

1

2

Behavioral and Self-report Measures Influencing Children's

3

Reported Attachment to Their Dog.

4

5

6

7

8

9

10

11 Abstract

12 Despite the prevalence of dogs as family pets and increased scientific interest in canine
13 behavior, few studies have investigated characteristics of the child or dog that influence the
14 child-dog relationship. In the present study, we explored how behavioral and self-report
15 measures influence a child's reported feelings of attachment to their dog, as assessed by the
16 Lexington Attachment to Pets Scale (LAPS). We tested specifically whether children ($N= 99$;
17 Age: $M= 10.25$ years, $SD= 1.31$ years) reported stronger attachment to dogs that were perceived
18 as being more supportive (measured by a modified version of the Network of Relationships
19 Inventory), to dogs that are more successful in following the child's pointing gesture in a
20 standard two-object choice test, or to dogs that solicited more petting in a sociability assessment.
21 In addition, we assessed whether children's attachment security to their parent, and whether
22 being responsible for the care of their dog, influenced reported feelings of attachment to the dog.
23 Overall, perceived support provided by the dog was highly predictive of all subscales of the
24 LAPS. The dog's success in following the child's pointing gesture and lower rates of petting
25 during the sociability assessment were associated with higher ratings on the general attachment
26 subscale of the LAPS, but not of other subscales of the LAPS. Caring for the dog did not predict
27 child's reported attachment to dog, but did predict the dog's behavior on the point following task
28 and petting during the sociability task. If the child cared for the dog, the dog was more likely to
29 be successful on the pointing task and more likely to be petted. These results indicate a dyadic
30 relationship in which the child's care for the dog is associated with the dog's behavior on the
31 behavioral tasks, which in turn is related to the child's reported feelings of attachment. The
32 direction of influence and nature of this dyad will be a fruitful area for future research.

33 **Keywords:** Human animal interaction, dogs, *canis familiaris*, children

34 Behavioral and Self-report Measures Influencing Children's
35 Reported Attachment to Their Dog.

36 Recent years have seen increased scientific interest in the field of human animal
37 interaction, and the results have suggested several potential benefits to pet ownership. One
38 simple benefit of owning a pet dog may be increased exercise in the form of taking a dog for a
39 walk (Anderson, Reid, & Jennings, 1992; Cutt, Giles-Corti, Knuiman, & Burke, 2007).
40 Interacting with and petting a dog has been shown to have several positive physiological benefits
41 such as increases in β -endorphins, prolactin, β -phenylethylamine, oxytocin, and dopamine
42 (Miller et al., 2009; Nagasawa, Kikusui, Onaka, & Ohta, 2009; Nagasawa et al., 2015; Odendaal,
43 2000), and a reduction in blood pressure (Anderson et al., 1992; Demello, 1999; Friedmann,
44 Katcher, Thomas, Lynch, & Messent, 1983). Even mutual gazing with a dog has been shown to
45 increase urinary oxytocin levels (Nagasawa et al., 2009, 2015). Pet ownership may also be
46 beneficial in providing a social catalyst increasing positive social interaction with others (Wells,
47 2004), and interaction with a therapy dog has been shown to increase social interactions amongst
48 residents in a nursing home (Fick, 1993). Children can also form a strong emotional bond with
49 pets (Beck & Madresh, 2008) and pets may provide children a source of non-evaluative
50 companionship (Allen, Blascovich, Tomaka, & Kelsey, 1991).

51 Children have also been shown to receive social and emotional benefits from animals.
52 These benefits include reduced blood pressure, higher empathy scores, and greater emotional
53 stability and social cohesion in the classroom (K. L. Anderson & Olson, 2006; Friedmann et al.,
54 1983; Friedmann & Thomas, 1985; Kotrschal & Ortbauer, 2003; Poresky, 1990; Vidović, Štetić,
55 & Bratko, 1999). In addition, the benefits of animal presence may extend to clinical settings. For
56 example, pet visits may improve the welfare of children in hospital (Wu, Niedra, Pendergast, &

57 McCrindle, 2002), and pet assisted therapy programs may extend to clinical populations such as
58 children with developmental disorders (K. L. Anderson & Olson, 2006; Limond, Bradshaw, &
59 Cormack, 1997; Martin & Farnum, 2002; Nimer & Lundahl, 2007). It is important to note,
60 however, animals can also pose serious risks to children, especially dog bites (Jalongo, 2008;
61 Schalamon et al., 2006). Dog bites in children, compared to adults, are more likely to result in
62 medical treatment (Gilchrist, Sacks, White, & Kresnow, 2008). The high benefits, but potentially
63 high costs, of children interacting with dogs highlights the importance of research on human
64 animal interaction, particularly with children.

65 Pets are prevalent in American homes, with 68% of homes now including a pet
66 (American Pet Products Association survey, 2014). With this high prevalence of pet ownership
67 there has been increasing interest in assessing the relationships formed between people and pets.
68 Among the most widely known measures is the Lexington Attachment to Pets Survey (LAPS),
69 developed by Johnson, Garrity and Stallones (1992), to assess peoples relationship with their
70 pets by having participants respond to what degree they agree or disagree with statements such
71 as, "Quite often I confide in my pet." This empirically derived measure assesses the rater's
72 feelings of attachment to their pet in three subscales: General Attachment, Animal Rights and
73 Welfare, and People Substituting. The LAPS has been used with several populations, including
74 children. For example, Daly and Morton (2006) have shown that children scoring higher on the
75 LAPS attachment scale also tend to be more empathetic.

76 Although dogs are among children's most common 'favorite' pets (Westgarth et al.,
77 2013), little is known about what influences children's feelings of attachment to their dogs. One
78 hypothesis is that children's feelings of attachment towards their dog are linked to their
79 attachment security with their parent. According to Bowlby (1982), the quality of attachment to a

80 parent influences a child's "internal working model" of relationships in general, such that secure
81 attachment between mother and child could extend to higher quality relationships between the
82 child and other social partners. A history of secure attachment to parents predicts better social
83 competence, including the inclination to form closer relationships with others in childhood
84 (Sroufe, 2005), and higher perceived support from their partners upon reaching adulthood
85 (Collins & Feeney, 2004).

86 Variation in dog behaviors, such as how often a dog solicits petting, may also be related
87 to children's feelings of attachment to their dog. Given that petting has known positive
88 physiological effects on the person petting (e.g., Miller et al., 2009; Nagasawa et al., 2009;
89 Odendaal & Meintjes, 2003), such as increased oxytocin levels, it is possible that children may
90 form stronger feelings of attachment to dogs that solicit more petting. The same may be true for
91 dogs that gaze more towards children, as gazes between an adult owner and dog have also been
92 shown to increase oxytocin (Nagasawa et al., 2015, 2009). Finally, interacting with a dog that
93 can better respond to human social behavior may increase feelings of attachment. Work on
94 canine cognition has focused on dogs' remarkable sensitivity to human social behavior, in
95 particular, dogs' ability to follow a human pointing gesture to a target location (Hare, Call, &
96 Tomasello, 1998; Miklósi, Polgárdi, Topál, & Csányi, 1998; Udell, Dorey, & Wynne, 2008).
97 Dogs are also adept at reading human behavior and can utilize a variety of gestures (Miklósi &
98 Soproni, 2005; Udell, Hall, Morrison, Dorey, & Wynne, 2013; Udell, Spencer, Dorey, & Wynne,
99 2012), and types of gazes (Agnetta, Hare, & Tomasello, 2000; Hare & Tomasello, 1999; for a
100 review see Miklósi & Soproni, 2005). Perhaps dogs that perform better on a point-following
101 social cognitive task may be better able to engender stronger feelings of attachment from their
102 child owners.

103 Unfortunately, little research has assessed the child-dog relationship in terms of observed
104 behavioral interactions. The one exception is a series of studies in the 1980s that explored child-
105 dog communicative interactions from videotape (Filiâtre, Millot, & Montagner, 1986; Millot &
106 Filiâtre, 1986; Millot, Filiâtre, Gagnon, Eckerlin, & Montagner, 1988). This research indicated
107 that, in general, children are the initiators of child-dog interactions twice as often as dogs (Millot
108 et al., 1988), and are the ones most likely to seek out contact with the dog (Filiâtre et al., 1986).
109 What is not known, however, is how the dog's response to a child's bids for interaction has an
110 impact on the child's feelings of attachment to the dog.

111 The aim of the present study was to explore the effect of five variables (enumerated
112 below) on children's reported feelings of attachment to their dogs (LAPS General Attachment
113 scale), their reported view of the dog's role in the house (LAPS Animal Rights and Welfare
114 scale), and how central the dog is to their life (LAPS People Substituting scale). We
115 hypothesized that children will report stronger feelings of attachment, more importance, and a
116 more central importance in the child's life to dogs that (1) are more responsive to the child's
117 pointing gesture and, (2) are more likely to seek out contact with the child. With respect to child
118 predictors, the reported feelings of attachment to pet will be examined according to (3) how
119 supportive children report their pet to be as measured by the Network Relationship Inventory
120 scale, and (4) the attachment security children have with their parent (measured by Kerns
121 security scale). Lastly, although Johnson et al. (1992) showed that, for adults, the level of care
122 provided to their pet did not correlate with reported attachment, given developmental differences
123 in the nature of attachment relationships between children and adults, we also tested (5) whether
124 children who are responsible for caring for their dogs will have stronger feelings of attachment to
125 their dogs that those who are not.

148 *General procedure*

149 Children along with a parent and pet dog participated in the study at the research
150 laboratory at the University of (blinded). Parents and children were provided with written
151 consent and assent materials, respectively. Participants and parents were then asked to complete
152 questionnaires in separate rooms (see Questionnaires). The child completed the questionnaires
153 with the aid of an experimenter to ensure comprehension while the dog waited with the parent
154 who filled out questionnaires in the other room. All rooms were temperature controlled and
155 water was available for the dog in the waiting room. In addition, every 45 min an assistant took
156 the dog for a brief walk outside. Following completion of the questionnaires, child-dog
157 interactions were behaviorally measured in a sociability assessment followed by an evaluation of
158 the dog's ability to follow the child's pointing gesture. All procedures were approved by the
159 University of (blinded) Institutional Review Board and the Institutional Animal Care and Use
160 Committee.

161 *Questionnaires*

162 *Lexington Attachment to Pets Scale.* To measure children's attachment to their dogs, they
163 completed the Lexington Attachment to Pet Scale (Johnson et al., 1992). The scale asks children
164 to rate their agreement to statements on a 1-4 Likert scale, with higher scores indicating stronger
165 feelings of attachment. The scale contains three subscales: General Attachment, Animal Rights
166 and Welfare, and Person Substituting. General Attachment includes statements relating to the
167 general relationship the respondent has with the dog, such as "My pet and I have a very close
168 relationship," and "I consider my pet to be a great companion". Animal Rights and Welfare
169 indicates the pet's status in the household and includes statements such as "I think my pet is just
170 a pet," and "I believe pets should have the same rights and privileges as family members."

171 Person Substituting indicates how central the dog is to the respondent's life, which is assessed
172 through ratings of statements such as "My pet means more to me than any of my friends," and "I
173 love my pet because it never judges me." Cronbach's α for this study was 0.75.

174 *Kerns Security Scale.* Children's perceived attachment security with their mother was
175 assessed using the Kerns Security Scale (Kerns, Klepac, & Cole, 1996). On this scale, children
176 are asked to rate 15 statements such as "Some kids find it easy to trust their mom BUT other kids
177 are not sure if they can trust their mom," on a 1-4 scale with higher scores indicating more secure
178 attachment. A total security score was computed by averaging all item scores. Cronbach's α in
179 this study was 0.75.

180 *Modified NRI.* Perceived support from pet dogs were reported by children using the
181 Network of Relationships Inventory (NRI; Furman & Buhrmester, 1985). The original NRI,
182 which had 21 items, was designed to assess perceived support across various diverse social
183 relationships such as teachers and peers. An example of the items is "How often do you tell this
184 person everything that you are going through?" The NRI was evaluated in a pilot study with
185 children owning pet dogs to determine the relevance of items for assessing child-pet
186 relationships. With the exception of three items reflecting instrumental aid (e.g., "How much
187 does this person help you figure out things?"), all items were retained, resulting in a modified
188 questionnaire of 18 items. Items were scored on a 1 – 5 Likert scale and the scores were
189 averaged to create a total score of perceived support. Cronbach's α in this study was 0.91.

190 *Dog information.* Parents completed questionnaires indicating the dog's breed, age, and
191 sex. The dog's breed was subsequently classified into one of the following categories to test for
192 possible confounding effects of breed: lap dogs (toy breeds such as Maltese and Chihuahua,
193 $n=32$), sporting breeds (Labrador retrievers and golden retrievers, $n=20$), herders (e.g., German

194 shepherds, Australian shepherds, $n=19$), terriers/ratters (e.g., Jack Russell terrier, rat terrier,
195 $n=13$), bully/fighting breeds (e.g., Pit bulls, bulldogs, boxers, $n=11$), and unknown mixes ($n=5$;
196 (Protopopova et al., 2012). The questionnaire also asked parents whether children were
197 responsible for any of three aspects of pet care: walking the dog, feeding the dog, or grooming
198 the dog. Nine parents reported that their child engaged in none of these behaviors, thirty-nine
199 children were reported as responsible for at least one task, and fifty-one were responsible for
200 multiple tasks. This information was used to create a binary variable, which indicated either the
201 child was responsible for at least one aspect of dog care or the child did not have any
202 responsibility in caring for the dog.

203 *Behavioral measures*

204 *Sociability assessment.* The aim of this assessment was to measure the amount of time the
205 child and dog spent interacting while the child was sitting quietly in a room (4.5m by 3m) that
206 contained a chair, desk, and lamp. During this 10-min task, adapted and developed from one
207 reported by Jakovcevic, Mustaca and Bentosela, (2012), the child sat in a chair at the center of a
208 1 m radius semi-circle that was marked with tape. The child was asked to stay in the seat during
209 the test and was instructed to call the dog over once at the beginning of the session and once
210 again halfway through. The child was asked to otherwise remain neutral unless the dog entered
211 the semi-circle. If the dog entered this circle the child was permitted to pet the dog and interact
212 with it as if they were at home. Two observers were present during every session and provided
213 appropriate guidance to the child if necessary. One observer was previously familiar with the dog
214 from waiting with the dog with the parent. The dog had a brief period to greet the other observer
215 (<5 min), while the child was given instructions for the task. During the assessment, observers
216 stood in the back of the room and were unresponsive to the dog if it approached.

217 *Behavioral coding.* Two trained observers scored each session live on two dimensions:
218 gazing and petting. Each behavior was scored using partial-interval recording by breaking the
219 ten-minute session into 120 5-s epochs. If the dog engaged in a target behavior during that epoch,
220 the interval was scored. The proportion of epochs in which a behavior was scored was calculated
221 for each behavior, and averaged across the two observers. Gazing was defined as the percentage
222 of 5-s intervals in which the dog's head and eyes turned to look at the child's upper body and
223 head for at least 1 sec. Petting was defined as the percentage of intervals in which the dog and
224 child make physical contact. Inter-observer agreement was calculated by dividing the number of
225 epochs in which the two-observers agreed by the total number of epochs. Inter-observer
226 agreement was 87.4% for gazing and 94.7% for petting.

227 *Gesture following.* The aim of the gesture following test was to assess the dog's ability to
228 utilize the child's social communicative cues in a two-object choice task. Specifically, we
229 assessed the dog's spontaneous ability to follow a momentary distal point to one of two paint
230 cans using a procedure modified procedure from Udell et al. (2008). In the present study a
231 clicker was not used to mark correct choices. In this task the child was placed between two cans
232 (1 m apart) and made a brief gesture toward one of the paint cans while the dog was watching 1.5
233 m away. The aim of this task is to assess whether the dog comprehended the child's pointing
234 gesture and followed the gesture to the correct can.

235 *Task familiarization.* Prior to the testing session the child and dog each received a brief
236 introduction to familiarize them with the materials and environment. Testing was conducted in
237 the same room as the sociability assessment. First, the child was instructed on how to point to
238 one of the cans in the absence of the dog. The experimenters conducted five practice trials with
239 the child to insure the child was comfortable with the procedure. If the child performed all five

240 practice-trials correctly, an assistant brought the dog into the room. If the child did not perform
241 all practice trials correctly, additional trials were conducted until the child responded
242 appropriately. Once the dog entered the room, it was familiarized to the paint cans, by having the
243 child place a dog treat on top of the left and right paint cans alternately, twice each. Pupperoni™
244 was used as the dog treat, or if a dog showed hesitancy to take Pupperoni™, small pieces of a
245 commercial brand hot dog were used. Four dog showed signs of fear of the cans, and in these
246 cases the lids of the can were used instead of the cans themselves.

247 *Test trials.* The test trials assessed whether, when a child pointed to one of two objects,
248 the dog responded to this gesture as communicative and investigated the pointed-to object.
249 Alternatively, the dog could investigate the opposite object or not respond to either object. To
250 insure the child correctly implemented the procedure, the child was guided through each
251 component of this assessment by an assistant. The child was first directed to stand between two
252 empty paint cans 1 m apart and then asked to call the dog to gain its attention, while a second
253 assistant held the dog back at least 1.5 m. Once the dog attended to the child, the child was told
254 which can to point to. The child then pointed to that can for approximately 2 sec and was told to
255 return to a neutral position. The dog was then released to assess whether it would follow the
256 child's point and approach the pointed-to can. A choice was defined as touching one of the paint
257 cans, or approaching within 10 cm of a can. If the dog approached the correct can, the child was
258 told to place a treat on top of the can for the dog. The child only held a few treats in their non-
259 pointing hand at a time, and an assistant gave the child more treats if needed throughout the
260 session. If the dog approached the incorrect can, it was called back for the next trial without
261 receiving a treat. If the dog failed to approach either can within 30 sec, a no-choice was recorded
262 and scored as incorrect. 'No choices' were scored as incorrect because we were interested in the

263 dog's spontaneous response to a child's pointing gesture. In some prior studies on point
264 following in dogs, if a dog does not make a choice, the trial is repeated until it does so (e.g.,
265 Pongrácz, Gácsi, Hegedüs, Péter, & Miklósi, 2013). We did not do this, because we expected
266 that the child may form different feeling of attachment to a dog that immediately attends to their
267 pointing gesture compared to dogs that only attend to their pointing gesture after several
268 attempts. If the dog failed to respond for two trials in a row, or made three incorrect responses in
269 succession, two trials in which food was simply placed on top of the can were conducted to
270 insure the dog was sufficiently food motivated to participate and not fearful of the cans. If a dog
271 failed to approach the can and take the food on these trials, it was considered insufficiently
272 motivated to continue participation. This occurred for two dogs, and they were not included in
273 the final sample.

274 *Control trials.* Control trials were conducted to insure the dog was following the child's
275 gesture and not unintentional cues such as odor. For these trials, all procedures were identical to
276 test trials except the child did not point (i.e., the child was still informed of the 'correct' can and
277 the dog was reinforced if it went to the 'correct' can). If the dog was successfully following only
278 the pointing cue, and not relying on unintentional cues then we expected its performance on
279 these trials never to exceed chance.

280 Each dog received a total of ten test trials and six control trials. Control trials were
281 interspersed after every two test-trials and two control trials were conducted at the end of the
282 session. For each trial, the location of the correct can was pseudo-randomly determined so that
283 the same side was not correct more than twice in row and counterbalanced so that each side was
284 correct on half of the trials.

285 *Statistical Analyses*

286 Linear regression was used to assess whether children reported higher scores on each
287 LAPS scale if (1) dogs were reported as being more supportive, (2) dogs were more responsive
288 to their pointing gestures, (3) dogs spent more time in proximity, gazing or contact with the child
289 in a sociability assessment, (4) children were responsible for dogs' care, (5) or children reported
290 more secure attachments to the primary caregiver. Backwards elimination was used to determine
291 those factors most strongly associated with children's attachment to the pet dog. To test the five
292 hypotheses, an initial regression model was fit with control variables for the breed of the dog and
293 sex of the child. The experimental predictors were then added to the full model, which was
294 subjected to backwards elimination based on Akaike's Information Criterion (AIC) utilizing the
295 step routine in statistical software package R to identify the optimal regression model (R Core
296 Team, 2013).

297 In addition, we also wanted to assess whether the children's responsibility for caring for
298 their dog was associated with the dog's behavior. Here we tested whether having the child care
299 for the dog was associated with two outcome variables: (1) how much petting occurred during
300 the sociability assessment, and (2) how well the dog followed the child's pointing gesture. We
301 hypothesized that if children care for the dog, we would observe higher rates of petting during
302 the sociability assessment. In addition, we hypothesized that caring for the dog would lead to
303 more success at following the child's gesture. To explore these hypotheses, two separate linear
304 regressions were conducted. The first explored whether petting during the sociability assessment
305 was predicted by whether the child cared for the dog, and included the dog breed and child
306 gender as control variables. The second regression assessed whether these same predictors and
307 control variables were related to success in following the child's pointing gesture. Both models
308 were then subjected to backwards elimination using the AIC as described above.

309 Results

310 *Summary of behavioral measures*

311 *Sociability assessment.* Petting showed high inter-observer agreement (mean inter-
312 observer agreement: 94.7%). Petting was observed on average during 50% of the observed
313 epochs of the sociability assessment (SD= 31%). Gazing showed an acceptable but lower inter-
314 observer agreement (87.4%), likely due to the difficulty in determining the precise direction in
315 which the dog and child were gazing. On average, gazing was observed much less than petting
316 and in only 19% of the epochs (SD= 15%).

317 *Gesture following.* Overall, dogs responded correctly on 74% of the children's points,
318 which is significantly greater than chance (one sample t-test, $t_{98} = 10.40, p < .0001$). The dog's
319 accuracy for following children's points fell well within the expected range for dogs following a
320 momentary distal point given by an experimenter or an adult owner (Udell et al., 2008). In
321 addition, based on performance on control trials there was no indication that children were
322 giving their dogs unintentional cues. Although dogs performed above chance when the child
323 pointed, they were not above chance on control trials when the child refrained from pointing
324 (mean performance on control trials 28%, one-sided t-test, $t_{98} = -9.19, p = 1$). Thus, the dogs
325 were overall following the children's points and were not influenced by unintentional cues from
326 the child.

327 *Predictors of Child Attachment to Dog (LAPS)*

328 *Subscale: General Attachment.* The final reduced model following backward elimination
329 (adjusted $R^2 = .27, p < .001$) indicated that children reported stronger feelings of attachment to
330 dogs that scored higher on the pointing task ($F_{(1,94)} = 7.38, p = <.01, \beta = .24$) and to dogs that
331 were petted less during the sociability assessment ($F_{(1,94)} = 4.21, p = .04, \beta = -.18$). Children also

332 indicated stronger feelings of attachment to dogs that were reported as being more supportive
333 ($F_{(1,94)} = 27.58, p = <.001, \beta = .46$), but only marginally stronger if they reported greater
334 attachment security with their parent ($F_{(1,95)} = 2.74, p = <.10, \beta = .15$). The breed of the dog, sex
335 of the child, and gazing during the sociability task were removed as non-significant predictors of
336 feelings of attachment during model selection.

337 *Subscale: Animal Rights and Welfare.* Using the same procedure as for General
338 Attachment, we assessed which variables predicted the Animal Rights and Welfare Scale from
339 the LAPS (adjusted $R^2 = .12, p < .01$). Unlike General Attachment, only perceived support
340 (modified NRI) predicted Animal Rights and Welfare in the final model ($F_{(1,95)} = 13.19, p =$
341 $<.001, \beta = .35$). Petting and child gender were retained in the final model based on fit statistics
342 but neither significantly predicted the Animal Rights Welfare scale ($F_{(1,95)} = 2.47, p = .12, \beta = -$
343 $.15; F_{(1,95)} = 2.46, p = .12, \beta = -.15$, respectively). All other experimental variables were
344 removed during model selection.

345 *Subscale: People Substituting.* The final model for People Substituting (adjusted $R^2 =$
346 $.28, p < .001$) was only influenced by the perceived support modified NRI measure ($F_{(1,97)} =$
347 $38.27, p < .00001, \beta = .53$). All other variables, however, did not improve model fit according to
348 the AIC and were removed (see Table 2).

349 *Predictors of sociability and gesture following.*

350 Above we identify the variables that influenced the child's reported feelings of
351 attachment to their dog. Next we tested the hypothesis that, if children are responsible for
352 providing dogs with reinforcers such as feeding or walking, their dogs would be more responsive
353 to their gestures, and more petting would be observed during the sociability task. Dogs that were
354 cared for by the children scored higher overall on the gesture following task than dogs that the

355 child did not feed, walk or groom (see Figure 1; $F_{(1,97)} = 5.43, p = .02, \beta = .23$). The breed of the
356 dog and child gender were removed as non-significant predictors of gesture following during
357 model fitting. Similarly, dogs that were fed, walked or groomed by children were more likely to
358 be in contact and petted during the sociability assessment (see Figure 1; $F_{(1,97)} = 6.21, p = <.01, \beta$
359 $= .24$), but petting was not predicted by the breed of the dog or child gender, both of which were
360 removed as non-significant predictors.

361 Discussion

362 The results indicate that several child and dog characteristics are associated with
363 children's reported general attachment (LAPS General Attachment) to their dog. Prior research
364 has found several benefits children and adults may gain from a relationship with a pet. For
365 example, stronger attachments to pets are associated with higher empathy scores in children
366 (Daly & Morton, 2006), and relationships with pets may provide a secure attachment relationship
367 for adults (Beck & Madresh, 2008) and provide a source of non-evaluative support (Allen et al.,
368 1991). The present research extends upon this by exploring variables that contribute to the
369 strength of this relationship. Our results indicate that the strength of the child-dog attachment is
370 associated with how supportive the dog is reported to be, how well the dog follow's the child's
371 gestures, and is associated with less petting during our sociability task.

372 Our finding that children reported stronger feelings of attachment to dogs that followed
373 their pointing gesture, builds upon the work of Filiâtre and colleagues (1986) who previously
374 showed that children are the major initiators of interactions with pet dogs. Here, we show that
375 children report stronger feelings of attachment to dogs that are better able to respond
376 appropriately to their gestures. Petting during the sociability assessment was also associated with
377 child feelings of attachment towards the dog, but the direction of the association was reversed

378 compared to our hypotheses. Higher General Attachment scores were associated with less petting
379 during the sociability assessment. The reason for this negative association is not clear, but
380 perhaps children report stronger feeling of attachment to dogs that solicit less petting in novel
381 surroundings when the dog might be expected to engage in more exploratory behavior rather
382 than solicit petting. Further research, however, is needed to determine what is driving this
383 association. Regardless of the direction of effect, however, both significant associations indicate
384 that children attend to dogs' behaviors, which influences their reported feelings of attachment to
385 their dogs.

386 Interestingly, dog behaviors were associated only with General Attachment and not with
387 the Animal Rights and Welfare or the People Substituting scales of the LAPS. This suggests that
388 feelings of attachment towards a pet dog are directly influenced by the dog's behavior, but
389 feelings on the dog's role in the family or how central the dog is to child's life are not. Those
390 components of child's feelings towards their pets may be dependent on other dog behaviors not
391 assessed in this study, or more general attitudes about animals or pets. The results across the
392 three LAPS subscales suggest that the dog's ability to follow points and the amount of petting
393 that was observed in the sociability task are not associated with all types of attitudes and feelings
394 regarding pets, but are associated specifically with feelings of attachment towards the pet.

395 The level of social support the dog provides (as reported by the child via the NRI) was
396 highly associated with children's reported attachment to their dog. In fact, the social support
397 scale was the only variable strongly related to all three subscales of the LAPS. This indicates that
398 the dog's perceived social support is relevant not only for feelings of attachment to their pet dog
399 but also for children's self-reported feelings regarding animal rights and welfare and the degree
400 to which they view pets as similar to human social partners.

401 Notably, the NRI has, to our knowledge, never previously been applied to assessing
402 child-pet relationships. The observed relations between social support as indexed by the NRI
403 with all three subscales of the LAPS provides evidence for some degree of convergent validity
404 between these two measures. Given that the NRI is commonly used to index children's
405 relationships with (multiple) social partners other than parents, this measure could be useful for
406 examining the impact of child-pet relationships within the child's broader social networks.

407 The results also indicated a trend towards an association between children's attachment
408 security to their parent with their feelings of attachment towards their dog. This marginal
409 association likely reflects the fact that attachment with the primary caregiver is a more distal
410 (early development) predictor compared to some of the other, more proximal predictors assessed
411 in this study. Attachment security to a primary caregiver is widely believed to provide the
412 foundation for children's internal working model that broadly impacts other, later developing
413 social relationships (Sroufe and Waters, 1977; Weinfield, Sroufe, & Egeland, 2000). Although
414 attachment security to the parent is typically considered an early life predictor, we used this
415 measure because there has been less methodological research on attachment in middle childhood
416 (for exceptions see Kerns, Klepac & Cole, 1996; Target, Fonagy, & Shemueli-Goetz, 2003).
417 Given that attachment security is an early developmental predictor, even a marginal association
418 with attachment security in middle childhood suggests attachment security may be important in
419 the later development of relationships with pets.

420 We found no evidence that caring for the pet dog (walking, feeding, or grooming) was
421 associated with increased feelings of attachment towards the dog. These results are consistent
422 with findings in adults (Johnson et al., 1992). None of our control variables, the breed of the dog
423 nor child gender, were significantly associated with any of the LAPS scales. Children reported

424 no stronger feelings of attachment for companion dogs (toy breeds such as Maltese) over other
425 dogs such as larger family dogs (e.g. golden retrievers), or bully breeds such as pit bulls.

426 Although we found no association between whether a child was responsible for care of
427 their dog and the LAPS scales, caring for the dog was a significant predictor of the dog's
428 gesture-following behavior, as well as the probability it would be petted during the sociability
429 assessment. These results suggest an interesting bi-directional influence on the child-dog
430 relationship, such that dogs may be sensitive to whether children interact with the dog, and
431 children are sensitive to how well dogs responds to their communicative gestures.

432 There are several limitations worth considering in the present study. One is that our
433 outcome variable was reported attachment to the dog using the LAPS. Although the
434 psychometric properties of the LAPS have been previously discussed (Johnson et al., 1992) and
435 it has been associated with higher empathy scores in children (Daly & Morton, 2006), it is not
436 clear whether higher LAPS scores are associated with benefits to the child. Future research will
437 be needed to determine how the reported attachment to a dog is related to benefits the child may
438 receive from the dog. Another limitation is that although we observed that whether the child
439 cared for the dog was a potentially import factor in the dog's behavior, we did not directly
440 observe the quality and nature of the care the child reported, but instead relied on parent report.
441 A future research program could evaluate how the child's behavior and interaction with the dog
442 more directly influences the dog's social behavior towards the child.

443 In sum, we show that children's reported feelings of attachment to their dog are
444 positively associated with the dog's ability to follow the child's pointing gesture, children's
445 reported social support provided by the dog (NRI scale), and negatively associated with the
446 amount of petting that occurred spontaneously in a laboratory environment while the child sat

447 quietly. No associations with reported attachment to the dog were observed for the breed of the
448 dog, child gender, or whether the child was typically responsible for the care of the dog at home.
449 Children's feelings about animal rights and welfare, as well as the degree to which they view
450 pets similarly to people, were only related to how supportive the child rated the dog. The dog's
451 ability to follow gestures and amount of petting, however, were related to whether the child was
452 responsible for the care of the dog. Overall, these findings reveal dyadic relationships in which
453 dogs' behaviors are associated with the children's reported feelings of attachment towards their
454 dogs, and the dog's behavior was associated with whether the child was responsible for caring
455 for the dog.

456 **References**

- 457
458 American Pet Products Association. (July 2014). Household penetration rates for pet ownership
459 in the United States from 1988 to 2013 . In Statista - The Statistics Portal. Retrieved
460 October 24, 2014, from [http://www.statista.com/statistics/198086/us-household-](http://www.statista.com/statistics/198086/us-household-penetration-rates-for-pet-owning-since-2007/)
461 [penetration-rates-for-pet-owning-since-2007/](http://www.statista.com/statistics/198086/us-household-penetration-rates-for-pet-owning-since-2007/)
- 462 Agnetta, B., Hare, B., & Tomasello, M. (2000). Cues to food location that domestic dogs (*Canis*
463 *familiaris*) of different ages do and do not use. *Animal Cognition*. 3: 107–112.
- 464 Allen, K. M., Blascovich, J., Tomaka, J., & Kelsey, R. M. (1991). Presence of human friends and
465 pet dogs as moderators of autonomic responses to stress in women. *Journal of*
466 *Personality and Social Psychology*. 61: 582–589. doi:10.1037/0022-3514.61.4.582
- 467 Anderson, K. L., & Olson, M. R. (2006). The value of a dog in a classroom of children with
468 severe emotional disorders. *Anthrozoos: A Multidisciplinary Journal of The Interactions*
469 *of People & Animals*. 19: 35–49. doi:10.2752/089279306785593919
- 470 Anderson, W., Reid, C., & Jennings, G. (1992). Pet ownership and risk factors for cardiovascular
471 disease. *The Medical Journal of Australia*. 157: 298–301.
- 472 Beck, L., & Madresh, E. A. (2008). Romantic partners and four-legged friends: An extension of
473 attachment theory to relationships with pets. *Anthrozoös*. 21: 43–56.
474 doi:10.2752/089279308X274056
- 475 Bowlby, J. (1982). Attachment and loss: Retrospect and prospect. *American Journal of*
476 *Orthopsychiatry*. 52: 664–678. doi:10.1111/j.1939-0025.1982.tb01456.x
- 477 Collins, N. L., & Feeney, B. C. (2004). Working Models of Attachment Shape Perceptions of
478 Social Support: Evidence From Experimental and Observational Studies. *Journal of*
479 *Personality and Social Psychology*. 87: 363–383. doi:10.1037/0022-3514.87.3.363

- 480 Cutt, H., Giles-Corti, B., Knuiaman, M., & Burke, V. (2007). Dog ownership, health and physical
481 activity: A critical review of the literature. *Health & Place*. 13: 261–272.
482 doi:10.1016/j.healthplace.2006.01.003
- 483 Daly, B., & Morton, L. L. (2006). An investigation of human–animal interactions and empathy
484 as related to pet preference, ownership, attachment, and attitudes in children. *Anthrozoos:
485 A Multidisciplinary Journal of The Interactions of People & Animals*. 19: 113–127.
486 doi:10.2752/089279306785593801
- 487 Demello, L. R. (1999). The effect of the presence of a companion-animal on physiological
488 changes following the termination of cognitive stressors. *Psychology & Health*. 14: 859–
489 868. doi:10.1080/08870449908407352
- 490 Fick, K. M. (1993). The Influence of an Animal on Social Interactions of Nursing Home
491 Residents in a Group Setting. *American Journal of Occupational Therapy*. 47: 529–534.
492 doi:10.5014/ajot.47.6.529
- 493 Filiâtre, J. C., Millot, J. L., & Montagner, H. (1986). New data on communication behaviour
494 between the young child and his pet dog. *Behavioural Processes*. 12: 33–44.
495 doi:10.1016/0376-6357(86)90068-9
- 496 Friedmann, E., Katcher, A., Thomas, S. A., Lynch, J. J., & Messent, P. R. (1983). Social
497 Interaction and Blood Pressure: Influence of Animal Companions. *The Journal of
498 Nervous and Mental Disease*. 171: Retrieved from
499 [http://journals.lww.com/jonmd/Fulltext/1983/08000/Social_Interaction_and_Blood_Press
500 ure__Influence.2.aspx](http://journals.lww.com/jonmd/Fulltext/1983/08000/Social_Interaction_and_Blood_Pressure__Influence.2.aspx)
- 501 Friedmann, E., & Thomas, S. (1985). Health Benefits of Pets for Families. *Marriage & Family
502 Review*. 8: 191–203. doi:10.1300/J002v08n03_14

- 503 Furman, W., & Buhrmester, D. (1985). Children's perceptions of the personal relationships in
504 their social networks. *Developmental Psychology*. *21*: 1016–1024. doi:10.1037/0012-
505 1649.21.6.1016
- 506 Gácsi, M., Gyoöri, B., Virányi, Z., Kubinyi, E., Range, F., Belényi, B., & Miklósi, Á. (2009).
507 Explaining Dog Wolf Differences in Utilizing Human Pointing Gestures: Selection for
508 Synergistic Shifts in the Development of Some Social Skills. *PLoS ONE*. *4*: e6584.
509 doi:10.1371/journal.pone.0006584
- 510 Gee, N. R., Friedmann, E., Stendahl, M., Fisk, A., & Coglitore, V. (2014). Heart Rate Variability
511 During a Working Memory Task: Does Touching a Dog or Person Affect the Response?
512 *Anthrozoos: A Multidisciplinary Journal of The Interactions of People & Animals*. *27*:
513 513–528. doi:10.2752/089279314X14072268687763
- 514 Gilchrist, J., Sacks, J. J., White, D., & Kresnow, M.-J. (2008). Dog bites: still a problem? *Injury*
515 *Prevention*. *14*: 296–301. doi:10.1136/ip.2007.016220
- 516 Hare, B., Call, J., & Tomasello, M. (1998). Communication of Food Location Between Human
517 and Dog (*Canis Familiaris*). *Evolution of Communication*. *2*: 137–159.
518 doi:10.1075/eoc.2.1.06har
- 519 Hare, B., & Tomasello, M. (1999). Domestic dogs (*Canis familiaris*) use human and conspecific
520 social cues to locate hidden food. *Journal of Comparative Psychology*. *113*: 173–177.
521 doi:10.1037/0735-7036.113.2.173
- 522 Jakovcevic, A., Mustaca, A., & Bentosela, M. (2012). Do more sociable dogs gaze longer to the
523 human face than less sociable ones? *Behavioural Processes*. *90*: 217–222.
524 doi:10.1016/j.beproc.2012.01.010

- 525 Jalongo, M. R. (2008). Beyond a Pets Theme: Teaching Young Children to Interact Safely with
526 Dogs. *Early Childhood Education Journal*. 36: 39–45. doi:10.1007/s10643-008-0272-1
- 527 Johnson, T. P., Garrity, T. F., & Stallones, L. (1992). Psychometric Evaluation of the Lexington
528 Attachment to Pets Scale (LAPS). *Anthrozoos: A Multidisciplinary Journal of The*
529 *Interactions of People & Animals*. 5: 160–175. doi:10.2752/089279392787011395
- 530 Kerns, K. A., Klepac, L., & Cole, A. (1996). Peer relationships and preadolescents' perceptions
531 of security in the child-mother relationship. *Developmental Psychology*. 32: 457–466.
532 doi:10.1037/0012-1649.32.3.457
- 533 Kotrschal, K., & Ortbauer, B. (2003). Behavioral effects of the presence of a dog in a classroom.
534 *Anthrozoös*. 16: 147–159. doi:10.2752/089279303786992170
- 535 Limond, J. A., Bradshaw, J. W. S., & Cormack, M. K. F. (1997). Behavior of Children with
536 Learning Disabilities Interacting with a Therapy Dog. *Anthrozoos: A Multidisciplinary*
537 *Journal of The Interactions of People & Animals*. 10: 84–89.
538 doi:10.2752/089279397787001139
- 539 Martin, F., & Farnum, J. (2002). Animal-Assisted Therapy for Children with Pervasive
540 Developmental Disorders. *Western Journal of Nursing Research*. 24: 657–670.
541 doi:10.1177/019394502320555403
- 542 Miklósi, Á., Polgárdi, R., Topál, J., & Csányi, V. (1998). Use of experimenter-given cues in
543 dogs. *Animal Cognition*. 1: 113–121. doi:10.1007/s100710050016
- 544 Miklósi, Á., & Soproni, K. (2005). A comparative analysis of animals' understanding of the
545 human pointing gesture. *Animal Cognition*. 9: 81–93. doi:10.1007/s10071-005-0008-1
- 546 Miller, S., Kennedy, C., DeVoe, D., Hickey, M., Nelson, T., & Kogan, L. (2009). An
547 Examination of Changes in Oxytocin Levels in Men and Women Before and After

- 548 Interaction with a Bonded Dog. *Anthrozoos: A Multidisciplinary Journal of The*
549 *Interactions of People & Animals*. 31–42. doi:10.2752/175303708x390455
- 550 Millot, J. L., & Filiâtre, J. C. (1986). The behavioural sequences in the communication system
551 between the child and his pet dog. *Applied Animal Behaviour Science*. 16: 383–390.
552 doi:10.1016/0168-1591(86)90010-9
- 553 Millot, J. L., Filiâtre, J. C., Gagnon, A. C., Eckerlin, A., & Montagner, H. (1988). Children and
554 their pet dogs : How they communicate. *Behavioural Processes*. 17: 1–15.
555 doi:10.1016/0376-6357(88)90046-0
- 556 Nagasawa, M., Kikusui, T., Onaka, T., & Ohta, M. (2009). Dog's gaze at its owner increases
557 owner's urinary oxytocin during social interaction. *Hormones and Behavior*. 55: 434–
558 441. doi:10.1016/j.yhbeh.2008.12.002
- 559 Nagasawa, M., Mitsui, S., En, S., Ohtani, N., Ohta, M., Sakuma, Y., ... Kikusui, T. (2015).
560 Oxytocin-gaze positive loop and the coevolution of human-dog bonds. *Science*. 348:
561 333–336. doi:10.1126/science.1261022
- 562 Nimer, J., & Lundahl, B. (2007). Animal-Assisted Therapy: A Meta-Analysis. *Anthrozoos: A*
563 *Multidisciplinary Journal of The Interactions of People & Animals*. 20: 225–238.
564 doi:10.2752/089279307X224773
- 565 Odendaal, J. S. (2000). Animal-assisted therapy - magic or medicine? *Journal of Psychosomatic*
566 *Research*. 49: 275–280.
- 567 Odendaal, J. S., & Meintjes, R. A. (2003). Neurophysiological Correlates of Affiliative
568 Behaviour between Humans and Dogs. *The Veterinary Journal*. 165: 296–301.
569 doi:10.1016/S1090-0233(02)00237-X

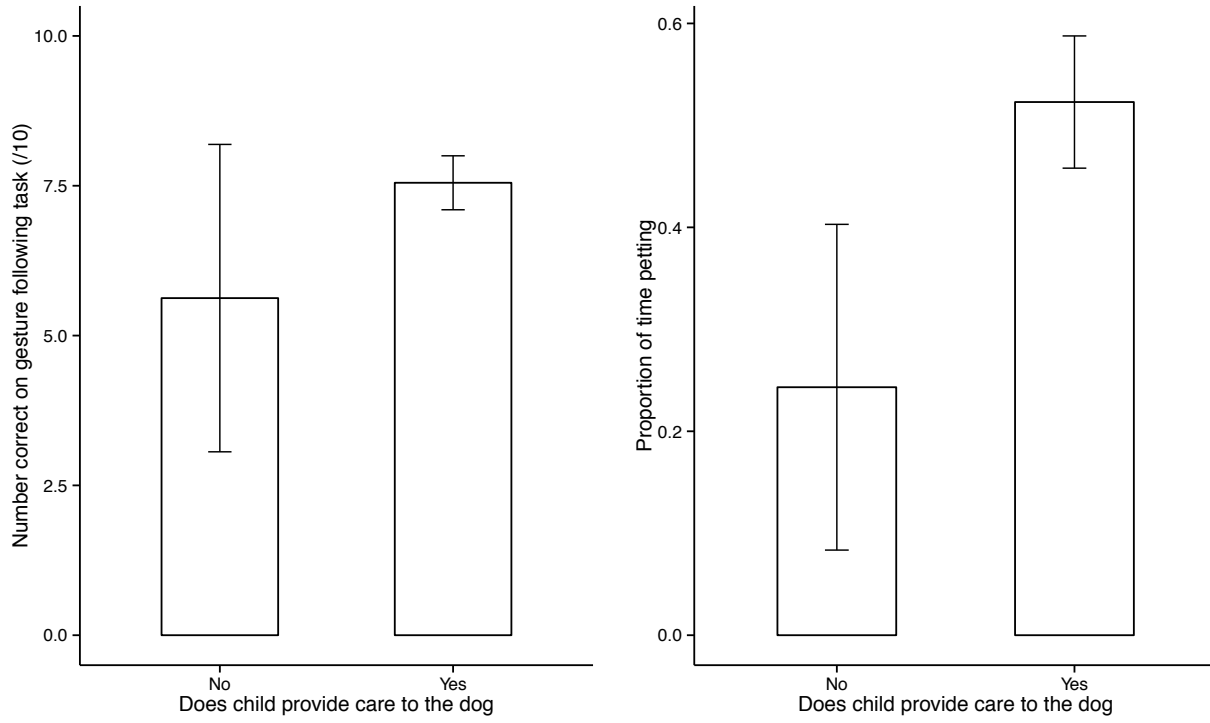
- 570 Pongrácz, P., Gácsi, M., Hegedüs, D., Péter, A., & Miklósi, Á. (2013). Test sensitivity is
571 important for detecting variability in pointing comprehension in canines. *Animal*
572 *Cognition*. *16*: 721–735. doi:10.1007/s10071-013-0607-1
- 573 Poresky, R. H. (1990). The young children's empathy measure: Reliability, validity and effects
574 of companion animal bonding. *Psychological Reports*. *66*: 931–936.
- 575 Protopopova, A., Gilmour, A. J., Weiss, R. H., Shen, J. Y., & Wynne, C. D. L. (2012). The
576 effects of social training and other factors on adoption success of shelter dogs. *Applied*
577 *Animal Behaviour Science*. *142*: 61–68. doi:10.1016/j.applanim.2012.09.009
- 578 R Core Team. (2013). *R: A language and environment for statistical computing*.
- 579 Schalamon, J., Ainoedhofer, H., Singer, G., Petnehazy, T., Mayr, J., Kiss, K., & Höllwarth, M.
580 E. (2006). Analysis of Dog Bites in Children Who Are Younger Than 17 Years.
581 *Pediatrics*. *117*: e374–e379. doi:10.1542/peds.2005-1451
- 582 Sroufe, L. A. (2005). Attachment and development: A prospective, longitudinal study from birth
583 to adulthood. *Attachment & Human Development*. *7*: 349–367.
584 doi:10.1080/14616730500365928
- 585 Sroufe, L. A., & Waters, E. (1977). Attachment as an organizational construct. *Child*
586 *development*, 1184-1199.
- 587 Target, M., Fonagy, P., & Shmueli-Goetz, Y. (2003). Attachment representations in school-age
588 children: the development of the child attachment interview (CAI). *Journal of child*
589 *psychotherapy*, *29*(2), 171-186.
- 590 Udell, M., Dorey, N. R., & Wynne, C. D. L. (2008). Wolves outperform dogs in following
591 human social cues. *Animal Behaviour*. *76*: 1767–1773.

- 592 Udell, M., Dorey, N. R., & Wynne, C. D. L. (2010). What did domestication do to dogs? A new
593 account of dogs' sensitivity to human actions. *Biological Reviews*. 85: 327–345.
594 doi:10.1111/j.1469-185X.2009.00104.x
- 595 Udell, M., Hall, N. J., Morrison, J., Dorey, N. R., & Wynne, C. D. L. (2013). Point Topography
596 and Within-Session Learning Are Important Predictors of Pet Dogs' (*Canis lupus*
597 *familiaris*) Performance on Human Guided Tasks. *Revista Argentina de Ciencias Del*
598 *Comportamiento*. 5: 3–20.
- 599 Udell, M., Spencer, J. M., Dorey, N. R., & Wynne, C. D. L. (2012). Human-Socialized Wolves
600 Follow Diverse Human Gestures... And They May Not Be Alone. *International Journal*
601 *of Comparative Psychology*. 25: Retrieved from <http://escholarship.org/uc/item/9rb9d1zk>
- 602 Vidović, V. V., Štetić, V. V., & Bratko, D. (1999). Pet Ownership, Type of Pet and Socio-
603 Emotional Development of School Children. *Anthrozoos: A Multidisciplinary Journal of*
604 *The Interactions of People & Animals*. 12: 211–217. doi:10.2752/089279399787000129
- 605 Weinfield, N. S., Sroufe, L. A., & Egeland, B. (2000). Attachment from infancy to early
606 adulthood in a high-risk sample: Continuity, discontinuity, and their correlates. *Child*
607 *development*, 71(3), 695-702.
- 608 Wells, D. L. (2004). The facilitation of social interactions by domestic dogs. *Anthrozoos: A*
609 *Multidisciplinary Journal of The Interactions of People & Animals*. 17: 340–352.
610 doi:10.2752/089279304785643203
- 611 Westgarth, C., Boddy, L. M., Stratton, G., German, A. J., Gaskell, R. M., Coyne, K. P., ...
612 Dawson, S. (2013). Pet ownership, dog types and attachment to pets in 9–10 year old
613 children in Liverpool, UK. *BMC Veterinary Research*. 9: 102. doi:10.1186/1746-6148-9-
614 102

- 615 Wu, A. S., Niedra, R., Pendergast, L., & McCrindle, B. W. (2002). Acceptability and impact of
616 pet visitation on a pediatric cardiology inpatient unit. *Journal of Pediatric Nursing*. 17:
617 354–362. doi:10.1053/jpdn.2002.127173
618
619

620 **Figure Captions**

621
622 **Figure 1.** Performance on the behavioral tasks and whether child was responsible for caring for
623 the dog. The left figure shows the mean number correct (/10) on the point following task for dog
624 that were following the gestures of children that were responsible for the care of their dog
625 compared to children that were not responsible for the care of their dog. Error bars show 95%
626 confidence intervals. Right figure show the mean proportion of intervals of the sociability
627 assessment in which petting occurred. Bars show mean and error bars show 95% confidence
628 intervals.
629



630
631
632

Figure 1