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

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Abstract

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

Keywords

Conflict resolution; personality; sociability; boldness; dog puppies; *Canis familiaris*

1. Introduction

Group-living confers many advantages to animals such as increased foraging or prey-capture efficiency, defence of kills and territory, vigilance and defence against predators, and rearing of young (Krause & Ruxton, 2002). However, there are costs associated with sociality such as increased competition, incompatible goals, or clashes of interest regarding the

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coordination of activities or travel decisions, which may lead to inter-individual conflicts (Aureli & De Waal, 2000; Preuschoft & van Schaik, 2000; Aureli et al., 2002; Bergmüller & Taborsky, 2010). To maintain the benefits of group living and avoid the costs of aggressive interactions, behavioural conventions such as greeting gestures, reconciliation (affiliative post-conflict behaviours between former adversaries), and the establishment of dominance relationships are common in group living animals (de Waal 2000, Preuschoft & van Schaik 2000, Aureli et al., 2002).

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

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

Domestic dogs (*Canis familiaris*) constitute a suitable model species to investigate the proposed link between personality and conflict resolution for various reasons. Over the course of domestication, they appear to have evolved specialised and flexible social skills for reading human social and communicative behaviour (Hare & Tomasello, 2005), and the human environment and social setting has become their natural ecological niche (Miklósi et al., 2004). Thus, it is possible to test dogs' personality and conflict behaviours outside of the laboratory environment but in a standardised way by using a human test person. Many studies have described different personality traits in domestic dogs including reactivity,

fearfulness, trainability, aggressiveness and sociability (reviewed in Jones & Gosling, 2005). Surprisingly, not much scientific information is available on conflict resolution strategies in dogs (but see Cools et al., 2008, for reconciliation following intraspecific conflict). A few papers report dogs' differential responses in inter-group conflicts (Bonnani et al., 2010), or to a threatening human (Vas et al., 2005, 2008; Horváth et al., 2007; De Meester et al., 2008; Gy ri et al., 2008). Walker et al. (1997) classified dogs' strategies in relation to fear behaviour, adapting the model by Marks (1987a as cited by Walker et al., 1997) - freeze (immobility), flight (withdrawal, escape, avoidance), flirt (deflection of attack and appeasement/ submission), and fight (aggressive defence). Lindsay (2005) similarly suggested the following five behavioural reactions in conflict situations in dogs: fight, flight, flirt, freeze (wait for the situation to change), and forbear (tolerate or accept the situation).

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

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

2. Methods

All procedures were performed in compliance with the Austrian animal protection law and the University of Vienna's ethics guidelines, and with the breeders' consent. No special permission for use of animals in such non-invasive socio-cognitive studies is required in Austria.

2.1. Subjects and test setup

We tested 134 Border collie puppies (aged 40-50 days, 72 males and 62 females) from 23 litters of 15 different breeders in a personality test. All breeders were small-scale breeders

(with typically 1-2 litters per year) and bred according to FCI (Féderation Cynologique Internationale) standards, and the puppies spent most of their time in the house. Due to the risk of disease contraction for the young puppies, all tests were carried out at the breeders' homes, but in rooms that were unfamiliar to the puppies (only one litter had to be tested in a familiar room because no unfamiliar room was available).

2.2. Behavioural tests

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

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

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

2.3. Data processing

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

Reliability coding for the above variables was performed by two coders coder not involved in the study for 20 randomly selected puppies, one from each of 20 litters, with one coder coding the greeting test and the restraint tests and the other coding the novel object test. Reliability was assessed using Cohen's weighted kappa for scores and Cronbach's alpha for frequencies, durations and estimated distance. Correspondence of coders was good for all coded variables: Cohen's weighted kappa was 0.71 for approach latency score, 0.88 for jumping up, 0.70 for tail-wagging score, and 0.67 for giving the paw/ rolling over in the greeting test, 1.0 for interacting with the experimenter during the vetcheck test, 0.83 for fleeing during the vetcheck test, 1.0 for passive behaviour during the vetcheck test, 0.67 for approach latency score in the novel object test, 0.92 for tail position during the novel object test, and 0.89 for hunting of the novel object. Cronbach's alpha was 0.95 for duration of struggling during the back test, 0.84 for duration of vocalising during the back test, 0.88 for frequency of gaze avoidance during the staring test, and 0.89 for the estimated minimum distance of the puppies to the novel object.

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

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

3. Results

3.1. Greeting Test

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

3.2. Restraint tests

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

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

3.3. Novel Object test

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

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

Effects on the 'Passive/ Low Interaction' component—A LMM assessing the effect of 'Sociability' and 'Boldness' on a 'Passive/ Low Interaction' response yielded a highly significant negative effect of 'Sociability' (Table 6, Fig. 1a). That is, more sociable puppies were more likely to interact with the tester and less likely to show a passive response in the potential conflict situations. In contrast, 'Boldness' had no significant effect on the dependent variable (Table 6). Likelihood ratio tests showed that goodness of fit of a model with litter nested within breeder as random effect was significantly better than that of a model including only breeder as random effect (L.Ratio=12.59, p<0.001), but did not differ from a model including only litter as random effect (L.Ratio<0.001, p=0.99). The latter model was therefore retained (Table 6). This model was significantly better than a model

without random effects (L.Ratio=22.54, p <0.001), demonstrating an effect of litter on the tendency to show a passive or interaction response in restraint tests.

Effects on the 'Flight' component—Neither 'Sociability' nor 'Boldness' had a significant effect on the 'Flight' component (Fig. 1b, Table 6). A model with litter nested within breeder as a random effect was significantly better than a model without random effects but did not differ significantly from models with either breeder only (L.Ratio<0.001, p=0.99) or litter only as a random effect (L.Ratio= 1.03, p= 0.31; Table 6). Both models were significantly better than a model without random effects (random effect - breeder: L.Ratio=9.85, p=0.0017; random effect - litter: L.Ratio= 8.81, p=0.003), demonstrating that the tendency to flee differed between puppies from different breeders or litters, but was not related to puppies' 'Sociability'.

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

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

4. Discussion

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

The CATPCA components of behaviour in the three restraint tests can be considered to reflect three (or four) different conflict resolution strategies. Puppies that showed no or few overt behavioural reactions had high values of the first component ('Passive/ Low Interaction'), which may be comparable to a freeze response (Walker et al., 1997 and Lindsay 2005), forbearing (Lindsay 2005), 'standing still' during a physical examination (Åkerberg et al., 2011), a passive strategy as found by Vas et al. (2008, 2005), or tolerating (Gy ri et al., 2010). In contrast, low values on the 'Passive/ Low Interaction' component

were associated with interaction with the experimenter (licking, mouthing, and gaze aversion). This might correspond to the flirt strategy defined by Walker et al. (1997) and Lindsay (2005), or to dogs' friendly or contact-seeking responses towards a human who is threatening them (Vas et al., 2008, 2005; Gy ri et al., 2010) or performing a physical examination (Åkerberg et al., 2011). The second component ('Flight') corresponds to a flight strategy (Walker et al., 1997; Lindsay 2005; De Meester et al., 2008) or can be compared to dogs' active avoidance/ moving off (Vas et al., 2005, 2008; Gy ri et al., 2010).

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

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

No correlation between 'Boldness' towards a novel object and the 'Struggle' component (or any of the other components of conflict resolution) was found; neither was there an interaction between 'Boldness' and 'Sociability'. This lack of a relationship between social and non-social tests indicates that sociability and conflict behaviour in dog puppies may not

reflect a generalised coping style or behavioural syndrome extending to non-social behaviours. Similarly, MacDonald (1987) found fear of objects to be unrelated to attraction towards humans in young wolves, and Forkman et al. (1995) reports the lack of a relationship between numbers of escape attempts during the back test in piglets and their performance in other behavioural tests including a novel object test, extinction of a learned response, aggressiveness and social dependence. We conclude that social behaviour and boldness towards a non-social stimulus and are not related in our sample of well-socialised dog puppies. Clearly higher generalised fearfulness can be expected in puppies that have received little social and non-social stimulation, such as those raised in non-domestic environments (c.f. Appleby et al., 2002), which might explain the reported relationship between the factors 'Sociability' and 'Curiosity/Fearlessness' in domestic dogs (Svartberg, 2002).

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

There are furthermore parallels between our study and a study on domestic goats (*Capra hircus*) in a related context, third-party intervention in conflicts and use of agonistic or affiliative strategies. Goats with an 'affiliative profile' engaged in frequent affiliative interactions during everyday life and primarily used active, non-agonistic strategies when in a conflict situation, aiming to reduce social tension (Miranda-de la Lama et al., 2011). These individuals can be compared to puppies with low 'Passive/ Low Interaction' scores, which showed high sociability towards the experimenter and reacted to restraint tests by trying to interact with the experimenter. In contrast, goats with a passive profile seemed indifferent to their social environment, neither engaging in affiliative interactions nor in conflicts – similarly as the puppies scoring high on the 'Passive/ Low Interaction' component. The 'avoider profile' in goats, characterised by an avoidance of conflicts, could be compared to puppies scoring high on the 'Flight' component and presumably also on the 'Struggle' component; however, as discussed above, the flight – or avoidance – strategy seemed less consistent in our study and was not related to sociability. Finally, goats with an 'aggressive' profile used aggression as the main mechanism of social relationships. At least in the

interaction with humans, consistent aggressive strategies may be unlikely to occur in domestic dogs, which have been selected for low levels of aggression and a high level of social tolerance towards humans (e.g. Hare et al., 2012) and developed effective mechanisms to negotiate interactions and avoid the escalation of conflicts in interaction with humans (Gy ri et al., 2010).

5. Conclusions

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

Acknowledgments

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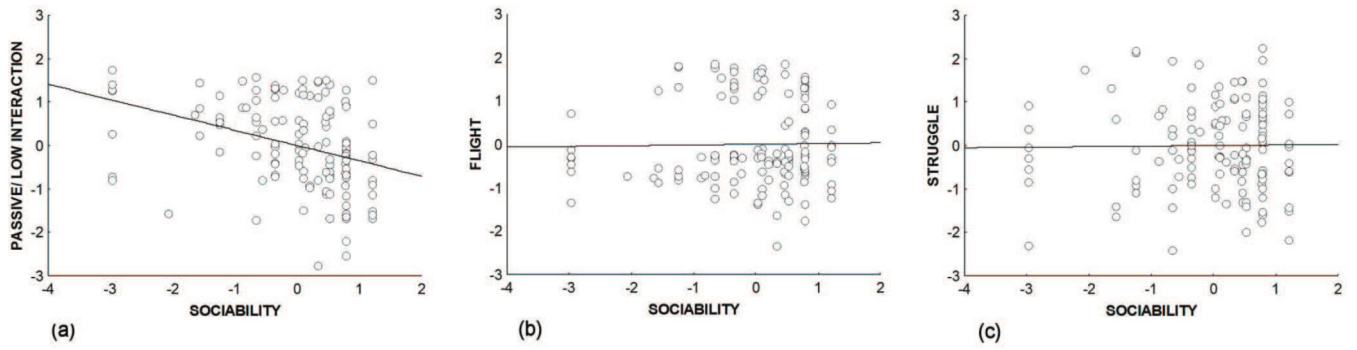
Fig. 1. Individuals' object scores for the 'Sociability' component plotted against object scores for (a) 'Passive/ Low Interaction' (b) 'Flight' and (c) 'Struggle'.

Table 1

Summary of the subtests of the puppy personality test.

Tests used for the present paper are in bold font.

	Subtest	Description	Aim	Duration
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.	60s
2.	**Greeting test**	**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.**	**Determining individual sociability.**	**60s**
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.	60s
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.	**Back test**	**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.**	**Determining conflict resolution strategies.**	**25 s**
7.	**Vetcheck test**	**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.**	**Determining conflict resolution strategies.**	**30 s**
8.	**Staring test**	**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.**	**Determining conflict resolution strategies.**	**30 s**
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.	**Novel object test**	**A battery-powered toy looking like a paper bag, approx. 20 × 10 × 5 cm, was placed approx. 2 m away from the puppy to assess its reactions to the novel object's erratic movements.**	**Determining boldness.**	**60 s**

Table 2

Scoring of variables derived from video analysis of behaviour in the various subtests.

Subtests are numbered as in Table 1.

	Variable	Type	Score	Description
2	***Greeting test***			
2a.	Approach latency	Rating	0	Does not approach the experimenter (10 cm from experimenters 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/	0	Does not jump up or climb into experimenters lap.
		Presence	1	Jumps up or climbs into experimenters lap.
2d.	Pawing/ rolling over	Absence/	0	Does not give the paw or attempt to roll over.
		Presence	1	Gives the paw or rolls over/ performs intention movements to roll over.
6.	***Back test***			
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.	***Vetcheck 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 latency	Rating	1	Does not approach to within 20 cm of the novel object within 30 s.
			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.

	Variable	Type	Score	Description
10b.	Tail position	Rating	1	Tail mostly low.
			2	Tail partly low, partly medium/high.
			3	Tail mostly medium to high.
10c.	Hunt	Absence/	0	Puppy did not 'hunt' the novel object (jump at the object with the fore paws and/ or bite into it).
		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.

Table 3

Variable loadings on the CATPCA component 'Sociability' and accounted variance.

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

Table 4

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

Restraint Test	Original variable	Component 1 Passive/ Low Interaction	Component2 Flight	Component 3 Struggle
Back Test	Struggling	–0.46	–0.03	0.77
	Vocalising	–0.45	–0.42	–0.34
Vetcheck Test	Flight	–0.25	0.88	0.10
	Interaction	–0.79	–0.24	–0.37
	Passive	0.78	–0.53	0.24
Staring Test	Look away	–0.59	–0.43	0.41
	% of variance	34.15	24.59	18.00

Table 5

Variable loadings on the CATPCA component 'Boldness' and accounted variance.

Original variable	Component 1 Boldness
Approach latency	−0.80
Tail-wagging	−0.81
Hunt	−0.72
Minimum distance	0.85
% of variance	60.55

Table 6

Summary of mixed effects models, showing effects of 'Sociabiliy' and 'Boldness' (fixed effects) on the restraint test components 'Passive/ Low Interaction', 'Flight', and 'Struggle'.

All presented models include litter as a random effect.

Dependent variable	Model term	Value	Std. Error	numD F	denDF	F	P
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