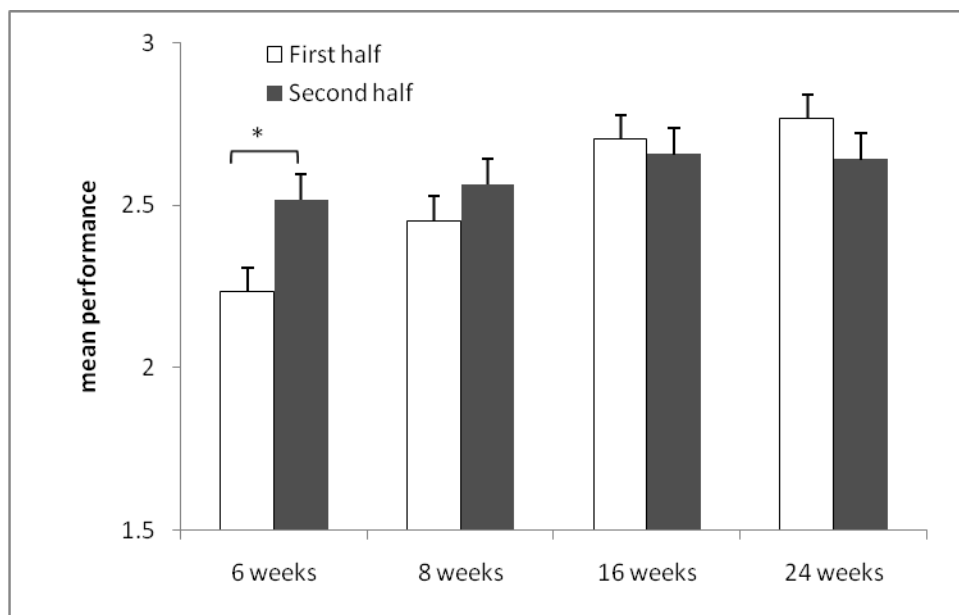
252 Figure 1



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255 Figure 2



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