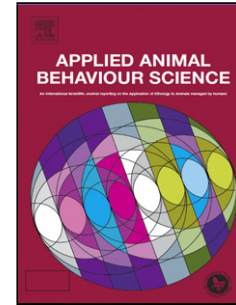


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Title: Choice of conflict resolution strategy is linked to sociability in dog puppies

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1 **Choice of conflict resolution strategy is linked to sociability in dog puppies**

2

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11

12 Measures that are likely to increase sociability in dog puppies, such as appropriate socialisation, are  
13 considered important in preventing future fear or aggression related problems. However, the interplay  
14 between sociability and conflict behaviour has rarely been investigated. Moreover, while many studies  
15 have addressed aggression in domestic dogs, alternative, non-aggressive conflict resolution strategies  
16 have received less scientific attention. Here we tested 134 Border collie puppies, aged 40-50 days, in a  
17 personality test which included friendly interactions with an unfamiliar person, exposure to a novel  
18 object, and three brief restraint tests. Considering the latter to be mild 'conflict' situations, we  
19 analysed whether the puppies' behaviour in the restraint tests was related to their sociability or to their  
20 boldness towards the novel object. Strategies employed by the puppies during restraint tests included  
21 trying to interact socially with the experimenter, remaining passive, and attempting to move away. In  
22 line with findings from humans and goats, puppies scoring high on sociability were more likely to  
23 adopt an interactive conflict resolution strategy, while those with low sociability scores tended to react  
24 passively. In contrast, avoidance behaviours were unrelated to sociability, possibly reflecting  
25 inconsistency in the flight strategy in dogs. Boldness towards a novel object was not related to  
26 sociability or to puppies' reactions in restraint tests. This is one of the first studies to demonstrate a  
27 link between sociability and conflict resolution strategies in non-human animals.

28

**29 Keywords:**

30 Conflict resolution, personality, sociability, boldness, dog puppies, *Canis familiaris*

31

## 32 **1. Introduction**

33           Group-living confers many advantages to animals such as increased foraging or prey-capture  
34 efficiency, defence of kills and territory, vigilance and defence against predators, and rearing of young  
35 (Krause & Ruxton, 2002). However, there are costs associated with sociality such as increased  
36 competition, incompatible goals, or clashes of interest regarding the coordination of activities or travel  
37 decisions, which may lead to inter-individual conflicts (Aureli & De Waal, 2000; Preuschoft & van  
38 Schaik, 2000; Aureli et al., 2002; Bergmüller & Taborsky, 2010). To maintain the benefits of group  
39 living and avoid the costs of aggressive interactions, behavioural conventions such as greeting  
40 gestures, reconciliation (affiliative post-conflict behaviours between former adversaries), and the  
41 establishment of dominance relationships are common in group living animals (de Waal 2000,  
42 Preuschoft & van Schaik 2000, Aureli et al., 2002).

43

44           Conflict management strategies such as appeasement, submission, or avoidance serve to  
45 increase tolerance within the group, control aggression and reduce conflicts (reviewed in Aureli & de  
46 Waal, 2000; Aureli et al., 2002; Miranda-de la Lama et al., 2011). In the behavioural context, a  
47 strategy can be defined as a behaviour or collection of behaviour patterns which an individual uses to  
48 achieve a goal, whereby different behavioural solutions to the same problem may be equally  
49 successful (Mendl & Deag, 1995). It has been suggested that personality represents an important,  
50 underlying factor for individuals' choices of strategy (Miranda de la Lama et al., 2011). Work  
51 primarily on rodents and some birds has shown that responses to challenge – referred to as 'coping  
52 styles' – are often related to a suite of other behavioural tendencies, as well as physiological responses:  
53 Proactive individuals are bolder, more explorative, and tend to react to stressful events with a fight-or-  
54 flight response, whereas reactive individuals show lower aggressiveness, tend to freeze in aversive  
55 situations, and are more flexible to environmental changes (Benus et al., 1991; Koolhaas et al., 1999;  
56 Carere et al., 2010).

57

58           In humans, personality factors, especially those related to social interactions – extraversion  
59 and agreeableness – are suggested to be helpful predictors of individual preferences of conflict

60 resolution strategies (Wood & Bell, 2008). Similarly, it has been suggested that behaviour, such as use  
61 of aggression, in non-human animals can be predicted and manipulated based on a knowledge of  
62 individual coping strategies (Mendl & Deag, 1995). However, there is a lack of studies on conflict  
63 behaviour other than aggression and post-conflict reconciliation (reviewed in de Waal, 2000, Aureli et  
64 al., 2002) in non-human animals, particularly in non-primate species (Judge, 2000; Aureli et al., 2002;  
65 but see Miranda-de la Lama et al., 2011). Moreover, apart from the coping styles model, where the  
66 presence or absence of a fight/flight response or freezing in a challenging situation is inherent in the  
67 definition of two behavioural extremes (proactive and reactive coping styles, Koolhaas et al., 1999),  
68 links between personality and behaviour in social conflict situations in non-human animals have  
69 received little scientific attention (but see Thierry, 2000; Cote & Clobert, 2007; Miranda-de la Lama et  
70 al., 2011).

71  
72 Domestic dogs (*Canis familiaris*) constitute a suitable model species to investigate the  
73 proposed link between personality and conflict resolution for various reasons. Over the course of  
74 domestication, they appear to have evolved specialised and flexible social skills for reading human  
75 social and communicative behaviour (Hare & Tomasello, 2005), and the human environment and  
76 social setting has become their natural ecological niche (Miklósi et al., 2004). Thus, it is possible to  
77 test dogs' personality and conflict behaviours outside of the laboratory environment but in a  
78 standardised way by using a human test person. Many studies have described different personality  
79 traits in domestic dogs including reactivity, fearfulness, trainability, aggressiveness and sociability  
80 (reviewed in Jones & Gosling, 2005). Surprisingly, not much scientific information is available on  
81 conflict resolution strategies in dogs (but see Cools et al., 2008, for reconciliation following  
82 intraspecific conflict). A few papers report dogs' differential responses in inter-group conflicts  
83 (Bonnani et al., 2010), or to a threatening human (Vas et al., 2005, 2008; Horváth et al., 2007; De  
84 Meester et al., 2008; Györi et al., 2008). Walker et al. (1997) classified dogs' strategies in relation to  
85 fear behaviour, adapting the model by Marks (1987a as cited by Walker et al., 1997) - freeze  
86 (immobility), flight (withdrawal, escape, avoidance), flirt (deflection of attack and appeasement/  
87 submission), and fight (aggressive defence). Lindsay (2005) similarly suggested the following five

88 behavioural reactions in conflict situations in dogs: fight, flight, flirt, freeze (wait for the situation to  
89 change), and forbear (tolerate or accept the situation).

90

91 Relating personality and conflict resolution in dogs has been addressed only to the extent that  
92 behavioural assessments have aimed at identifying dogs' tendency to react aggressively, typically by  
93 threatening or manipulating the dog or by removing resources from the dog (e.g. Netto & Planta,  
94 1997; Bollen & Horowitz, 2008; De Meester et al., 2008; van der Borg et al., 2010; Bennett et al.,  
95 2012). There is currently a lack of scientific data on dogs' use of alternative, non-aggressive, conflict  
96 resolution strategies. Our aim was therefore to determine alternative conflict resolution strategies in  
97 dogs and to investigate whether dogs' reactions to a perceived conflict situation are related to their  
98 personality, particularly their sociability and boldness.

99

100 We compared the behaviour of 134 Border collie puppies in a friendly greeting situation with  
101 an unfamiliar person to that in three restraint tests (a back test, a simulated veterinary examination and  
102 staring into the puppies' eyes), which could be perceived as conflicts by the dogs. We predicted that  
103 the puppies' sociability is positively correlated with active but nonaggressive ways of conflict  
104 resolution (interaction, c.f. flirt strategy), and negatively with aggressive (fight strategy) or avoidant  
105 (flight strategy) strategies (c.f. Walker et al., 1997; Lindsay, 2005). Passivity could either indicate high  
106 tolerance (forbearing) or constitute a freeze strategy (c.f. Lindsay, 2005). While highly sociable  
107 puppies might potentially be more tolerant of handling, less sociable puppies might be more likely to  
108 freeze during handling; therefore no a priori prediction was made. Given a suggested association  
109 between boldness and reactions in the back test (e.g. Hessing et al., 1994 – but see Forkman et al.,  
110 1995), we furthermore analysed whether boldness towards a novel object was related to behaviour in  
111 the restraint tests.

112

113

## 114 **2. Methods**

115 All procedures were performed in compliance with the Austrian animal protection law and the

116 University of Vienna's ethics guidelines, and with the breeders' consent. No special permission for use  
117 of animals in such non-invasive socio-cognitive studies is required in Austria.

118

### 119 *2.1. Subjects and test setup*

120 We tested 134 Border collie puppies (aged 40-50 days, 72 males and 62 females) from 23  
121 litters of 15 different breeders in a personality test. All breeders were small-scale breeders (with  
122 typically 1-2 litters per year) and bred according to FCI (Fédération Cynologique Internationale)  
123 standards, and the puppies spent most of their time in the house. Due to the risk of disease contraction  
124 for the young puppies, all tests were carried out at the breeders' homes, but in rooms that were  
125 unfamiliar to the puppies (only one litter had to be tested in a familiar room because no unfamiliar  
126 room was available).

127

### 128 *2.2. Behavioural tests*

129 All tests were conducted by the same experimenter (SR), who was unfamiliar to the puppies  
130 prior to the test. A cameraman filmed the test for subsequent video analysis. Besides the experimenter  
131 and the cameraman, the breeder or a familiar person was present in 62 of the 134 tests – this was  
132 accounted for in the analysis (see below).

133

134 The test lasted about 20 minutes per puppy and consisted of eleven subtests exposing the  
135 puppy to different social and non-social stimuli (see Table 1 for descriptions of the subtests). These  
136 form part of a test routinely used for assessing puppies' suitability as service dogs (Erik Kersting,  
137 Hundezentrum Canis Familiaris, pers. comm.). Social tests started after an initial exploration phase of  
138 two minutes in which the puppy was free to explore the unfamiliar surroundings. None of the people  
139 present interacted with the puppy during this time. The first social test was the greeting test (subtest 2)  
140 to assess sociability. The three restraint tests (subtests 6-8), back test, vetcheck test and staring test,  
141 followed after three subtests that were not used for analysis here (see Table 1). The novel object test  
142 constituted the final test in the sequence.

143

144           Following the restraint tests, the experimenter resolved the situation by crouching,  
145 encouraging the puppies to approach, and interacting with the puppies in a friendly way. Despite  
146 constituting potentially stressful situations, the restraint tests did not appear to affect the puppies'  
147 ensuing behaviour in a negative way. They did not show strongly submissive or fearful behaviours  
148 during the restraint tests; only one puppy that had recently woken up urinated during the back test.  
149 After the test, the puppies usually returned to the experimenter when encouraged to exchange  
150 affiliative interactions.

151

### 152 *2.3. Data processing*

153           The puppies' behaviour was scored by the first author from the videos, using Solomon coder  
154 (© András Péter), according to the definitions in Table 2. A range of socio-positive behaviours was  
155 scored during the greeting test (subtest 2), using ordinal scores and presence/ absence of behaviours.  
156 For the back test (subtest 6), durations of struggling and vocalising were coded. In the vetcheck test  
157 (subtest 7), attempts to interact with the experimenter by licking or mouthing of the experimenter's  
158 fingers/ face and escape behaviour were noted. In the staring test (subtest 8), the number of times the  
159 puppy averted its gaze was counted. In the novel object test, approach latency, tail position and  
160 whether or not the puppies 'hunted' the novel object (i.e., jumped at the object with their fore paws  
161 and/ or bit into it) were scored and minimum distance to the novel object was estimated (Table 2). For  
162 tests terminated prematurely due to measurement error (back test: N=12, range 14.6-24.8 s; staring  
163 test: N=7, range 14-29.2 s), durations and frequencies were extrapolated to the full duration.

164

165           Reliability coding for the above variables was performed by two coders coder not involved in  
166 the study for 20 randomly selected puppies, one from each of 20 litters, with one coder coding the  
167 greeting test and the restraint tests and the other coding the novel object test. Reliability was assessed  
168 using Cohen's weighted kappa for scores and Cronbach's alpha for frequencies, durations and  
169 estimated distance. Correspondence of coders was good for all coded variables: Cohen's weighted  
170 kappa was 0.71 for approach latency score, 0.88 for jumping up, 0.70 for tail-wagging score, and 0.67  
171 for giving the paw/ rolling over in the greeting test, 1.0 for interacting with the experimenter during



172 the vetcheck test, 0.83 for fleeing during the vetcheck test, 1.0 for passive behaviour during the  
173 vetcheck test, 0.67 for approach latency score in the novel object test, 0.92 for tail position during the  
174 novel object test, and 0.89 for hunting of the novel object. Cronbach's alpha was 0.95 for duration of  
175 struggling during the back test, 0.84 for duration of vocalising during the back test, 0.88 for frequency  
176 of gaze avoidance during the staring test, and 0.89 for the estimated minimum distance of the puppies  
177 to the novel object.

178

179 Statistical analysis was carried out using R 2.12.0 (R Development Core Team, 2010) and  
180 SPSS Statistics 21. (IBM Corp. Armonk, NY, 2012). Sample size was 134 for all tests. Nonlinear  
181 principal components analyses (called CATPCA or categorical principal components analyses in  
182 SPSS; Linting et al., 2007, Linting & Kooji, 2012) were performed on relevant subsets of variables to  
183 obtain components for sociability, conflict resolution strategies, and boldness.

184

185 Linear mixed models (LMM) were calculated to assess effects of sociability and boldness on  
186 behaviour in conflict situations. Components derived from the restraint tests were dependent variables,  
187 and sociability (assessed in the greeting test), boldness in the novel object test, and presence or  
188 absence of the breeder (to account for a possible effect of the breeder's presence on the puppies'  
189 behaviour during the test) were included as fixed effects. Interactions between the predictors were  
190 included in the initial models, but none of these turned out as significant and so they are not discussed  
191 in the results. Also, presence of the breeder did not act as a confounding factor (no effect in any of the  
192 models) and is therefore not discussed further. Therefore, we present reduced models where only the  
193 main predictors – sociability and boldness – were retained. Litter nested within breeder was included  
194 as a random effect in the initial models. Subsequently we computed alternative models without  
195 random effects or with breeder only or litter only as a random effect and compared goodness of fit of  
196 the different models with likelihood ratio tests.

197

### 198 **3. Results**

#### 199 *3.1. Greeting Test*

200 Latency to approach the stranger, amount of tail wagging, jumping up and pawing/ rolling  
201 over all had high positive loadings on the first component of the CATPCA (Table 3), accounting for  
202 44.7% of total variance. This component was labelled ‘Sociability’ and was used in the ensuing  
203 analysis.

204

### 205 3.2. Restraint tests

206 The puppies showed various behavioural reactions when faced with potential conflict  
207 situations in the restraint tests. All but two puppies struggled during the back test, and 114 of the 134  
208 puppies also vocalised. The median proportion of time spent struggling and vocalising was 71.7%  
209 (Interquartile Range IQR=51.7-85.3%) and 25.3% (IQR=4.7-50.7%) respectively. Only two puppies  
210 displayed aggression (snapping at the experimenter’s hand) during the back test. Due to the 1/0  
211 scoring system, only distinct responses were identified in the vetcheck test: 51 puppies (38.1%) were  
212 passively tolerating the procedure; 37 puppies (27.6%) tried to interact with the experimenter by  
213 mouthing or licking the experimenter’s fingers/ face but did not attempt to escape; 34 puppies (25.4%)  
214 tried to move away but did not interact with the tester; and 12 puppies (9.0%) showed both interaction  
215 and escape attempts. During these handling procedures, no stiffness or other signs of aggression were  
216 shown by the puppies. During the staring test, the number of times the puppies averted their gaze  
217 ranged from 0 to 20 (median = 8, IQR=4-11).

218

219 The CATPCA of the restraint test variables yielded 3 components accounting for 76.8% of  
220 total variance (Table 4). Puppies with high values on the first component ‘Passive/ Low Interaction’  
221 tended to show passivity or low levels of responses in all three restraint tests. Puppies with low values  
222 on the first component tried to diffuse the situation through social interaction or social signalling, such  
223 as by licking or mouthing of the experimenter’s hands or face during the vetcheck test, looking away  
224 during the staring test, and (to a lesser extent) also struggling and vocalising during the back test.  
225 Puppies with high values on the second component ‘Flight’ tried to escape during the vetcheck test  
226 and were less likely to show passive behaviour, looking away and vocalising. Puppies with high  
227 values on the third component ‘Struggle’ showed a lot of struggling in response to the back test and

228 also tended to look away during the staring test.

229

### 230 3.3. Novel Object test

231 The first component, labelled 'Boldness' accounted for 63.48% of variance. A short latency to  
232 approach the novel object, tail position and 'hunting' of the novel object loaded highly negatively on  
233 this component, while minimum distance to the novel object had a high positive loading (Table 5).

234 Thus, high values on this component indicate a lack of boldness.

235

### 236 3.4. Relationship between 'Sociability', 'Boldness' and behaviour in restraint tests

237

#### 238 *Effects on the 'Passive/ Low Interaction' component*

239 A LMM assessing the effect of 'Sociability' and 'Boldness' on a 'Passive/ Low Interaction'  
240 response yielded a highly significant negative effect of 'Sociability' (Table 6, Fig. 1a). That is, more  
241 sociable puppies were more likely to interact with the tester and less likely to show a passive response  
242 in the potential conflict situations. In contrast, 'Boldness' had no significant effect on the dependent  
243 variable (Table 6). Likelihood ratio tests showed that goodness of fit of a model with litter nested  
244 within breeder as random effect was significantly better than that of a model including only breeder as  
245 random effect (L.Ratio=12.59,  $p<0.001$ ), but did not differ from a model including only litter as  
246 random effect (L.Ratio<0.001,  $p=0.99$ ). The latter model was therefore retained (Table 6). This model  
247 was significantly better than a model without random effects (L.Ratio=22.54,  $p<0.001$ ),  
248 demonstrating an effect of litter on the tendency to show a passive or interaction response in restraint  
249 tests.

250

#### 251 *Effects on the 'Flight' component*

252 Neither 'Sociability' nor 'Boldness' had a significant effect on the 'Flight' component (Fig.  
253 1b, Table 6). A model with litter nested within breeder as a random effect was significantly better than  
254 a model without random effects but did not differ significantly from models with either breeder only  
255 (L.Ratio<0.001,  $p=0.99$ ) or litter only as a random effect (L.Ratio= 1.03,  $p= 0.31$ ; Table 6). Both

256 models were significantly better than a model without random effects (random effect - breeder:  
257 L.Ratio=9.85,  $p=0.0017$ ; random effect - litter: L.Ratio= 8.81,  $p=0.003$ ), demonstrating that the  
258 tendency to flee differed between puppies from different breeders or litters, but was not related to  
259 puppies' 'Sociability'.

260

#### 261 *Effects on the 'Struggle' component*

262 A model testing for effects of 'Sociability' and 'Boldness' on the 'Struggle' component found  
263 no significant effect for either predictor (Table 6, Fig. 1c). A model including litter nested within  
264 breeder as a random effect did not differ significantly from a model including only litter  
265 (L.Ratio=0.006,  $p=0.99$ ) but was significantly better than a model including only breeder  
266 (L.Ratio=15.53,  $p=0.001$ ). The model including litter as a random effect was also significantly better  
267 than a model without random effects (L.Ratio=19.70,  $p<0.001$ ) and was therefore selected (Table 6).

268

269 In summary, 'Sociability' was positively associated with interaction during restraint tests and  
270 negatively with passivity. In contrast, there was no relationship of 'Sociability' with flight responses  
271 and struggling. 'Boldness' was unrelated to reactions in the restraint tests. Responses in restraint tests  
272 were, however, affected by litter or breeder.

273

274

#### 275 **4. Discussion**

276 The dog puppies showed much variation in their willingness to engage positively with the  
277 unfamiliar experimenter during the greeting test, which was assumed to measure sociability. The  
278 fourth to eight weeks of life are particularly important in the socialisation of dog puppies (Lord 2013);  
279 thus puppies' behavioural responses may have been affected by previous experiences with unfamiliar  
280 people and handling procedures. Nonetheless, this does not preclude the notion of personality, as the  
281 expression of personality traits is influenced by an interaction of genes and experiential factors  
282 (Stamps & Groothuis 2010). Litter or breeder significantly affected responses in all restraint tests,  
283 suggesting that the puppies' behaviour was influenced by genetics, maternal factors, and/ or early

284 environment. The relative influences of these cannot be determined from our data.

285

286 The CATPCA components of behaviour in the three restraint tests can be considered to reflect  
287 three (or four) different conflict resolution strategies. Puppies that showed no or few overt behavioural  
288 reactions had high values of the first component ('Passive/ Low Interaction'), which may be  
289 comparable to a freeze response (Walker et al., 1997 and Lindsay 2005), forbearing (Lindsay 2005),  
290 'standing still' during a physical examination (Åkerberg et al., 2011), a passive strategy as found by  
291 Vas et al. (2008, 2005), or tolerating (Györi et al., 2010). In contrast, low values on the 'Passive/ Low  
292 Interaction' component were associated with interaction with the experimenter (licking, mouthing, and  
293 gaze aversion). This might correspond to the flirt strategy defined by Walker et al. (1997) and Lindsay  
294 (2005), or to dogs' friendly or contact-seeking responses towards a human who is threatening them  
295 (Vas et al., 2008, 2005; Györi et al., 2010) or performing a physical examination (Åkerberg et al.,  
296 2011). The second component ('Flight') corresponds to a flight strategy (Walker et al., 1997; Lindsay  
297 2005; De Meester et al., 2008) or can be compared to dogs' active avoidance/ moving off (Vas et al.,  
298 2005, 2008; Györi et al., 2010).

299

300 Struggling in the back test, the variable that loaded most highly on the third component, could  
301 be interpreted as an attempt to escape the situation (thus it could be classified as a flight strategy, c.f.  
302 Forkman et al., 1995) or as a fight strategy (Walker et al., 1997). Struggling was not associated with  
303 aggressive behaviour (fight strategy), as only two puppies displayed any aggression (snapping during  
304 the back test) at all. This lack of aggressive responses could be explained by the young age of the  
305 puppies and/ or because they did not perceive the tests as severely threatening. If we interpret  
306 struggling as avoidance behaviour, then the puppies with high values on the third component could be  
307 said to display both elements of active avoidance (moving away) and passive avoidance (gaze  
308 aversion) after Vas et al. (2008). Notably, struggling during the back test seemed to be unrelated to  
309 escape responses during the vetcheck test; however, the loading of looking away on the 'Struggle'  
310 factor would be suggestive of avoidance behaviour, rather than a fight response.

311

312           It is possible that flight responses are a more inconsistent strategy in dogs than other forms of  
313 conflict resolution: When analysing test-retest responses to a threatening human, Vas et al. (2008)  
314 found that dogs exhibiting friendly or threatening behaviour tended to respond consistently in a  
315 subsequent test, whereas dogs classified as active avoidant (moved away behind the owner from the  
316 approaching stranger whilst keeping eye contact) or passive avoidant (interrupted the eye contact with  
317 the stranger and averted its gaze permanently) altered their responses (Vas et al., 2008). If dogs'  
318 avoidance behaviour in social situations is generally inconsistent as suggested by Vas et al. (2008),  
319 this could explain the lack of a relationship between the 'Flight' and the 'Struggle' components and  
320 with 'Sociability' in our study. Moreover, the main variables on the components 'Flight' and  
321 'Struggle' differ in that the flight response was scored as present/ absent, whereas the dominating  
322 variable of the 'Struggle' component – proportion of time spent struggling – was a continuous  
323 variable. The puppies may have perceived the back test as more threatening than the vetcheck test and  
324 so nearly all of them exhibited some degree of struggling during the back test, whereas only 25.4%  
325 tried to escape during the vetcheck test. Such a situational change in response strategy is in line with  
326 Vas et al.'s (2008) interpretation who suggest that the change in behavioural responses of 'active  
327 avoidant' or 'passive avoidant' dogs with repeated testing may can be regarded as different  
328 manifestations of the same continuum, for example representing approach/ avoidance motivational  
329 conflicts.

330

331           No correlation between 'Boldness' towards a novel object and the 'Struggle' component (or  
332 any of the other components of conflict resolution) was found; neither was there an interaction  
333 between 'Boldness' and 'Sociability'. This lack of a relationship between social and non-social tests  
334 indicates that sociability and conflict behaviour in dog puppies may not reflect a generalised coping  
335 style or behavioural syndrome extending to non-social behaviours. Similarly, MacDonald (1987)  
336 found fear of objects to be unrelated to attraction towards humans in young wolves, and Forkman et al.  
337 (1995) reports the lack of a relationship between numbers of escape attempts during the back test in  
338 piglets and their performance in other behavioural tests including a novel object test, extinction of a  
339 learned response, aggressiveness and social dependence. We conclude that social behaviour and

340 boldness towards a non-social stimulus and are not related in our sample of well-socialised dog  
341 puppies. Clearly higher generalised fearfulness can be expected in puppies that have received little  
342 social and non-social stimulation, such as those raised in non-domestic environments (c.f. Appleby et  
343 al., 2002), which might explain the reported relationship between the factors ‘Sociability’ and  
344 ‘Curiosity/Fearlessness’ in domestic dogs (Svartberg, 2002).

345

346 We acknowledge that conclusions about personality should be cautious as no measure of  
347 temporal consistency (inherent in the definition of personality) is available in this study. However, our  
348 findings are in agreement with results from human children: In developmental psychology, children  
349 are often classified into three groups according to their styles of emotional regulation, which seem to  
350 be related to both their sociability and their conflict resolution strategies (Blair et al., 2004). Children  
351 described as ‘highly inhibited’ tended to show socially withdrawn behaviour and passive coping in  
352 conflict situations, which corresponds to those puppies that showed low interest and little affiliative  
353 behaviour towards the stranger during the greeting test and tended to react passively in the restraint  
354 tests. Children who are ‘optimally regulated’ were found to exhibit the most positive, adaptive  
355 behaviour in conflict situations and were judged as more sociable and socially competent (Blair et al.,  
356 2004). These may correspond to puppies with high sociability scores. As aggression was hardly  
357 observed in our study, we found no equivalents to children classified as ‘undercontrolled’, who score  
358 low in prosocial behaviour and are most likely to employ non-constructive strategies such as reactive  
359 aggression when in a social conflict situation (Blair et al., 2004).

360

361 There are furthermore parallels between our study and a study on domestic goats (*Capra*  
362 *hircus*) in a related context, third-party intervention in conflicts and use of agonistic or affiliative  
363 strategies. Goats with an ‘affiliative profile’ engaged in frequent affiliative interactions during  
364 everyday life and primarily used active, non-agonistic strategies when in a conflict situation, aiming to  
365 reduce social tension (Miranda-de la Lama et al., 2011). These individuals can be compared to puppies  
366 with low ‘Passive/ Low Interaction’ scores, which showed high sociability towards the experimenter  
367 and reacted to restraint tests by trying to interact with the experimenter. In contrast, goats with a

368 passive profile seemed indifferent to their social environment, neither engaging in affiliative  
369 interactions nor in conflicts – similarly as the puppies scoring high on the ‘Passive/ Low Interaction’  
370 component. The ‘avoider profile’ in goats, characterised by an avoidance of conflicts, could be  
371 compared to puppies scoring high on the ‘Flight’ component and presumably also on the ‘Struggle’  
372 component; however, as discussed above, the flight – or avoidance – strategy seemed less consistent in  
373 our study and was not related to sociability. Finally, goats with an ‘aggressive’ profile used aggression  
374 as the main mechanism of social relationships. At least in the interaction with humans, consistent  
375 aggressive strategies may be unlikely to occur in domestic dogs, which have been selected for low  
376 levels of aggression and a high level of social tolerance towards humans (e.g. Hare et al., 2012) and  
377 developed effective mechanisms to negotiate interactions and avoid the escalation of conflicts in  
378 interaction with humans (Györi et al., 2010).

379  
380

## 381 **5. Conclusions**

382 We show that conflict resolution strategies are related to sociability in dog puppies. The most  
383 sociable puppies were most likely to employ active and communicative ways of conflict resolution,  
384 while passive responses were negatively associated with sociability. These results add to previous  
385 findings that dogs showing aggression obtained lower sociability scores in a behavioural assessment  
386 (Valsecchi et al., 2011). They are further in agreement with the proposed importance of measures  
387 which are likely to increase puppies’ sociability (i.e. appropriate socialisation) in preventing future  
388 problem behaviour (e.g. Freedman et al., 1961, Serpell, 1995, Duxbury & Anderson, 2003). Even  
389 though our sociability measure is rather rough and can only represent a snapshot in time, the observed  
390 relationship between dog puppies’ sociability and conflict resolution strategies is in line with findings  
391 from other species. The relationship of sociability and conflict behaviour in adult dogs, as well as their  
392 stability over time, warrants further research.

393

394

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404

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510 **Tables**

511

512 **Table 1**

513 Summary of the subtests of the puppy personality test. Tests used for the present paper are in bold  
514 font.

515 **Table 2**

516 Scoring of variables derived from video analysis of behaviour in the various subtests. Subtests are  
517 numbered as in Table 1.

518 **Table 3**

519 Variable loadings on the CATPCA component ‘Sociability’ and accounted variance.

520 **Table 4**

521 Variable loadings on the three CATPCA components from the restraint tests and accounted variance.

522 **Table 5**

523 Variable loadings on the CATPCA component ‘Boldness’ and accounted variance.

524 **Table 6**

525 Summary of mixed effects models, showing effects of ‘Sociability’ and ‘Boldness’ (fixed effects) on  
526 the restraint test components ‘Passive/ Low Interaction’, ‘Flight’, and ‘Struggle’. All presented models  
527 include litter as a random effect.

528

529 **Figure captions**

530

531 **Fig. 1**

532 Individuals' object scores for the 'Sociability' component plotted against object scores for (a)

533 'Passive/ Low Interaction' (b) 'Flight' and (c) 'Struggle'.

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1 Table 1

	<b>Subtest</b>	<b>Description</b>	<b>Aim</b>	<b>Duration</b>
1.	Room exploration	The puppy was allowed to explore the unfamiliar room for two minutes; experimenter, cameraman and breeder remained passive.	Not used for analysis here.	60 s
2.	<b>Greeting test</b>	<b>The experimenter crouched down approximately 2.5 m away from the puppy and encouraged it to make contact by calling its name, chatting in a friendly voice or clicking her tongue. When the puppy approached, she petted the puppy and talked to it in a friendly way for 20 seconds. If the puppy did not want to approach within 45 seconds, the subtest was terminated.</b>	<b>Determining individual sociability.</b>	<b>60 s</b>
3.	Play	The experimenter tried to engage the puppy in play by wiggling a soft toy in front of it. When the puppy was following and/or trying to grab the toy for at least 10 seconds, she threw it two metres away and vocally encouraged the puppy to return to her with the toy. This was repeated three times.	Not used for analysis here.	2-3 min
4.	Following test	The experimenter started walking away from the puppy, encouraging the puppy to follow by calling it, clicking her tongue, and clapping her hands, changing direction of movement several times.	Not used for analysis here.	60 s
5.	Problem solving	The experimenter showed some pieces of sausage to the puppy and then placed them under a transparent cup, which the pup had to knock over to obtain the food. This was repeated three times.	Not used for analysis here.	2-4 min
6.	<b>Back test</b>	<b>The experimenter was sitting on the floor and gently turned the puppy on its back, holding it in this position with both hands while casually looking at the puppy, but not staring at it in a threatening way.</b>	<b>Determining conflict resolution strategies.</b>	<b>25 s</b>

7.	<b>Vetcheck test</b>	<b>Simulated veterinary examination. The experimenter, sitting on the floor, stroked the puppy's body, touched its paws, looked into its ears and examined its teeth.</b>	<b>Determining conflict resolution strategies.</b>	<b>30 s</b>
8.	<b>Staring test</b>	<b>The experimenter lifted the puppy up, holding it upright under its armpits, so that she could look directly into its eyes. When the puppy averted its gaze, the experimenter reoriented the puppy and took up eye contact again.</b>	<b>Determining conflict resolution strategies.</b>	<b>30 s</b>
9.	Startle test	A balloon was burst approximately 3 m away from the puppy. Thereafter, the experimenter behaved cheerfully and tried to engage the puppy in play.	Not used for analysis here.	60 s
10.	Table test	The puppy was placed at the centre of a table for one minute. Four different dog toys had been placed in the four corners of the table for the puppy to explore.	Not used for analysis here.	60 s
11.	<b>Novel object test</b>	<b>A battery-powered toy looking like a paper bag, approx. 20 x 10 x 5 cm, was placed approx. 2 m away from the puppy to assess its reactions to the novel object's erratic movements.</b>	<b>Determining boldness.</b>	<b>60 s</b>

3 **Table 2**

	<b>Variable</b>	<b>Type</b>	<b>Score</b>	<b>Description</b>
<b>2</b>	<b><u>Greeting test</u></b>			
2a.	Approach latency	Rating	0	Does not approach the experimenter (10 cm from experimenter's hands) within 45 seconds.
			1	Approaches the experimenter within 21-45 seconds after she started calling.
			2	Approaches the experimenter within 11-20 seconds after she started calling.
			3	Approaches the experimenter within 10 seconds after she started calling.
2b.	Tail-wagging	Rating	0	Wags tail <30% of interaction time.
			1	Wags tail 30-69% of interaction time.
			2	Wags tail 70% or more of interaction time.
2c.	Jumping up	Absence/ Presence	0 1	Does not jump up or climb into experimenter's lap. Jumps up or climbs into experimenter's lap.
2d.	Pawing/ rolling over	Absence/ Presence	0 1	Does not give the paw or attempt to roll over. Gives the paw or rolls over/ performs intention movements to roll over.
<b>6.</b>	<b><u>Back test</u></b>			
6a.	Struggling	Duration	% time	Quick movements of body, head, and legs. Does not include slow movement of individual limbs or the

head. Absolute duration in seconds (precision 0.2 s).

6b. Vocalising      Duration      % time      Duration of vocalisations. Absolute duration in s (precision 0.2 s).

**7. Vetchek test**

7a. Flight      Absence/      0      No escape attempt.  
 Presence      1      Escape attempt (trying to move away with the whole body while being held – does not include movement with the head to avoid teeth control or walking away when not held).

7b. Interaction      Absence/      0      Mouthing or licking of experimenter's fingers/ face for <20% of the time.  
 Presence      1      Mouthing or licking of experimenter's fingers/ face for at least 20% of the time.

**8. Staring test**

8. Look away      Event      Frequency      Averting gaze (head turn away from experimenter's face). This is followed by the experimenter reorienting the puppy to look into its eyes again.

**10. Novel object test**

10a. Approach      Rating      1      Does not approach to within 20 cm of the novel object within 30 s.  
 latency  
 2      Approaches to within 20 cm of the novel object after 5 s.  
 3      Approaches to within 20 cm of the novel object within 5 s/ does not retreat more than 20cm when

				approached by the novel object.
10b.	Tail position	Rating	1	Tail mostly low.
			2	Tail partly low, partly medium/high.
			3	Tail mostly medium to high.
		Absence/	0	Puppy did not 'hunt' the novel object (jump at the object with the fore paws and/ or bite into it).
10c.	Hunt	Presence	1	Puppy 'hunted' the novel object (i.e., jumped at the object with their fore paws and/ or bit into it).
10d.	Minimum distance	Estimate	continuous	Estimated closest distance (cm) of puppy to paper bag.

4

5

6 **Table 3**

<b>Original variable</b>	<b>Component 1 Sociability</b>
Approach latency	0.77
Tail-wagging	0.84
Jumping up	0.62
Pawing/ rolling over	0.34
<b>% of variance</b>	44.72

7

8 **Table 4**

<b>Restraint Test</b>	<b>Original variable</b>	<b>Component 1 Passive/ Low Interaction</b>	<b>Component 2 Flight</b>	<b>Component 3 Struggle</b>
<b><u>Back Test</u></b>	Struggling	-0.46	-0.03	0.77
	Vocalising	-0.45	-0.42	-0.34
<b><u>Vetcheck Test</u></b>	Flight	-0.25	0.88	0.10
	Interaction	-0.79	-0.24	-0.37
	Passive	0.78	-0.53	0.24
<b><u>Staring Test</u></b>	Look away	-0.59	-0.43	0.41
	<b>% of variance</b>	34.15	24.59	18.00

9

10

11 **Table 5**

<b>Original variable</b>	<b>Component 1 Boldness</b>
Approach latency	-0.80
Tail position	-0.81
Hunt	-0.72
Minimum distance	0.85
<b>% of variance</b>	<b>60.55</b>

12

13

14 **Table 6**

<b>Dependent variable</b>	<b>Model term</b>	<b>Value</b>	<b>Std. Error</b>	<b>numD</b>	<b>denDF</b>	<b>F</b>	<b>P</b>
Passive/ Low Interaction	Sociability	-0.21	0.08	1	110	7.97	0.006**
	Boldness	-0.04	0.08	1	110	0.26	0.61
Flight	Sociability	0.01	0.09	1	110	0.01	0.91
	Boldness	0.04	0.09	1	110	0.19	0.66
Struggle	Sociability	-0.01	0.08	1	110	0.002	0.97
	Boldness	0.08	0.09	1	110	0.88	0.35

15

Figure 1

