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Assessing companion dog behaviour in a social setting

Lina S V Roth* & Per Jensen

IFM Biology, AVIAN Behaviour Genomics and Physiology Group. 581 83

Linköping University, Sweden. *Corresponding author: linaroth@ifm.liu.se, Phone:

+4613282611

1 **Abstract**

2 There is a growing and important need for large-scale characterisation of dog
3 behaviour, for example to conduct genetic analyses or to assess welfare. An extensive
4 number of standardised tests and questionnaires are used for this, but few focus on the
5 normal behaviour in situations which are frequently encountered in the everyday life
6 of companion dogs. The aim of this study was to develop and validate a fast, but
7 standardised method to characterise behavioural variation in pet dogs, based on a brief
8 observation in a situation often encountered by many dogs, namely during training
9 classes. The spontaneous behaviour of dogs was video-recorded during 3 minutes in a
10 standardised setting, while their owners were occupied filling in a short questionnaire,
11 and during 30 seconds of walking on leash. Behaviours, including contact seeking
12 behaviour with both the owner, a stranger and other dogs, together with general
13 activity and interaction with a novel object were later analysed and further processed
14 in two separate Principal Component Analyses (PCA). The PCs from the two test
15 parts correlated significantly with each other and aspects of both home and test
16 environment influenced several components in both PCAs. Age and sex also showed
17 significant effects on test outcome, e.g. age affected how social and explorative the
18 dog was and females jumped more on their owner, whilst males pulled the leash more.
19 In addition, dogs that were perceived as cooperative by their owner, looked more at
20 their owner and pulled the leash less. In conclusion, this simple test captures essential
21 parts of the normal, everyday behaviour profile of dogs, such as owner- and dog-
22 directed social behaviour, which are not usually measured in the commonly used test
23 batteries for dogs.

24

25 **Keywords:** companion dog, behaviour, method, assessment, social, exploration

26 **Introduction**

27 Dogs (*Canis familiaris*) have been domesticated for thousands of years [1,2] and their
28 importance in today's society ranges from companions to workers, including
29 examples such as guide dogs and dogs used by the police, the armed forces and
30 customs. This has sparked a large interest in research into dog behaviour, as a means
31 to understand dog welfare and performance, as well as dog-human relationships, and
32 since dogs are increasingly used for behaviour genetics studies [3,4]. Many such
33 studies require extensive phenotyping of large numbers of individuals, which calls for
34 standardised, high-throughput test batteries. Preferably, such tests should capture
35 essential aspects of the behaviour in situations where the dog is as relaxed as possible.
36 One problem is that observations in the home environment are time-consuming and
37 incompatible with high throughput, whereas standardised test situations may not be
38 representative of the normal life of most companion dogs.

39
40 In Sweden, as in many western countries, most companion dogs participate in training
41 classes such as puppy training classes, various obedience training, agility or show
42 handling at least some time during their lifetime. These courses therefore offer a
43 promising possibility to reach a large number of companion dogs in a limited time,
44 and to record their behaviour while they are in a setting which resembles their
45 everyday life situation i.e. when they are together with their owners in an environment
46 with less familiar dogs and humans.

47
48 Previously, a number of test batteries have emerged with the purpose of determining
49 individual dog behaviour [5]. Most standardised tests are performed in an
50 environment, which is unfamiliar to the dog and often include both sudden and novel

stimuli [5-7], to a large extent measuring the behaviour during stress and fear. For example, the Swedish armed forces select dogs for training and breeding based on performance in a battery of more or less fear-inducing test situations [8-10]. The dog mentality assessment (DMA), and the new version Behavioural and Personality description for Dogs (BPD) in Sweden, aim at describing the behaviour and temperament of mainly companion dogs. Their subtests score the dog's behaviour when he/she is approached by different social and non-social fear-inducing stimuli, in a play situation, in a passive situation while stimulating chasing and in BPD also in a problem solving task [11,12]. These tests are popular among dog owners, generate large data sets, and can be valuable tools for enhancing our understanding of behavioural differences, e.g. between breeds [13]. However, crucially, the tests fail to measure some of the most important aspects of dog behaviour in present society: the relationship to the owners and the behaviour towards other dogs. Perceived dysfunction in any of these aspects of dog behaviour cause large welfare problems to both owners and dogs, and are important causes of early euthanasia of dogs in the western world [14,15]. Furthermore, the tests rely on subjective scoring of behaviour, based on the impression gained by a test leader who usually lacks formal ethological training. Hence, there is an urgent need for ethologically rigorous, standardised behavioural tests, which capture a broad range of dog behaviour in a situation where a minimum of stress and fear is induced, and where behaviour can be scored using quantitative ethological methods.

Only a few studies have been performed in an environment familiar to the dog or in situations that are more or less normal to the individual dog [5]. For example, a recent study video-recorded owners and their dogs under natural circumstances during walks

in both city centres and in green areas [16], but this study did not attempt to evaluate the behaviour or temperament of the dogs in a broader context. The small number of studies performed in the natural environment of dogs is probably due to the difficulty in standardising and evaluating these kinds of tests. Still, being able to faithfully record the normal behaviour repertoire is essential for a full and rich understanding of behaviour variation. Social interaction, exploratory behaviour and general activity in everyday life should be valuable behavioural components when comparing breeds, age classes and sexes, and when relating this to, e.g., earlier experiences of the dogs.

Another common approach is to use questionnaires to collect owners' subjective impressions about their dogs [17,18]. The owners' knowledge about their dogs can reduce behavioural noise due to daily or seasonal variations, which cannot be accounted for in a single behavioural test. Even though questionnaires are to some extent subjective, they are still regarded valuable complements to behavioural studies [11,19,20].

Facing the limitations of current test methods, the aim of the present study was to develop and evaluate a simple, fast and standardised behavioural assay for companion dogs which can be applied when they are kept together with their owners and other dogs. The test should be possible to apply on large numbers of dogs with limited time expenditure, while still providing rigorous, quantitative ethological data.

Material and methods

Animals and test environments

Recordings were taken immediately before ordinary dog training classes for companion dogs in the cities of Linköping and Vimmerby, in South-Eastern Sweden. We visited obedience courses, puppy courses, freestyle courses, agility and tracking courses (see supplementary table 1 for a complete list). In total we visited four outdoor environments, which all were open fields looking similar to each other (fig. 1A) except for the tracking course that was visited on a forest road. The indoor courses were performed either on the second floor of a barn with fitted carpet and with the total measurements of approximately 12 x 30 m (fig. 1B; we only used half of the length) or in a smaller dog training room with fitted carpet and approximately 5 x 10 m.

It was voluntary for the owners to be included in this study and they all gave their written consent. All study subjects (N=85) were privately owned dogs including 33 females and 52 male dogs with an average age of 31 months (SEM=2.8; see supplementary table 1 for breed and individual details). Information about the home situation, the course experience of the dog, the dog training experience of the owner and the owner's own subjective scoring of some behavioural parameters were obtained by a questionnaire.

Testing procedure

The general aim of the test was to video-record the behaviour of dogs during a standardised procedure which was likely to be perceived by the dog to be as normal as possible. Additionally, we aimed for a situation where the dogs could choose to behave freely without restrictions from their owners. These videos were then subjected to a detailed ethological analysis. The owners were informed about the

procedure, without revealing the methods or any details of the intended analysis. During the entire test, the behaviour of all dogs in that test session was video-recorded using two HD camcorder (Canon Legria HF M52), positioned on a tripod approximately 4-8 m from the dogs.

The test was split into two different parts, in which the owners were not paying attention to the dogs during part one, while they did interact loosely during the second part. This procedure was intended to allow calculations of the consistency of the behavioural assessment over two different situations. By performing the two different assessments shortly after each other, two different data sets could be obtained from each dog without having to invite the dog owners to participate on different occasions. Hence, all dogs participated in both situations. Still, behavioural data from a few dogs were excluded since their owners paid them so much attention during the first part of the test (> 3 owner contacts with the dog) that the dogs were not regarded to be representative.

Part one

The owners were asked to walk up with their dogs on leash and each stand behind an orange plastic cone (4 cm high and 19 cm in diameter) with an extended black and white paper roll. This resembles the situation most dogs encounter during a training class while the instructor informs owners, and in this test the cones served as a novel object for the dog as well as a position marker (fig. 1). The paper roll was 21 cm high (4 cm within the cone), rigid and did not move or generate noise when affected by wind, and, in spite of it being a novel object, should therefore have been minimally

fearful for the dogs. The distance between the cones was 2.5 m and the number of dogs tested at the same time was between two and eight.

To distract dog owners from affecting their dogs during video-recording, they were asked to fill out a questionnaire while standing at the cone, and the intention was to create a situation where the dog could act on his/her own initiative, without any obvious interference from the owner. Hence, the questionnaire did not primarily serve to gather representative information, but mainly to occupy the owners for a few minutes, but nevertheless some fundamental data about the background of the dogs could be collected in this way (see below). In addition, during the whole procedure, the owners were asked not to give any command or treat to their dogs and concentrate on filling out the questionnaire.

On three occasions during part one, the reactions of the dogs towards an approaching unknown person were recorded. This was obtained by the test leader (acting as a stranger in this test) approaching each of the owners and their dogs while handing out the questionnaires. During a second round, pencils were handed out and later, after a couple of minutes, the test leader collected all completed questionnaires, approaching each owner and dog a third time.

For part one, three minutes of the recorded video was later analysed and this first part of the test assessed the behaviour of the dogs towards the stranger, the novel object, the owner and other dogs, and the general activities of the dogs, while the owners were occupied filling out the questionnaires.

174 **Part two**

175 Part two took place subsequent to part one, after the collection of the surveys. For this
176 part, the owners were asked to walk their dogs on a loose leash in a big circle around
177 all orange plastic cones and during this time, behaviour was recorded during 30 s.

178

179 **Questionnaire**

180 As mentioned previously, the purpose of the questionnaire was to keep the owners
181 occupied and not attentive to the dogs. However, some basic information about the
182 dogs was possible to obtain in this way. The survey consisted of eight questions about
183 the dog; what sex, breed and age the dog was; whether the dog was living in an
184 apartment or in a house; whether the dog was living alone or with other dogs; if the
185 dog had been attending training classes before or not; if this was the first training
186 class for the owner or whether he/she had attended several courses before or if he/she
187 where training and competing regularly; and lastly about the aim of participating in
188 this training class. In addition the survey included short general statements where the
189 owner was asked to rate his/her dog on a scale 1-5 for; how happy the dog is to see
190 humans; how happy the dog is to see other dogs; how curious/unafraid the dog is;
191 how playful the dog is; how aggressive or threatful the dog is towards humans; how
192 aggressive or threatful the dog is towards other dogs; how cooperative their dog is and
193 finally how stressed they generally perceive their own dog to be. These statements
194 were deliberately kept subjective, since their purpose was only to obtain the owners'
195 personal impressions.

196

197 **Analysis**

From the two test parts, the frequency of all behaviours of interest were recorded from video-recordings according to a pre-determined ethogram (Table 1). The recordings from part one started from the time that the dog was less than one meter from the plastic cone, and proceeded for 3 min. From the second part of the test when the dogs were being walked around the cones, an additional 30 seconds were analysed. All behaviours were scored while watching the videos in iMovie '11 (version 9.0.9; Apple Inc.) using Excel 2011 (Microsoft) with 1/0 interval sampling every five seconds. Hence, for each 5 sec interval a behaviour item could score maximum 1 even though the behaviour was performed several time, which thereby generate a minimum frequency of each behaviour over 3 minutes (part1) and 30 sec (part2). We will henceforth refer to this as frequency. Each video was viewed repeatedly scoring behaviour from one dog at the time. One trained person scored the behaviour for all dogs. One additional person scored seven main behaviour items for eight of the dogs and an inter-observer reliability test showed high correlation (Spearman's correlation; $r=0.98$; $p<0.001$)

Statistics

A principal component analysis (PCA) without rotation of PCs was performed both for behaviours recorded from the first part of the study (the three minutes when the dog was situated by the cone) (Table 2; $N=78$; Bartlett's sphericity test, $\chi^2=1249.92$, $df=231$, $p<0.001$; KMO= 0.605) and the second part (30 seconds of walking) (Table 3; $N=78$; Bartlett's sphericity test, $\chi^2=261.72$, $df=66$, $p<0.001$; KMO= 0.659). For each of the two PCAs, individual component scores were calculated for each of the dogs, and correlations between component scores from the two test parts were calculated with Pearson's correlation analysis. The effects of questionnaire item

responses on PC scores were analysed with a one-way ANOVA. Separate behavioural items were analysed with non-parametric methods. All statistical analyses were performed in IBM SPSS Statistics 22.

Results

Part one

The PCA of the recorded behaviours from part one resulted in seven components with Eigenvalues above one. Based on the scree plot we chose to focus on the first five with Eigenvalues above 1.34, which explained 65% of the variation. The first component was labelled *Social* and had high loadings for contact behaviours towards both other dogs and the stranger (Table 2). The second component was named *Explorative* and was mainly related to interest in the novel object, activity and sniffing the ground. The third component was called *Curious and still* and had high loadings for behaviours such as lie down, looking at owner and interest in novel object. The fourth component, labelled *Contact*, relates mainly to the behaviour looking at the owner but also looking at the stranger and, lastly, the fifth component that was named *Restless*, had high loadings for shaking and yawning behaviours.

Young dogs (≤ 2 years; $N=41$) had higher PC scores for both component 1 (*Social*; fig. 2A) and component 2 (*Explorative*; fig. 2B) than older dogs (>2 years; $N=37$; one-way ANOVA; $F(1,76)=6.6$ and 5.2 respectively; $p<0.05$). In addition, the total number of dogs in the household had a significant effect on component 2 (*Explorative*; fig. 2C) and 5 (*Restless*; fig. 2D) where dogs living as the only dog in the household ($N=49$) had higher scores than those living with other dogs ($N=27$; one-way ANOVA; $F(1,74)=6.1$ and 5.3 respectively; $p<0.05$).

249

250 Dogs attending outdoor courses (N=51) showed higher loadings for component 1
251 (Social; fig. 2E) than dogs on indoors courses (N=27; one-way ANOVA; $F(1,76)=6.3$;
252 $p<0.05$) and the latter also had higher values for component 5 (Restless; fig. 2F; one-
253 way ANOVA; $F(1,76)=9.2$; $p<0.01$).

254

255 However, comparing the results between the different outdoor environments revealed
256 that the tracking course (that was visited in the forest) showed significantly higher
257 loadings in component 1 (Social) than all other outdoor courses performed in open
258 fields (one-way ANOVA; $F(3,49)=7.8$; $p<0.001$). Nevertheless, when the five dogs
259 from the tracking course were excluded the component 1 (Social) still showed higher
260 loadings for outdoor courses compared to indoor courses (one-way ANOVA; $F(1,$
261 $73)=4.0$; $p<0.05$). No differences were found when comparing results between two
262 different indoor environments.

263

264 Dividing the dogs depending on whether it was the first course day (N=39) or not
265 (N=39) revealed dogs on the first course day to have lower scores for component 4
266 (Contact; fig. 2G; one-way ANOVA; $F(1,76)=10.3$; $p<0.01$).

267

268 **Part two**

269 The Principal component analysis of behaviours from part two resulted in four
270 components with Eigenvalues over one, explaining 65% of the variation (Table 3).
271 The first component was labelled *Social* and had high PC loadings for all recorded
272 behaviours towards other dogs. The second component was named *Explorative* and
273 relates mainly to interest in the novel object, sniffing the ground and pulling the leash.

The third component relates to both interest in the novel object and contact behaviour with the owner and was named *Curious & contact*. Finally, the forth component, labelled *Restless*, had high loadings for shaking behaviour and to some extent also jumping on owner. Note that there were fewer behaviour items scored during part two compared to part one since we did not have a stranger situation (which heavily influenced PC 1 in part one, labelled Social) and since the dogs always were walking during part two. However, the essential behaviour items in the corresponding components were still very similar.

Unsurprisingly, age had a significant effect on PC 2 (Explorative; fig. 3A) where young dogs (≤ 2 years; $N=41$) had higher scores than older dogs (>2 years; $N=37$; one-way ANOVA; $F(1, 76)=8.0$; $p<0.01$). Furthermore, the dog's home environment influenced the behaviour of the dog since access to a garden significantly affected PC 2 (Explorative; fig. 3B). Dogs living in an apartment without direct garden access ($N=34$) showed higher scores than those living in a house having direct access to garden ($N=44$; one-way ANOVA; $F(1,76)=4.6$; $p<0.05$). In addition, our results suggest that the test environment could affect behaviour since dogs on outdoors courses ($N=51$) had higher loadings for both component 1 (Social; fig. 3C) and component 2 (Explorative; fig. 3D) than dogs on indoors courses ($N=27$; one-way ANOVA; $F(1, 76)=6.1$ and 7.1 respectively; $p<0.05$ and $p<0.01$ respectively).

Comparing the results from the different outdoor environments showed that the loadings from component 2 (Explorative) differed between the two main outdoors sites on open fields (one-way ANOVA; $F(3, 49)=4.0$; $p<0.05$). Worth noting is that dogs from the outdoor setting with lower loadings exclusively were about to train

agility, while the other main outdoor site with higher loadings consisted of different kinds of obedience classes. Hence, the dogs on the two sites were about to perform two quite different activities. No differences were found when comparing results from the two different indoor environments.

Dividing the dogs depending on whether it was the first course day (N=39) or not (N=39) revealed dogs on the first course day to have higher PC scores for component 1 (Social; fig. 3E; one-way ANOVA; $F(1,76)=20.3$; $p>0.001$) suggesting that the familiarity of the situation/environment also affects the behaviour of the dog.

Comparing the two PCAs

Comparing the two PCAs (N=78) showed that scores on component 1 (Social) from both test parts strongly correlated with each other (fig. 4A; Pearson's correlation; $r=0.48$; $p<0.001$). Furthermore, scores on component 1 from part one (Social) correlated with component 3 of part two (Curious and Contact; fig. 4B; Pearson's correlation; $r=0.31$; $p<0.01$) and component 3 of both PCAs (both named Curious; fig. 4C) correlated with each other (Pearson's correlation; $r=0.23$; $p<0.05$). In addition, scores on component 4 from part one (Contact) correlated negatively to component 1 from part two (Social; fig. 4D; Pearson's correlation; $r=-0.40$; $p<0.001$).

Separate behaviour items

Correlating the cooperative scores (as assessed by the owners in the questionnaire) with the separate behaviour items from part one (N=82) we found a positive correlation with the frequency of looking at the owner (Spearman's correlation; $r=0.36$; $p<0.01$) and negative correlation with frequency of pulling the leash

(Spearman's correlation; $r=-0.32$; $p<0.01$). The cooperative score also correlated positively to the PC 4 from part one (Contact; Spearman's correlation; $r=0.27$; $p<0.05$) and negatively to the PC 1 and PC 2 for part two (Social and Explorative; Spearman's correlation; -0.23 ; $p<0.5$ and $r=-0.30$; $p<0.01$ respectively). No significant age or sex differences were found for the behaviour looking at owner (Mann Whitney U; $U=848.5$ and $U=620.0$ respectively; $p=0.91$ and $p=0.10$ respectively), but young dogs (≤ 2 years) pulled the leash more often than adults (>2 years; Mann Whitney U; $U=550.5$; $p<0.01$). No correlation was found between looking at owner and looking at the stranger (Spearman's correlation; $r=0.18$; $p=0.10$). None of the other seven owner scores were significantly correlated to any behaviour results (see supplementary table 2 for mean values).

We found differences in both part one and part two between dogs on their first course day and dogs attending their second day or later during the course. Dogs tested later during the course (≥ 2 course day) looked more often at their owner than dogs on course day one (Table 4). The opposite was found for looking, pulling and jumping towards other dogs (Table 4).

Interestingly, examining sex differences from part one, we found that females ($N=31$) jumped significantly more on their owners than males ($N=51$; Mann Whitney U; $U=603.5$; $p<0.05$). Male dogs instead pulled the leash significantly more than females (Mann Whitney U; $U=1032.0$; $p<0.05$) if pulling towards other dogs was excluded. There was no significant difference between female and male dogs in course experience (Mann Whitney U; $U=825.5$; $p=0.69$), experience of the owner

(Mann Whitney U; $U = 922.0$; $p = 0.53$), or in age distribution of the dogs (Mann Whitney U; $U = 847.5$; $p = 0.90$).

Discussion

The aim of this study was to develop and test a simple way of obtaining a detailed behaviour assessment of dogs in a situation which would reflect as much as possible of their everyday situation, while still being performed in a standardised and controlled manner, using quantitative ethological methods. We found that it is quite feasible to quantify behavioural variation among dogs, including central aspects of human- and dog-directed social behaviour, based on a very short period of observations in a standardised, low-fearful situation for the dog. The test we applied resembles everyday experiences of many companion dogs in western countries; it does not expose the dogs to any obvious or intentional frightening stimuli, and allows an assessment of the unaffected behaviour towards owners, a stranger and other dogs. High correlations between the PCA scores in the first and second parts of the test indicate consistent behaviour profiles. However, PC 2 from both PCAs (both labelled Explorative) did not significantly correlate with each other. The most probable explanation for this is that the PCA from part two are lacking behaviour items such as move, stand and sit (since the dogs are walking during part two), which all have large influence on PC 2 (Explorative) in part one.

Furthermore, the fact that the behaviour scores were highly consistent with the subjective cooperative score in the owner assessments of the dogs indicates that the test captured important elements of the normal behaviour. In addition, besides

behavioural differences due to sex and age our results reveal that both home and test environment influenced the behaviour of the dog, e.g. number of dogs living together, whether the dog had access to a garden, whether the test was performed indoors or outdoors, and also the familiarity of the situation/environment.

There are few studies on companion dog behaviour in their normal environment. Udell [21] showed that dogs were better in a following pointing gestures test when tested at home than if tested in an outdoor area suggesting that familiarity of the environment affects their behaviour. Similarly, a recent study video-recorded dogs and their owners on walks both in the city centre and in green areas to evaluate the dog-owner contact [22]. Interestingly, when comparing the eye contact behaviour in their study with results from standardised tests in laboratory environment, the dogs paid much more attention towards their owner in laboratory environment than under natural conditions [22,23]. Besides the fact that the dog performed different tasks, the difference could also be caused by the new situations being perceived as stressful, indicating that the commonly used behaviour tests may not always reflect the normal dog behaviour. Further supporting this, hormonal analysis of dogs in dog parks show that cortisol correlated negatively with the frequency of visiting the park [24] and repeated DMAs found that fearful and aggressive behaviours decreased and exploratory behaviour increased from first to second test [6]. Consistent with those results, we found differences in behaviour depending on whether it was the first course day for the dog or not. Even though our test did not include any stimuli that were obviously fearful, some dogs might have perceived some parts of the test as stressful or even fearful. The differences in frequency of looking at the owner (i.e. probably seeking eye contact with owner) and also looking, pulling and jumping

towards other dog between dogs on their 1st course day and dogs attending their 2nd day or later during the course could possibly be related to the familiarity of the environment and their advancement in training. This could imply that the dog becomes progressively more attentive towards their owner and less concerned with the surroundings. Hence, the familiarity of the environment and also the dog's possible progress in training could matter for the dog's behaviour.

Our results indicate that not only the test environment but also the home environment influences the behaviour of the dog in the present test. Those being the only dog in the household showed more explorative and restless behaviour than those with dog companions and dogs living in apartments were more explorative than those living with access to a garden. However, in behavioural studies on pointing comprehension [25,26] neither the housing condition, nor the location of the testing affected the performance of the dog. The latter is in contrast with Udell's study, where dogs in their home environment showed better performance [21]. Worth noting when comparing our results to these studies is that we neither trained nor tested the dogs but only observed their behaviour when the dogs were affected only by stimuli of a low-stressful and everyday character.

Young dogs have been suggested to be bolder than older dogs [18]. In studies on beagles [27] young dogs were more explorative and interacted more with novel toys, humans, and a model dog than old dogs. This corresponds well with our results where young dogs scored high for the components Social and Explorative. These results at least to some extent validate our method used in this study.

With respect to sex differences, females jumped more on their owners, hence sought more physical contact, than male dogs. Similar sex differences were found in a recent behavioural test of approximately 500 laboratory beagles [28]. However, none of the studies observed any sex differences in contact behaviours other than physical contact, i.e. there was no sex differences in looking up at owner or stranger, which is similar to results from pointing comprehension studies [26].

One drawback with studying several dogs simultaneously is the possibility for dogs to influence each other in an uncontrolled way, and this could have an effect on the behaviour of some individuals. However, our aim was to develop a simple test to study dogs' behaviour in the presence of other dogs since we believe this to be an important part of the normal life of a dog and something that is often missed out on in common test batteries. For future studies, we suggest that important test development could include testing the dogs repeatedly on different occasions. If a stable assessment of a single dog's behaviour is required, it could be argued that they should always be tested on for example both first and fifth class to evaluate whether the behaviour is stable over time.

Together with a validated questionnaire (e.g. Canine Behavioral Assessment and Research Questionnaire) this behavioural assessment could be a more complete description of a dog's behaviour, also including social behaviours towards other dogs. Hopefully, in future application it will be possible to focus on the frequency of certain key behaviours and this could be a promising start to finding candidate genes for social behaviour.

The present method offers a simple and rapid way of collecting quantitative behaviour data with a controlled and standardised procedure. However, due to our differences in results from different test environments we would suggest to perform future tests in only one type of setting, e.g. only outdoors in an open field. Also, if visiting dog classes it could be wise to consider that dogs attending an active training class such as agility or tracking might differ in behaviour and excitement from dogs in various obedience classes because of differences in situational expectations.

Unlike most available, commonly used behavioural test batteries, the present method utilises a situation where dog owners voluntarily take their companion dogs to training classes, and where we do not deliberately expose dogs to the plethora of frightening and stressful situations commonly associated with different sorts of mentality assessment tests. We suggest that the present test has the potential of providing a more precise and unbiased assessment of variation in everyday behaviour in the companion dog population. The demands for such assessment is growing as dogs are more frequently used in behaviour genetics, which requires behavioural assessment of a large number of dogs, and in studies focusing on welfare problems among companion dogs [4,29].

Conclusion

We developed a simple method for assessing dog behaviour in a social and everyday setting. The validity of the method was demonstrated by consistency in behavioural ratings between different test parts, agreement with some questions in the owner assessments and by the fact that many of the effects observed were consistent with earlier published experiments. Our results show that the dog's age and the

environment, both at home and during the test, influence the dog's social and explorative behaviour. Dogs perceived as cooperative by their owner look more often up at their owner and also pull the leash less than other dogs. In addition we found some sex differences, e.g. females jumped more than male dogs on their owner. With this simple and fast method, we have shown that it is possible to evaluate dog behaviour from only a couple of minutes of detailed behaviour recordings in a standardised everyday context.

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Ethical considerations

No special permission for use of privately owned dogs in non-invasive observational studies is required in Sweden, Still, all experiments in this paper were conducted in line with ethical approval from the regional ethical committee for animal experiments in Linköping, Sweden (Permit number: 51-13).

498

499 **Conflict of interest statement**

500 The authors declare no conflict of interest.

501

502 **Authorship statement**

503 The idea for the paper and the design of the experiment was conceived by both LSV

504 Roth and P Jensen. Experiments and data analyses were performed by LSV Roth

505 while both authors were involved in the interpretation of the results and the

506 development of the manuscript. Both authors have approved the final article.

507

508 **References**

509

510 1. Clutton-Brock J (1981) Domesticated animals from early times. London:
511 Heinemann and British Museum (Natural History).

512 2. Vilà C, Savolainen P, Maldonado JE, Amorim, IR, Rice JE. et al. (1997)
513 Multiple and ancient origins of the domestic dog. Science 276: 1687–
514 1689.

515 3. Udell MAR, Wynne CDL (2008) A review of domestic dogs' (*Canis*
516 *familiaris*) human-like behaviors: or why behavior analysts should stop
517 worrying and love their dogs. J Exp Anal Behav 89: 247–261.

518 4. Yokoyama JS, Hamilton SP (2012) Genetics of Canine Behavioural
519 Disorders. In: Ostrander EA, Ruvinsky A, editors. The Genetics of the
520 Dog, 2nd Edition. Cambridge: CABI. pp.275-294.

521

522 5. Jones AC, Gosling SD (2005) Temperament and personality in dogs
523 (*Canis familiaris*): A review and evaluation of past research. Appl Anim
524 Behav Sci 95: 1-53.

525 6. Svartberg K, Tapper I, Temrin H, Radesäter T (2005) Consistency of
526 personality traits in dogs. Anim Behav 69: 283-291.

527 7. Murphy JA (1998) Describing categories of temperament in potential
528 guide dogs for the blind. Appl Anim Behav Sci 58: 3–178.

- 529 8. Foyer P, Bjällerhag N, Wilsson E, Jensen P (2014) Behaviour and
530 experiences of dogs during the first year of life predict the outcome in a
531 later temperament test. *Appl Anim Behav Sci* 155: 93–100.
- 532 9. Arvelius P, Strandberg E, Fikse WF (2014) The Swedish Armed Forces
533 temperament test gives information on genetic differences between dogs.
534 *J Vet Behav*: 1–35.
- 535 10. Wilsson E, Sundgren PE (1997) The use of a behaviour test for selection
536 of dogs for service and breeding. II. Heritability for tested parameters and
537 effect of selection based on servicedog characteristics. *Appl Anim Behav*
538 *Sci* 54: 235–241.
- 539 11. Svartberg K (2005) A comparison of behaviour in test and in everyday
540 life: evidence of three consistent boldness-related personality traits in
541 dogs. *Appl Anim Behav Sci* 91: 103–128.
- 542 12. Svartberg K, Forkman B (2002) Personality traits in the domestic dog
543 (*Canis familiaris*). *Appl Anim Behav Sci* 79: 133–155.
- 544 13. Svartberg K (2006) Breed-typical behaviour in dogs - Historical remnants
545 or recent constructs? *Appl Anim Behav Sci* 96: 293–313.
- 546 14. Lund JD, Agger JF, Vestergaard KS (2004) Reported behaviour problems
547 in pet dogs in Denmark: age distribution and influence of breed and
548 gender. *Prev Vet Med* 28: 33–48.
- 549 15. Fatjó J, Ruiz-de-la-Torre JL, Manteca X (2006) The epidemiology of
550 behavioural problems in dogs and cats: a survey of veterinary
551 practitioners. *Anim Welfare* 15: 179–185.
- 552 16. Mongillo P, Pitteri E, Carnier P, Gabai G, Adamelli S, Marinelli L.
553 (2013) Does the attachment system towards owners change in aged dogs?
554 *Physiol Behav* 120: 64–69.
- 555 17. Serpell JA, Hsu Y (2005) Effects of breed, sex, and neuter status on
556 trainability in dogs. *Anthrozoos* 18: 196–207.
- 557 18. Starling MJ, Branson N, Thomson PC, McGreevy PD (2013) Age, sex
558 and reproductive status affect boldness in dogs. *Vet J* 197: 868–872.
- 559 19. Mirkó E, Dóka A, Miklósi Á (2013) Association between subjective
560 rating and behaviour coding and the role of experience in making video
561 assessments on the personality of the domestic dog (*Canis familiaris*).
562 *Appl Anim Behav Sci* 149: 45–54.
- 563 20. Meyer I, Forkman B (2014) Dog and owner characteristics affecting the
564 dog-owner relationship. *J Vet Behav* 9: 143–150.
- 565 21. Udell M, Dorey NR, Wynne CDL (2008) Wolves outperform dogs in
566 following human social cues. *Anim Behav* 76: 1767–1773.

- 567 22. Mongillo P, Adamelli S, Pitteri E, Marinelli L (2014) Reciprocal
568 attention of dogs and owners in urban contexts. *J Vet Behav* 9:158-163.
- 569 23. Horn L, Range F, Huber L (2012) Dogs' attention towards humans
570 depends on their relationship, not only on social familiarity. *Anim Cogn*
571 16: 435–443.
- 572 24. Ottenheimer-Carrier L, Cyr A, Anderson RE, Walsh CJ (2013) Exploring
573 the dog park: Relationships between social behaviours, personality and
574 cortisol in companion dogs. *Appl Anim Behav Sci* 146: 96–106.
- 575 25. Pongrácz P, Gácsi M, Hegedüs D, Péter A, Miklósi Á (2013) Test
576 sensitivity is important for detecting variability in pointing
577 comprehension in canines. *Anim Cogn* 16: 721–735.
- 578 26. Gácsi M, Kara E, Belényi B, Topál J, Miklósi Á (2009) The effect of
579 development and individual differences in pointing comprehension of
580 dogs. *Anim Cogn* 12: 471–479.
- 581 27. Siwak CT (2001) Effect of age and level of cognitive function on
582 spontaneous and exploratory behaviors in the beagle dog. *Learn Mem* 8:
583 317–325.
- 584 28. Persson M, Roth LSV, Johnson M, Wright, D, Jensen P (in press)
585 Human-directed social behaviour in dogs shows significant heritability.
586 *Genes, Brain and Behavior*.
- 587 29. Ascher L, Diesel G, Summers JF, McGreevy PD, Collins LM (2009).
588 Inherited defects in pedigree dogs. Part 1: disorders related to breed
589 standards. *Vet J* 180:402-411.
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591
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Figure legends

Figure 1. Pictures of representative outdoor (A) and indoor (B) test environments. During the first part of the test, owners were asked to stand with their dogs behind an orange cone, and during the second part to walk their dogs in a circle around all the cones.

Figure 2. Scores (± 1 SEM) from the Principal Component analysis of part one of the test (3 min by the cone). The panels show the significant effects of items from the questionnaires on the component scores. A: Young vs adult dogs, scores on PC 1 (Social). B: Young vs adult dogs, scores on PC 2 (Explorative). C: Only dog in household vs dogs with other companion dogs, scores on PC 2 (Explorative). D: Only dog in household vs dogs with other companion dogs, scores on PC 5 (Restless). E: Test conducted during an indoor vs outdoor course, scores on PC 1 (Social). F: Test conducted during an indoor vs outdoor course, scores on PC 5 (Restless). G: Dog tested on its first day attending the course vs later during the course, scores on PC 4 (Contact).

Figure 3. Scores (± 1 SEM) from the Principal Component analysis of part two of the test (30 s of walking). The panels show the significant effects of items from the questionnaires on the component scores. A: Young vs adult dogs, scores on PC 2 (Explorative). B: Dogs with access to garden vs no such access, scores on PC 2 (Explorative). C: Test conducted during an indoor vs outdoor course, scores on PC 1 (Social). D: Test conducted during an indoor vs outdoor course, scores on PC 2 (Explorative). E: Dog tested on its first day attending the course vs later during the course, scores on PC 1 (Social).

Figure 4. Plots of individual component scores from the two different test parts. The panels show those cases where a significant correlation between the scores was found, together with the trend lines. A: PC 1 (Social) from part one vs PC 1 (Social) from part two. B: PC 1 (Social) from part one vs PC 3 (Curious and contact) from part two. C: PC 3 (Curious and still) from part one vs PC 3 (Curious and contact) from part two. D: PC 4 (Contact) from part one vs PC 1 (Social) from part two.

1 **Table 1. Ethogram of the behaviours of the dog used in the analyses.**

Behaviour	Definition
Novel Object	
Looks at	Head directed towards the novel object
Sniffs	Stretches the neck and head towards the novel object
Physical	Physical contact with the novel object
Owner	
Looks at	Head directed towards the owners face
Jumps on	≤ 2 paws on the ground, makes physical contact with the owner
Other dogs	
Looks at	Head towards another dog
Pulls towards	Pulls the leash towards another dog
Jumps towards	≤ 2 paws in contact with ground, head directed towards another dog
Stranger	
Looks at stranger	Head directed towards the stranger
Moves towards	Moves towards the stranger
Sniffs	Stretches his/her neck and head towards the stranger
Jumps on	≤ 2 paws on the ground, makes physical contact with the stranger
Looks at owner	Head directed towards the owner within 5 sec before or after stranger interaction
Other	
Stands	Stands up with all four legs and do not move
Sits	The behind is in contact with ground, forelegs are standing
Lies down	Belly in contact with the ground
Moves	Moves at least one paw to new location
Pulls	Stretches the leash towards other things than other dogs
Sniffs the ground	Stretches his/her neck with the nose close to the ground
Yawns	Widely opens his/her mouth
Shakes	Repeatedly and rapidly moves the body left-right
Vocalisation	Generates whining or barking noise

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Table 2. Principal component analysis, showing component loadings of the behavioural variables from part one of the test (3min by the novel object), where bold values have largest impact on the component.

Principle component	Social	Explorative	Curious/ Still	Contact	Restless
Pulls toward dog	0.84	0.05	-0.05	-0.29	-0.15
Jumps toward dog	0.77	-0.01	0.04	-0.31	-0.13
Moves towards stranger	0.77	0.04	0.16	0.26	0.3
Jumps towards stranger	0.74	0.05	0.21	-0.19	0.21
Sniffs stranger	0.7	0.09	0.27	0.25	0.25
Jumps on owner	0.5	0.15	0.27	0.07	-0.09
Barks	0.45	-0.12	0.06	0.05	-0.24
Lies down	-0.36	-0.09	0.36	-0.35	0.08
Moves	0.5	0.63	-0.41	0.11	0.1
Stands	0.38	0.64	-0.51	0.23	-0.12
Looks at dog	0.53	-0.48	-0.01	-0.33	-0.13
Sniffs the ground	-0.36	0.45	-0.6	0.19	0.15
Looks at stranger	0.35	-0.36	0.31	0.36	-0.02
Sits	-0.16	-0.67	0.31	-0.03	0.17
Looks at novel object	-0.2	0.7	0.61	-0.14	0.1
Sniffs at novel object	-0.18	0.68	0.64	-0.15	0.03
Physical with novel object	-0.12	0.61	0.71	-0.19	-0.07
Pulls (not towards dogs)	-0.1	0.37	-0.27	-0.15	0.11
Looks at owner	-0.09	-0.06	0.44	0.67	-0.04
Looks at owner (stranger)	-0.04	-0.03	0.31	0.72	-0.37
Yawns	-0.07	-0.26	0.1	-0.04	0.71
Shakes	0.11	0.06	-0.13	0.32	0.53
Explained variation (%)	21	16	14	9	6

Table 3. Principal component analysis, showing component loadings of the behavioural variables from the second part of the test (30 sec of walking), where bold values have largest impact on the component.

Principle component	Social	Explorative	Curious/ Contact	Restless
Looks at dog	0.74	-0.11	-0.01	0.02
Jumps towards dog	0.73	0.15	0.33	0.09
Barks	0.35	-0.23	0.44	0.22
Looks at novel object	-0.34	0.71	0.39	-0.2
Sniffs at novel object	-0.36	0.6	0.47	-0.05
Looks at owner	-0.52	-0.59	0.4	-0.08
Pulls towards dog	0.82	0.36	0.08	0.1
Sniffs the ground	-0.37	0.34	-0.45	0.1
Physical with novel object	-0.24	0.6	0.3	0.33
Jumps at owner	-0.16	-0.41	0.52	0.36
Pulls (not towards dogs)	0.23	0.68	-0.08	-0.12
Shakes	-0.2	0.17	-0.31	0.81
Explained variation (%)	23	21	13	9

Table 4: Average minimum frequencies (due to 1/0 sampling method) of separate behaviour items in both part one and part two of the test depending on course day that the test was conducted. P-values were calculated with Mann Whitney U Test.

	Behaviour	Mean ± SEM during 1 st course day		Mean ± SEM during ≥ 2 nd course day		P
Part one	Look at owner	7.0 ± 0.9	(N=39)	10.9 ± 0.8	(N=43)	0.001
	Look at dog	24.3 ± 1.5	(N=40)	18.0 ± 1.2	(N=43)	0.002
	Pull towards dog	5.7 ± 1.2	(N=40)	2.3 ± 0.5	(N=43)	0.030
	Jump towards dog	2.3 ± 0.7	(N=40)	0.4 ± 0.2	(N=43)	0.010
Part two	Look at owner	1.7 ± 0.3	(N=39)	3.1 ± 0.3	(N=43)	0.003
	Look at dog	5.0 ± 0.2	(N=39)	3.8 ± 0.3	(N=43)	0.003
	Pull towards dog	2.9 ± 0.3	(N=39)	1.1 ± 0.2	(N=43)	0.000
	Jump towards dogs	0.8 ± 0.2	(N=39)	0.2 ± 0.1	(N=43)	0.011

Supplementary Table 1. Information about the courses and also about the owners and dogs obtained from the questionnaire.

Course	In/Out	Owner		Dog age (months)	Age		Garden/Apartment	1 or ≥2 dogs at home	Dog been on course before	Owner experience (1-3)
		age	Breed		category	Female/Male				
1	puppy	O1	14	Border collie	5	1 F	garden	1	N	1
2	puppy	O1	24	Poodle	6	1 M	app	2	N	1
3	puppy	O1	64	Poodle	5	1 M	app	1	N	1
4	puppy	O1	25	Poodle	60	2 M	app	2	N	1
5	puppy	O1	39	Poodle/Golden	6	1 M	garden	1	N	1
6	obedience	O1	28	Labrador/Drever	22	1 F	app	1	Y	2
7	obedience	O1	47	Ridgeback	36	2 M	garden	1	Y	2
8	obedience	O1	21	Chihuahua/pincher	22	1 M	app	1	Y	2
9	obedience	O1	34	Schnauzer	24	1 F	garden	1	Y	2
10	obedience	I1	50	Lagotto	24	1 F	garden	1	Y	2
11	obedience	I1	49	Jack russell terrier	36	2 F	garden	1	Y	2
12	obedience	I1	12	Welsh springer spaniel	20	1 F	garden	2	Y	2
13	obedience	I1	26	Golden retriever	36	2 F	garden	1	Y	1
14	obedience	I1	38	Labrador	8	1 M	garden	1	N	1
15	obedience	I1	22	Scottish deerhound	5	1 M	app	2	N	3
16	obedience	I1	46	Border collie / Golden	20	1 M	garden	1	Y	2
17	obedience	I1	20	Cavalier king charles spaniel	9	1 M	app	1	N	1
18	puppy	O1	48	French bulldog	4	1 M	app	1	N	1
19	puppy	O1	22	Siberian Alaskan malamute	5	1 M	app	1	N	1
20	puppy	O1	28	Lancashire heeler	6	1 M	garden	1	N	1
21	puppy	O1	65	Lagotto	5	1 F	garden	1	N	1
22	puppy	O1	23	Swedish lapphund	3	1 M	app	1	N	1
23	puppy	O1	45	Chihuahua/Papillon	5	1 F	garden	1	N	1
24	puppy	O1	66	Dachshund	6	1 M	app	1	N	1
25	puppy	O1	66	Lagotto	5	1 F	garden	1	N	1
26	obedience	O1		Mixed breed	9	1 F	app	1	N	2
27	obedience	O1	28	French bulldog	18	1 M	app	1	Y	2
28	obedience	O1	48	Spanish waterdog	15	1 M	app	1	Y	2
29	Freestyle	I1	38	Border collie	30	2 M	garden	2	N	3
30	Freestyle	I1	31	Poodle	18	1 M	app	1	Y	2
31	Freestyle	I1		Springer spaniel	84	2 M	app	1	Y	2
32	Freestyle	I1		schnauzer	42	2 M	app	1	Y	3
33	Freestyle	I1	17	Japanese spitz/Cavalier king Charles Spaniel	24	1 M	garden	1	Y	2
34	Freestyle	I1	51	Shetland sheepdog	36	2 M	garden	2	Y	3
35	Freestyle	I1	36	Welsh springer spaniel	60	2 M	garden	2	Y	3
36	Freestyle	I1	34	Rottweiler	66	2 F	garden	1	Y	3
37	obedience	O1	27	Flat coated retriever	16	1 M	garden	1	Y	2
38	obedience	O1	23	Staffordshire bull terrier	18	1 F	app	1	Y	2
39	obedience	O1	53	Dachshund	15	1 M	app	2	Y	2
40	obedience	O1	24	Mixed breed	9	1 F	garden	1	Y	2
41	obedience	O1	24	Mongrel (Spain)	20	1 M	app	1	Y	2
42	obedience	I2	43	Danish-Swedish farm dog	24	1 M	app	2	Y	3
43	obedience	I2	42	Cavalier king charles Spaniel/Cocker spaniel	22	1 M	app	1	Y	2
44	obedience	I2	63	Bedlington terrier	84	2 M	app	1	Y	2
45	obedience	O1	28	German shepherd dog/Siberian husky	48	2 F	app	1	Y	2
46	obedience	O1	38	English springer spaniel	84	2 M	app	1	Y	2
47	obedience	O1	46	Australian kelpie	30	2 M	app	1	Y	2

48	obedience	O1	44	Golden retriever	48	2	F	app	2	Y	2
49	obedience	O1	44	Border collie	6	1	F	garden	1	Y	1
50	obedience	O1	30	Am Staffordshire bullterrier	48	2	F	app	2	Y	2
51	obedience	I2		Nova Scotia duck tolling retriever	18	1	F	garden	1	Y	2
52	obedience	I2	53	Dachshund	15	1	M	app	2	Y	2
53	obedience	I2	26	Jack russell/German spitz	6	1	F	app	1	Y	2
54	obedience	I2	23	Mongrel	36	2	F	app		N	1
55	obedience	I2		Mixed breed (Poodle-Coton de Tulean)	30	2	M	garden	1	Y	1
56	obedience	I2	24	Finish lapphund	6	1	M	app	1	Y	2
57	obedience	I2	35	Mixed breed	30	2	F	app	1	Y	2
58	obedience	I2	51	Swedish vallhund	16	1	M	garden	1	Y	2
59	obedience	I2	46	Flat-coated retriever	42	2	M	garden	1	Y	2
60	tracking	O4	70	Briard	30	2	F	garden	1	Y	2
61	tracking	O4	36	Boxer	12	1	F	garden	2	Y	3
62	tracking	O4	26	Shetland sheepdog	18	1	F	garden	1	Y	2
63	tracking	O4	32	Cirneco dell'etna	11	1	M	app	2	Y	2
64	tracking	O4	47	Jack russell	10	1	M	garden	1	Y	2
65	agility	O2	21	Border collie	72	2	M	garden	2	Y	3
66	agility	O2	48	Border collie	48	2	M	garden	2	Y	3
67	agility	O2	62	Border collie	78	2	M	garden	2	Y	3
68	agility	O2	48	Border collie	42	2	F	garden	1	Y	3
69	agility	O2	23	Pumi	36	2	M	garden	2	Y	3
70	agility	O2	44	Danish-Swedish farm dog	48	2	F	garden	1	Y	3
71	agility	O2	14	Schapendoes	48	2	F	garden	2	Y	3
72	agility	O2	55	Pincher	48	2	M	garden	2	Y	2
73	agility	O2	13	Schnauzer	31	2	F	garden	2	Y	2
74	agility	O2	34	Rhodesian ridgeback	18	1	F	garden	1	Y	2
75	agility	O2	51	Briard	102	2	M	garden	2	Y	2
76	agility	O2	56	Chihuahua	24	1	F	app	2	N	1
77	agility	O2	27	Chihuahua	36	2	M	app	2	Y	3
78	agility	O2	50	Pumi	108	2	M	garden	2	Y	3
79	agility	O2	48	Labrador	30	2	F	garden	2	Y	2
80	agility	O2	24	Lhasa apso	48	2	M	app	1	Y	1
81	agility	O2	18	Finish lapphund	36	2	M	garden	2	Y	3
82	agility	O2	49	English springer spaniel	9	1	M	garden	2	Y	3
83	agility	O2	54	Airdale terrier	102	2	F	garden		Y	3
84	agility	O2	54	Hovawart	102	2	M	garden	2	Y	3
85	obedience	O3	13	Australian kelpie	13	1	M	garden	1	Y	2
86	obedience	O3	32	Golden retriever	24	1	F	app	2	Y	2

Supplementary Table 2. Means and SEM of the owners' rating obtained from questionnaire.

Owners rating 1-5	N	Mean	SEM
Happy to see other humans	84	4.0	0.12
Happy to see other dogs	85	4.1	0.12
Curious/unafraid	85	3.8	0.11
Playful	85	4.3	0.09
Aggressive towards humans	85	1.3	0.07
Aggressive towards other dogs	85	1.6	0.10
Cooperative	85	3.9	0.09
Stressed	76	2.3	0.12