ANIMAL BEHAVIOUR, 2005, **69**, 283–291
doi:10.1016/j.anbehav.2004.04.011

Available online at www.sciencedirect.com
SCIENCE DIRECT®

Consistency of personality traits in dogs

KENTH SVARTBERG*, INGRID TAPPER†, HANS TEMRIN*, TOMMY RADESÄTER* & STAFFAN THORMAN‡

*Department of Zoology, Stockholm University
†Swedish Working Dog Association
‡Swedish Museum of Natural History

(Received 3 January 2003; initial acceptance 25 February 2003; final acceptance 26 April 2004; published online 5 November 2004; MS. number: 7577R)

We investigated the consistency of behaviour over repeated tests in dogs, *Canis familiaris*. Dogs were tested three times, with an average of 30 and 35 days between tests. The behavioural test used in the study included 10 subtests that exposed dogs to various situations, such as the appearance of an unfamiliar person, play, preylike objects, metallic noise and a suddenly appearing dummy. Studies using the same test with many dogs have revealed five specific personality traits, labelled Playfulness, Chase-proneness, Curiosity/Fearlessness, Sociability and Aggressiveness, and one higher-order, broader dimension, interpreted as a shyness–boldness continuum. We used these traits in the present study. We found significant correlations over the test series in all the specific traits as well as in the Boldness dimension. The magnitude of trait scores for Playfulness, Chase-proneness and Sociability, as well as for the Boldness dimension, was stable between tests. The scores for Aggressiveness and Curiosity/Fearlessness, however, differed between the first two tests: the intensity of behaviour related to fear and aggression decreased from test 1 to test 2, but the intensity of exploratory behaviour increased. This result indicates that these two traits in dogs are sensitive to novelty, although individual differences are also maintained in nonnovel situations. The results suggest that playful, social, exploratory, avoidant and aggressive behaviour in dogs is influenced by stable dispositions; i.e. personality traits, that seem to have been important during the evolution of the domestic dog.

Individual differences in behaviour have been reported in a range of animal species. Such differences, which have been referred to as differences in personality (Gosling & John 1999), temperament (Réale et al. 2000) or behavioural styles (Mendl & Harcourt 1988), have been found in behaviour related to exploration (Verbeek et al. 1994), predation defence (Coss & Biardi 1997), intraspecific aggression (Benus et al. 1991) and other social behaviour (Armitage 1986), and may therefore have major fitness consequences. Individual variation in behaviour may be adaptive in that it reflects different adaptive strategies rather than nonadaptive 'noise' around a mean (Slater 1981) and may be a product of natural selection (Wilson et al. 1994).

One important aspect of individual behavioural differences is consistency. If differences between individuals are important, there must be some consistency of behavioural reactions over time, because the concepts of personality and temperament are based on the view that enduring dispositions are important predictors of behaviour (Zuckerman 1991). Consistency has long been regarded as an important issue within human personality research (reviewed in Funder 2001). In nonhuman animals, there has been some interest in behavioural consistency (e.g. Lowe & Bradshaw 2001; van Erp-van der Kooij et al. 2002), but compared with research on humans, this issue has been relatively neglected.

Besides the more theoretical question of the importance of enduring dispositions for animal behaviour (i.e. whether temperaments and personality traits can be detected in nonhumans as well as in humans), the idea that individual differences reflect differences in life history strategies rests on consistency. Essential for the evolution of a trait are variability between individuals and individual consistency of the trait (Falconer & Mackay 1996). A high

Correspondence and present address: K. Svartberg, Department of Anatomy and Physiology, Faculty of Veterinary Medicine and Animal Science, Swedish University of Agricultural Sciences, Box 7011, S-750 07 Uppsala, Sweden (email: kenth.svartberg@afys.slu.se). H. Temrin and T. Radesäter are at the Department of Zoology, Stockholm university, SE-10691 Stockholm, Sweden. I. Tapper is at the Swedish Working Dog Association, Box 2050, SE-123 27 Farsta, Sweden. S. Thorman is at the Swedish Museum of Natural History, Box 50007, SE-104 05 Stockholm, Sweden.

0003–3472/04/$30.00/0

degree of phenotypic plasticity in a trait may limit the trait's potential to evolve, which makes consistency an important issue in the understanding of trait evolution (Hayes & Jenkins 1997). Furthermore, the degree of a trait's repeatability has been considered an upper limit of its heritability (Boake 1989). This view makes measures of behavioural consistency relevant to studies of behavioural genetics.

Behavioural consistency is also of practical relevance for animal welfare, because individual differences in behaviour influence the animals' abilities to cope with the environment and the exploitation of available resources (Voisinet et al. 1997; Ruis et al. 2002). Furthermore, information about the consistency of a behavioural trait is important for predictions of future behaviour based on a single observation. This has been applied to cooperation in handling situations in cattle, *Bos taurus* (Grandin 1993), prediction of success in potential service dogs (Goddard & Beilharz 1986) and prediction of behavioural problems in dogs (Van der Borg et al. 1991).

The studies on behavioural consistency indicate that far from all behavioural traits are consistent over time and repeated measures (e.g. Forkman et al. 1995; Bradshaw & Cook 1996; Coss & Biardi 1997; Weiss & Greenberg 1997). Several factors probably influence behavioural consistency, such as type of behaviour, seasonal variation and maturation. Another factor that could complicate studies in this area is individual differences in consistency, i.e. that some individuals are more stable in their behaviour than others. Such suggestions have been made, for both humans (Bem & Allen 1974; Kagan et al. 1988) and nonhumans (Wilson et al. 1994). However, these more subtle aspects of consistency, which can be of great importance for the understanding of animal personality, have been poorly studied.

The domestic dog, *Canis familiaris*, is a useful species for studies of behavioural consistency. For example, dogs are easy to work with, individual history can be well known, and they show a considerable intraindividual variation in behaviour because of a variety of selection pressures during domestication. Furthermore, the dog is used for several purposes in human society, which makes knowledge about behavioural consistency also practically relevant. For these reasons, the dog has been successfully used as a model in behavioural studies. Scott & Fuller's (1965) well-known study revealed genetically based breed differences in several behavioural traits. Others have studied the personality of dogs (e.g. Goddard & Beilharz 1985; Hart & Hart 1985; Draper 1995; Murphy 1998), but only a few attempts have been made to investigate the consistency of behavioural reactions and personality traits. Studies on puppies suggest low consistency and poor predictability of future behaviour (Beaudet et al. 1994; Wilsson & Sundgren 1998; but see Slabbert & Odendaal 1999), but few studies have focused on behavioural consistency in adult dogs.

In this study, we investigated the consistency of behaviour over repeated tests in dogs that were 1–2 years old. Svartberg & Forkman (2002) used data on behaviour from a standardized behavioural test ('Dog Mentality Assessment', DMA) from many dogs of several breed groups. The result of that study suggested five specific traits (Playfulness, Curiosity/Fearlessness, Chase-proneness, Sociability and Aggressiveness), and one higher-order dimension similar to a shyness–boldness axis. Studies have suggested that the behaviour registered in the DMA test is predictive for behaviour in other situations, such as performance in working dog trials (Svartberg 2002) and behaviour in the home environment (Svartberg, in press). However, even though these results indicate consistency, the repeatability of the test, and with that the consistency of the traits over time, has not been evaluated. In the present study, we investigated two aspects of consistency over repeated tests in the personality traits described above: the consistency of the dogs' rank orders for each of the six traits over repeated tests, and the consistency of the magnitude of the trait scores over repeated tests.

METHODS

Subjects

Privately owned pet dogs of different breeds and sexes were subjects in this study. In an advertisement in the Swedish nationwide dog magazine 'Hundsport' (published by the Swedish Kennel Club), we described the study and invited dog owners interested in participating with their dogs to contact us. All owners with dogs that fulfilled the age criterion (12–24 months old) were asked to participate in the first behavioural test. Some dogs were excluded because of scheduling problems. A total of 81 dogs carried out the first test. For practical reasons (time and financial limitations) not all dogs took part in tests 2 and 3. To limit the sample for the remaining tests but to maintain high behavioural variation between the dogs, we conducted a selection process after the first test. Trait scores for the five personality traits used (Playfulness, Curiosity/Fearlessness, Chase-proneness, Sociability, Aggressiveness) for all 81 dogs were calculated based on the test results, and the dogs were ranked according to these scores. The seven highest-ranked dogs and the seven lowest-ranked dogs, based on the trait scores for each trait, were selected for further testing ($N = 44$ dogs). After the second test, the owners of these dogs were invited to participate in a third test ($N = 41$ dogs; one dog did not complete the test, leaving 20 males and 20 females). The mean $\pm$ SD age of these dogs at the first test was 453.0 $\pm$ 68.1 days (range 365–712 days). This sample comprised 29 breeds, according to the breed nomenclature by the FCI (Fédération Cynologique Internationale), which were used in all analyses ($N = 1$ each for American Staffordshire terrier, beagle, border collie, border terrier, Chinese crested dog, collie (smooth), curly-coated retriever, Bernese mountain dog, boxer, field spaniel, German spaniel, golden retriever, great dane, Kerry blue terrier, miniature pinscher, Phalene continental toy spaniel, poodle (miniature), poodle (standard), Rottweiler, shorthaired Hungarian pointing dog and Tibetan terrier; $N = 2$ for Doberman pinscher, flat-coated retriever, German shepherd, Irish wolfhound and Lancashire heeler; $N = 3$ for giant schnauzer, labrador retriever and mudi).

Procedure

The 40 subjects carried out the same behavioural test three times in three areas in similar forested areas in the surroundings of Stockholm in April–June 2002. All dogs carried out each test in the same area and in the same order. The mean ± SD time was 30.0 ± 4.4 days (range 21–38 days) between the first and second tests and 35.0 ± 2.1 days (range 31–38 days) between the second and third tests. By changing areas between tests, the risk that the dogs associated a specific area with the test was minimized.

The behavioural test: general

We used a standardized behavioural test developed and organized by the Swedish Working Dog Association (SWDA). The behavioural test, called 'Dog Mentality Assessment' (DMA), was developed mainly as a tool in dog breeding (Fält 1997a, b). The DMA includes 10 subtests, but we excluded one subtest, 'Gunshots', in the second and third tests, because of the risk of sensitization with repetitions, which could cause problems for the dogs and the owners. The owner of the dog accompanied the dog during the test.

For each dog, the handler, i.e. the owner, was always the same. A test leader instructed the handler before the test how to act and guided the handler through the test. The dog's behavioural reactions were scored according to 33 predefined behavioural variables by one observer (32 variables in tests 2 and 3 because we excluded the variable in the Gunshots subtest). The observer (I.T.), who is both a trained, authorized observer in the SWDA and educated in behavioural sciences, was familiar with the aim of the study. However, she did not have access to the dogs' scores after the test or information about the dogs' ranks during the period of data collecting.

Besides the test leader and the observer, two other assistants participated in the test, who had been well trained by the SWDA and had had experience from previous tests. To help ensure that the tests for each dog were carried out as similarly as possible, the same assistants were used with each dog in all three tests, except for seven dogs in test 3. When assistants had to be replaced, they were matched according to sex and age. All equipment was the same in all tests.

Behavioural measurements

The dogs' behavioural reactions were scored according to predefined intensity scales, which were, as far as possible, free from subjective opinions. A standardized score sheet was used that contained scales for the 33 behavioural variables (although only 32 were used in tests 2 and 3 because of the exclusion of the Gunshots subtest). Responses to the variables were scored from 1 to 5 according to the intensity of the reaction (low score = low intensity).

The behavioural test: subtests

The test consisted of 10 subtests, which were carried out consecutively and without breaks except for the time needed for the handler, dog, test leader, observer and assistants to move from one subtest's station to the next. The subtests and numbered behavioural variables are described below (see also Svartberg & Forkman 2002).

Social contact. The dog and handler approached a stranger (the test leader), who greeted the handler and the dog. The test leader took the leashed dog for a short walk, during which the test leader stopped and petted the dog. Back with the handler, the test leader made a brief physical examination of the dog. The dog's greeting behaviour (1), following behaviour (2) and reaction to physical handling (3) were scored.

Play 1. The dog was unleashed, and a rag was thrown between the handler and the test leader, away from the dog. If the dog ran after and caught the rag, the test leader tried to call the dog back. This procedure was repeated once. After the repetition, the dog was invited to play tug-of-war with the test leader. The duration of this subtest was approximately 1.5 min. The dog's interest in play (4), intensity of grabbing (5) and interest in playing tug-of-war (6) were scored.

Chase. A rag was fixed to a cord approximately 40 m long that was put in a course around 10 small wheels on the ground in a zigzag pattern (about 2 m between the two lines of wheels, and about 3 m between each wheel in the line). The other end of the cord was connected to an electrically powered winch that could be manoeuvred at distance. By this arrangement, the rag could rapidly 'flee' from the dog. The subtest started by turning on the winch, then the dog was released and could freely run after and 'catch' the rag (which stopped after the 10th wheel). The test was repeated once. The dog's interest in chasing the object (7 and 9) and grabbing it (8 and 10) in both repetitions was scored.

Passive situation. The handler and the leashed dog were positioned by the test leader approximately 10 m from the observer, where they remained for 3 min. The handler was instructed not to make any movements or sounds during the subtest. The dog's activity level (11) during this period was scored.

Distance play. An assistant dressed in a cape with a hood moved and crouched several times about 40 m from the handler and the leashed dog. Then the assistant unhooded and tossed a rag in the air and ran a short distance to a hiding place. The dog was then unleashed so that it was free to approach the assistant. If this happened, the assistant played with the dog using the rag, then was passive for 10 s. The play and passivity phase was repeated once. The dog's interest in the person (12), aggressive behaviour (13), exploratory behaviour (14), attempts to play tug-of-war (15) and play invitations to the assistant (16) were scored.

Sudden appearance. During a walk by the handler and leashed dog, a humanlike dummy was suddenly pulled up

in front of the dog at a distance of 2 m. When the dummy was pulled up, the handler was instructed to release the grip of the leash. The dog was free to escape from or explore the dummy. If the dog did not approach the dummy by itself, the handler supported the dog in four successive steps (Svartberg & Forkman 2002) or until the dog had investigated the dummy. Thereafter, handler and dog walked close to the dummy four times. The dog's startle reaction (17), aggressive behaviour (18), exploratory behaviour (19), avoidance behaviour (20) and approach behaviour (21) during walks were scored.

Metallic noise. During a walk by the handler and leashed dog, a chain with large links was dragged over a sheet of corrugated metal 2 m from the dog. Thereafter, a similar procedure as in the subtest Sudden Appearance was carried out. The dog's startle reaction (22), exploratory behaviour (23), avoidance behaviour (24) and approach behaviour (25) during walks were scored.

Ghosts. Two assistants wearing white sheets and with a white plastic bucket over their heads ('ghosts') moved slowly towards the leashed dog and the handler. The distance between the assistants and the dog was 20 m at the beginning of the test, and the two ghosts were 25 m from each other. The ghosts moved in short, intermittent stages towards the dog for approximately 3 min, until they were close to the handler and dog. Then, the dog was released and could freely investigate the assistants, who removed their sheets and buckets when the dog approached them. The dog's aggressive behaviour (26), attention towards ghosts (27), avoidance reaction (28), exploratory behaviour (29) and greeting behaviour (30) were scored.

Play 2. This subtest was a repetition of the second subtest, Play 1, except that the tug-of-war was eliminated. The dog's interest in play (31) and intensity in grabbing (32) were scored.

Gunshots. In this subtest, we evaluated the dog's reaction to gunshots from a 9-mm handgun at 25 m that were fired during activity (handler played with the dog) and passivity (handler and dog were standing passive). The dog's avoidance reaction (33) was scored. This subtest was included only in test 1 and was not used in analyses.

Calculation of Personality Trait Scores

Five specific behavioural traits (Playfulness, Curiosity/Fearlessness, Chase-proneness, Sociability, Aggressiveness) and one higher-order dimension, Boldness, have been identified by factor analyses based on data for 15 329 dogs that performed the same behavioural test as used in this study (Svartberg & Forkman 2002). According to the factor analyses, each dimension was represented by several behavioural variables. We used these representative variables to calculate the dogs' trait scores for each of the five traits in the present study.

For the Playfulness score, we used the variables from subtests Play 1 and Play 2 (five variables: 4–6, 31, 32). The Curiosity/Fearlessness score was based on startle reactions, exploratory behaviour and avoidance behaviour from the two subtests Sudden Appearance and Metallic Noise (variables 17, 19, 20, 22–24), together with the exploration variable in the subtest Ghosts (variable 29). The variables describing startle reactions and avoidance behaviour were negatively correlated with this trait. The Chase-proneness score was based on the four variables in the subtest Chase (variables 7–10). For the Sociability score, the three variables in subtest Social Contact were used (variables 1–3). The last trait score, Aggressiveness, was based on the variables describing aggressive behaviour in subtests Distance Play, Sudden Appearance and Ghosts, together with the attention variable in the subtest Ghosts (variables 12, 18, 26, 27).

The dog's score (1–5) on each variable that represented a trait was standardized by subtracting the mean score from it and dividing by the standard deviation (Hair et al. 1998). The standardized values for the representative variables for each trait were averaged, creating individual trait scores for the specific traits for each of the three tests. We used the means and standard deviations from the first test to compute the trait scores in all three tests. The Boldness trait, according to Svartberg & Forkman (2002), was equally related to Playfulness, Curiosity/Fearlessness, Chase-proneness and Sociability. Because of this, we used the trait scores from these traits, given equal weight, to calculate the Boldness score. The scores for the four related traits were standardized and averaged for each dog, once again by using the means and standard deviations from the first test.

Breed Differences

Differences in breed-characteristic behaviour could cause consistency over repeated tests that could be interpreted as individual consistency. We had few representatives of each breed, so we investigated differences between breed groups, which should indicate differences in behaviour between breeds. Three breed groups, according to the nomenclature by the FCI, had enough representatives to make an appropriate examination: herding dogs (FCI group 1, $N = 9$), guarding dogs (FCI group 2, $N = 10$) and gun dogs (FCI group 8, $N = 9$). A comparison of the trait scores from the first test between these groups showed no differences in any of the traits (Kruskal–Wallis test: $N = 28$; Playfulness: $H_2 = 0.90$, $P = 0.637$; Chase-proneness: $H_2 = 1.76$, $P = 0.414$; Curiosity/Fearlessness: $H_2 = 2.64$, $P = 0.267$; Sociability: $H_2 = 2.01$, $P = 0.366$; Aggressiveness: $H_2 = 4.89$, $P = 0.087$; Boldness: $H_2 = 1.97$, $P = 0.374$). This result suggests that any consistency in behaviour over the test series was caused by stability in the behaviour of individual dogs and not by consistency in breed-characteristic behaviour.

Statistical Analyses

The internal consistency of the traits was examined by calculating the Cronbach's alpha for each trait. The

item-to-total correlation was calculated for the trait Boldness using Spearman rank order correlation.

Two aspects of consistency over repeated tests of the six personality traits were investigated: (1) consistency of rank orders and (2) consistency of the magnitude of trait scores over the series. We used nonparametric methods for the statistical analyses, with adjustments for tied ranks: Spearman rank order correlation analysis for consistency of rank orders and Friedman's method for randomized blocks to analyse consistency of the magnitude of trait scores, with the Wilcoxon signed-ranks tests as the post hoc test. If we found inconsistencies in the magnitude of scores over the series for any trait, we next analysed whether the degree of change was associated with the trait score from the first test. For this analysis, the dogs were ranked according to the trait scores from the first test and divided into four subgroups ($N = 10$ each) according to the scores Low, Intermediate-Low, Intermediate-High, and High. Thereafter, we used Kruskal–Wallis tests to analyse differences in change in trait scores between these subgroups from one test to another, and we used Mann–Whitney U tests as the post hoc test. The statistical software used in all analyses was Statistica (Statsoft, Inc., Tulsa, U.S.A.).

RESULTS

Before investigating the consistency of behaviour over the test series, we examined the internal consistency of the personality constructs in this sample by calculating the Cronbach's alpha for each trait from the first test. Four of the five traits had alpha values above 0.80: Playfulness (0.87), Chase-proneness (0.84), Curiosity/Fearlessness (0.80) and Sociability (0.89). Aggressiveness had a lower alpha value (0.67). However, alpha values above 0.6 can be regarded as acceptably high (Hair et al. 1998).

The general trait Boldness had an alpha value of 0.71. The range of Spearman rank order correlation coefficients between the scores for the four traits that were averaged in the calculation of Boldness (Playfulness, Chase-proneness, Curiosity/Fearlessness, and Sociability) and the Boldness scores was 0.67–0.80, but the correlation between the Aggressiveness scores and the Boldness scores was −0.04. This result indicates that Aggressiveness was unrelated to the other traits in this sample, which is in line with previous results (Svartberg & Forkman 2002).

Consistency of Rank Orders of Trait Scores Over the Test Series

To investigate the consistency of rank order for each trait, Spearman rank order correlation analyses of the trait scores in the three tests were carried out. These analyses showed significant correlations in all traits between the three tests (range (r_S) 0.57–0.89 for the specific traits, and 0.81–0.90 for Boldness, all Ps < 0.001; Table 1; Fig. 1). These results suggest high rank-order consistency of all of the investigated traits.

Table 1. Spearman rank order correlation coefficients for the general trait Boldness and for the five specific traits between the three tests in the test series

	Test		
Trait	1×2	2×3	1×3
Boldness	0.89	0.90	0.83
Playfulness	0.77	0.89	0.76
Chase-proneness	0.70	0.80	0.61
Curiosity/Fearlessness	0.72	0.75	0.58
Sociability	0.72	0.57	0.57
Aggressiveness	0.68	0.80	0.68

$N = 40$. All Ps < 0.001.

Consistency of Magnitude of Trait Scores Over the Test Series

We used Friedman's method for randomized blocks ($N = 40$) to test whether the scores for each of the six personality traits were stable through the test series (Fig. 2). Playfulness, Sociability, Chase-proneness and the general trait Boldness were consistent over the series (Playfulness: $\chi^2_2 = 0.09$, $P = 0.955$; Chase-proneness: $\chi^2_2 = 3.79$, $P = 0.150$; Sociability: $\chi^2_2 = 1.77$, $P = 0.413$; Boldness: $\chi^2_2 = 1.55$, $P = 0.461$). The trait scores for the remaining two traits differed over the test series: Curiosity/Fearlessness increased ($\chi^2_2 = 9.36$, $P = 0.009$), and Aggressiveness decreased ($\chi^2_2 = 32.55$, $P < 0.001$). In both traits there was a significant difference in trait scores between tests 1 and 2 (Wilcoxon signed-ranks test, $N = 40$; Curiosity/Fearlessness: $Z = 2.99$, $P = 0.003$; Aggressiveness: $Z = 4.85$, $P < 0.001$). No significant differences were found between tests 2 and 3 ($N = 40$; Curiosity/Fearlessness: $Z = 1.29$, $P = 0.197$; Aggressiveness: $Z = 0.25$, $P = 0.800$).

To investigate whether the change in Curiosity/Fearlessness and Aggressiveness scores from test 1 to test 2 was caused by any special group of dogs or was general among all dogs, we divided the 40 dogs into four groups based on their personality scores in the first test (Low,

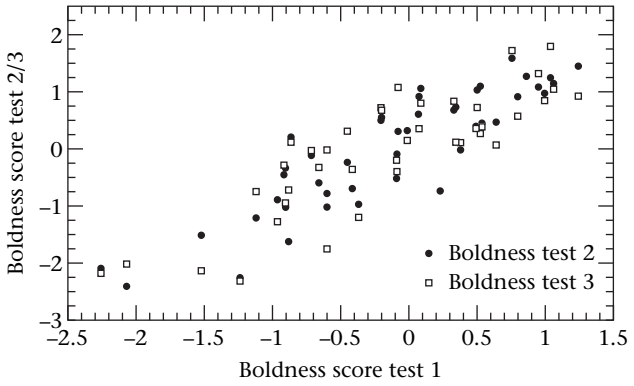

Figure 1. Boldness score for each dog from test 1 plotted against the Boldness scores in test 2 and test 3; correlation coefficient of Boldness, test 1 and 2: $r_S = 0.89$, tests 1 and 3: $r_S = 0.83$, both P values <0.001 (Spearman rank order correlation, $N = 40$).

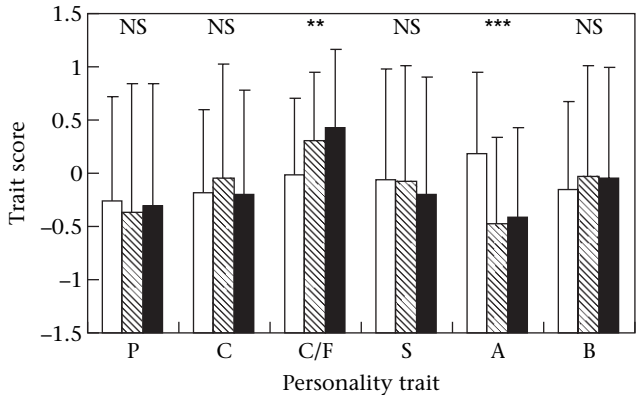

Figure 2. The average + SD trait scores in each of the three tests (□: test 1; ▨: test 2; ■: test 3) for the specific traits Playfulness (P), Chase-proneness (C), Curiosity/Fearlessness (C/F), Sociability (S) and Aggressiveness (A), and for the broad Boldness trait (B). $^{**}P < 0.01$; $^{***}P < 0.001$; Wilcoxon signed-ranks test.

Intermediate-Low, Intermediate-High and High) and investigated whether these groups differed in consistency (Fig. 3). No significant differences between subgroups were found for Aggressiveness (Kruskal–Wallis test, $H_3 = 3.55$, $N = 40$, $P = 0.315$), but there was a significant difference between subgroups for Curiosity/Fearlessness ($H_3 = 8.26$, $N = 40$, $P = 0.041$). Post hoc tests showed significant differences between the subgroup High and all the other subgroups for Curiosity/Fearlessness (Mann–Whitney U test, $N = 10$ in each subgroup: High versus Low: $U = 22.0$, $P = 0.034$; High versus Intermediate-Low: $U = 20.0$, $P = 0.023$; High versus Intermediate-High: $U = 17.0$, $P = 0.013$). No other significant differences between subgroups were found. This result indicates that the overall increase in Curiosity/Fearlessness score between the first two tests was caused by those dogs that scored low and intermediate in the first test (whose scores increased in test 2), and not by the high-scoring dogs.

DISCUSSION

The results of this study show that individual differences in the five specific traits, Playfulness, Chase-proneness, Sociability, Curiosity/Fearlessness and Aggressiveness, as well as the high-order trait Boldness, were consistent over time in repeated tests. The high correlations of rank orders based on trait scores from the three tests also show that the behavioural test reliably measured individual differences in these traits, and that these individual differences were consistent over at least 2 months. Furthermore, the magnitudes of the trait scores of Playfulness, Chase-proneness, Sociability and Boldness were stable over the test series despite repetitions of the same situation, which indicates strong stability of these traits, but the scores of Curiosity/Fearlessness and Aggressiveness were influenced by repeated exposures.

To our knowledge, there have been no previous studies on consistency in adult dogs of the traits Playfulness, Sociability and Chase-proneness and for the broad Boldness dimension investigated in the present study.

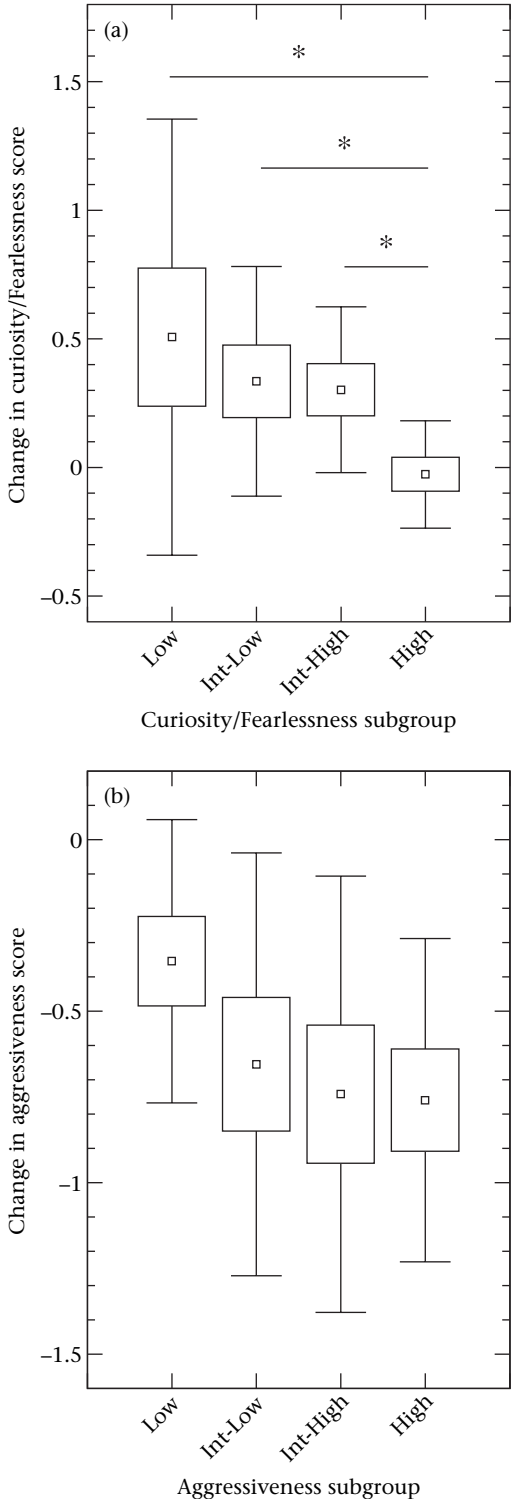

Figure 3. The change in (a) Curiosity/Fearlessness and (b) Aggressiveness scores from test 1 to test 2 for subgroups based on scores from the first test ($N = 10$ in each subgroup). $^{*}P < 0.05$; post hoc Mann–Whitney U tests. Small squares indicate the mean, the boxes the standard error, and the error bars indicate the standard deviation.

Comparisons can, however, be made with results from other species. In domestic cats, *Felis silvestris catus*, Lowe & Bradshaw (2001) found moderate-to-high consistency of

two traits related to exploration of a stranger, which can be compared to the trait Sociability in the present study. Indications of consistency of approach and avoidance behaviour towards humans have also been reported for black rhinoceros, *Diceros bicornis* (Carlstead et al. 1999) and deer, *Cervus elaphus* and *C. elaphus* × *Elaphurus davidianus* hybrids (Pollard et al. 1994).

Counterparts to the trait Boldness in the present study, related to generally confident, active and fearless behaviour in several test situations, have been reported in other species (e.g. Wilson et al. 1994), but there are only a few studies of the consistency of this trait. A general tendency to explore novel objects by great tits, *Parus major*, which is somewhat similar to Boldness in the present study, was moderately to highly consistent over tests in laboratory conditions (Verbeek et al. 1994) and in the wild (Dingemanse et al. 2002). A shyness–boldness continuum has also been found in humans. Kagan et al. (1988) reported high behavioural consistency of shy and timid behaviour in children 2–7 years old.

Results for the trait Aggressiveness can be compared with results from other studies on adult dogs. Netto & Planta (1997) studied aggression in adult dogs over repeated tests where the dogs were exposed to a range of stimuli. As in our study, the authors found high correlations for aggressive behaviour over repeated trials (Spearman rank correlation: $r_S = 0.52$–0.65). In contrast, studies on aggressive behaviour related to dominance towards other dogs and humans suggest moderate or low correlations between repeated tests (Goddard & Beilharz 1985; Weiss & Greenberg 1997). Dominance-related aggression may be more situation-specific, or specific towards certain individuals, compared with aggression elicited in novel situations like the ones used in the present study and in the one by Netto & Planta (1997), which might account for the different results.

The trait Curiosity/Fearlessness in our study can be compared with 'Fear/submission' in dogs, a trait partially related to fear towards surrounding stimuli (Weiss & Greenberg 1997). Repeated tests suggested very high consistency across tests for this trait (Spearman rank correlation: $r_S = 1.0$). Goddard & Beilharz (1985) found high correlations between repetitions of a trait related to fear in meetings with other dogs ('Confidence'). Even though the dogs used as stimuli were different between tests, the correlation between tests was as high as 0.48. These results support our findings of high rank-order consistency over time and repetitions of confident, fearful and aggressive behaviour in the adult dog, which indicates that these aspects of dog behaviour are expressions of persistent personality traits. The results of Goddard & Beilharz (1985) and Weiss & Greenberg (1997), however, indicate that aggressive behaviour may be more influenced by differences in the eliciting stimulus than by confident and fearless behaviour. High consistency of fearful and aggressive behaviour has also been reported in species other than the dog (e.g. fearfulness and aggressiveness in rats, *Rattus norvegicus*, and mice, *Mus domesticus*: Hall 1941; fearfulness in hens, *Gallus domesticus*: Jones 1988; aggression in cattle: Grignard et al. 2001).

The magnitudes of the scores for Playfulness, Chase-proneness and Sociability, as well as for the Boldness dimension, were stable over the test series. The scores for Aggressiveness and Curiosity/Fearlessness, however, changed over the series. There was a significant decrease in Aggressiveness between the first two tests, and the Curiosity/Fearlessness scores increased significantly from test 1 to test 2. These general changes were probably caused by habituation to repeated exposure to the test stimuli (Domjan 1998). An alternative explanation is that these changes could be the result of a maturation process. However, the relatively short periods between tests (30–35 days) make this explanation less probable. Thus, this result indicates that the magnitude (in this case similar to intensity) of behaviour related to curiosity, fearfulness and aggressiveness in the dog is sensitive to novelty, but playful and social behaviour, as well as behaviour related to chase, is not. A decrease in aggression from one test to another has been reported in cattle (Grignard et al. 2001). Studies have described a phenomenon similar to the one that we found for Curiosity/Fearlessness. For example, Visser et al. (2001) found shorter approach latency in horses, *Equus caballus*, in novel object tests, and longer duration of exploration. Similar results have been reported in hens (Jones 1988) and pigs, *Sus scrofa* (van Erp-van der Kooij et al. 2002). These results support our findings and indicate that, in nonhuman animals, behaviour related to exploration, fearfulness and aggressiveness is sensitive to novelty, even though our results indicate that individual differences are also maintained in nonnovel situations.

Martínek et al. (1975) found evidence for individual differences in consistency in the dog: some individuals were more persistent in their behaviour than others. Dogs rated as moderately excitable habituated faster to the test stimuli that elicited the excitement than did dogs with low and high excitability scores. Martínek et al.'s results are in line with the hypothesis that more extreme individuals should be more consistent in their behaviour than should intermediate individuals (Bem & Allen 1974; Wilson et al. 1994). Results consistent with this hypothesis have also been found for shyness in children over longer periods (Kagan et al. 1988). Our results suggest no differences in consistency between subgroups for the trait Aggressiveness, suggesting that the decrease in Aggressiveness from test 1 to test 2 was general for all dogs.

For Curiosity/Fearlessness, differences between subgroups were found. However, these results indicate that high-scoring dogs changed less from test 1 to test 2 than did the other dogs, which only partially agrees with the hypothesis that extreme individuals should be more consistent than intermediate ones. The finding that low-scoring dogs were as changeable as intermediate dogs might be because of a different norm of reaction for this trait compared to that suggested by Bem & Allen (1974) and Wilson et al. (1994). It is also possible that our sample of dogs, in spite of our selection process after test 1, did not include extremely fearful dogs, because owners of such dogs would be unlikely to volunteer for this study. If this conjecture were the case, our group of low-scoring dogs represented moderately curious and fearful individuals. Future studies that include extreme individuals could

give more knowledge about this aspect of individual differences in consistency.

The consistency between individuals in playful, social, fearful and exploratory behaviour, as well as in behaviour related to chase, indicates that these aspects of dog behaviour are expressions of stable dispositions or personality traits. The high repeatability also indicates that these traits may have high heritability (Boake 1989; Hayes & Jenkins 1997). This hypothesis is supported by other studies suggesting moderate to high heritability for all of the traits investigated in this study (P. Saetre, E. Strandberg, P.-E. Sundgren, U. Patterson, E. Jazin & T. Bergström, unpublished data; P.-E. Sundgren, personal communication). Considering the nature of the traits, exploration, avoidance and aggression in both social and nonsocial situations, and their possible fitness consequences, together with the indications of a genetic base and the variability between dogs (this study; Svartberg & Forkman 2002), it is likely that these traits have been important in the evolution of the domestic dog. Furthermore, the similarities between the Boldness dimension in the present study and dimensions reported in other species, such as the wolf (Fox 1972), indicate that personality traits in the dog originate from before the domestication of the dog. If this is the case, the shyness–boldness continuum has survived the selection pressures during the domestication process, which indicates a high evolutionary stability of this continuum.

Acknowledgments

We thank the dog owners that participated with their dogs in this study and all assistants that helped us in the behavioural tests. Thanks to Björn Forkman for valuable assistance during the preparation of the manuscript. The Swedish Working Dog Association financially supported this study.

References

Armitage, K. B. 1986. Individuality, social behavior, and reproductive success in yellow-bellied marmots. *Ecology*, **67**, 1186–1193.

Beaudet, R., Chalifoux, A. & Dallaire, A. 1994. Predictive value of activity level and behavioural evaluation on future dominance in puppies. *Applied Animal Behaviour Science*, **40**, 273–284.

Bem, D. J. & Allen, A. 1974. On predicting some of the people some of the time: the search for cross-cultural consistencies in behavior. *Psychological Review*, **81**, 506–520.

Benus, R., Bohus, B., Koolhas, J. & van Oortmerssen, G. 1991. Heritable variation for aggression as a reflection of individual coping strategies. *Experientia*, **47**, 1008–1019.

Boake, C. R. B. 1989. Repeatability: its role in evolutionary studies of mating behaviour. *Evolutionary Ecology*, **3**, 173–182.

Bradshaw, J. W. S. & Cook, S. E. 1996. Patterns of pet cat behaviour at feeding occasions. *Applied Animal Behaviour Science*, **47**, 61–74.

Carlstead, K., Mellen, J. & Kleiman, D. G. 1999. Black rhinoceros (*Diceros bicornis*) in U.S. zoos. I. Individual behavior profiles and their relationship to breeding success. *Zoo Biology*, **18**, 17–34.

Coss, R. G. & Biardi, J. E. 1997. Individual variation in the antisnake behavior of California ground squirrels (*Spermophilus beecheyi*). *Journal of Mammalogy*, **73**, 294–310.

Dingemanse, N. J., Both, C., Drent, P. J., Van Oers, K. & Van Noordwijk, A. J. 2002. Repeatability and heritability of exploratory behaviour in great tits from the wild. *Animal Behaviour*, **64**, 929–938.

Domjan, M. 1998. *The Principles of Learning and Behaviour*. Pacific Grove, California: Brooks/Cole.

Draper, T. W. 1995. Canine analogs of human personality factors. *Journal of General Psychology*, **122**, 241–252.

van Erp-van der Kooij, E., Kuijpers, A. H., Schrama, J. W., van Eerdenburg, F. J. C. M., Schouten, W. G. P. & Tielen, M. J. M. 2002. Can we predict behaviour in pigs? Searching for consistency in behaviour over time and across situations. *Applied Animal Behaviour Science*, **75**, 293–305.

Falconer, D. S. & Mackay, T. F. C. 1996. *Introduction to Quantitative Genetics*. New York: Longman.

Forkman, B., Furuhaug, I. L. & Jensen, P. 1995. Personality, coping patterns, and aggression in piglets. *Applied Animal Behaviour Science*, **45**, 31–42.

Fox, M. W. 1972. Socio-ecological implications of individual differences in wolf litters: a developmental and evolutionary perspective. *Behaviour*, **41**, 298–313.

Funder, D. C. 2001. Personality. *Annual Review of Psychology*, **52**, 197–221.

Fält, L. 1997a. *Anvisningar Mentalbeskrivning*. Farsta: Swedish Working Dog Association.

Fält, L. 1997b. *Kompendium Mentalitet*. Farsta: Swedish Working Dog Association.

Goddard, M. E. & Beilharz, R. G. 1985. Individual variation in agonistic behaviour in dogs. *Animal Behaviour*, **33**, 1338–1342.

Goddard, M. E. & Beilharz, R. G. 1986. Early prediction of adult behaviour in potential guide dogs. *Applied Animal Behaviour Science*, **15**, 247–260.

Gosling, S. D. & John, O. J. 1999. Personality dimension in nonhuman animals: a cross-species review. *Current Directions in Psychological Science*, **8**, 69–75.

Grandin, T. 1993. Behavioral agitation during handling of cattle is persistent over time. *Applied Animal Behaviour Science*, **36**, 1–9.

Grignard, L., Boivin, X., Boissy, A. & Le Neindre, P. 2001. Do beef cattle react consistently to different handling situations? *Applied Animal Behaviour Science*, **71**, 263–276.

Hair, J. F., Anderson, R. E., Tatham, R. L. & Black, W. C. 1998. *Multivariate Data Analysis*. Upper Saddle River, New Jersey: Prentice Hall.

Hall, C. S. 1941. Temperament: a survey of animal studies. *Psychological Bulletin*, **38**, 909–943.

Hart, B. L. & Hart, L. A. 1985. Selecting pet dogs on the basis of cluster analysis of breed behavioural profiles and gender. *Journal of the American Veterinary Medical Association*, **186**, 1181–1185.

Hayes, J. P. & Jenkins, S. H. 1997. Individual variation in mammals. *Journal of Mammalogy*, **78**, 274–293.

Jones, R. B. 1988. Repeatability of fear ranks among adult laying hens. *Applied Animal Behaviour Science*, **19**, 297–304.

Kagan, J., Reznick, J. & Snidman, N. 1988. Biological bases for childhood shyness. *Science*, **240**, 167–171.

Lowe, S. E. & Bradshaw, J. W. S. 2001. Ontogeny of individuality in the domestic cat in the home environment. *Animal Behaviour*, **61**, 231–237.

Martínek, Z., Lát, J., Sommerová, R. & Hartl, K. 1975. About the possibility of predicting the performance of adult guard dogs from early behaviour: II. *Activitas Nervosa Superior (Praha)*, **17**, 76–77.

Mendl, M. & Harcourt, R. 1988. Individuality in the domestic cat. In: *The Domestic Cat: The Biology of Its Behaviour* (Ed. by D. C. Turner & P. Bateson), pp. 159–177. Cambridge: Cambridge University Press.

Murphy, J. A. 1998. Describing categories of temperament in potential guide dogs for the blind. *Applied Animal Behaviour Science*, **58**, 163–178.

Netto, W. J. & Planta, D. J. U. 1997. Behavioural testing for aggression in the domestic dog. *Applied Animal Behaviour Science*, **52**, 243–263.

Pollard, J. C., Littlejohn, R. P. & Webster, J. R. 1994. Quantification of temperament in weaned deer calves of two genotypes (*Cervus elaphus* and *Cervus elaphus* × *Elaphurus davidianus* hybrids). *Applied Animal Behaviour Science*, **41**, 229–241.

Réale, D., Gallant, B. Y., Leblanc, M. & Festa-Bianchet, M. 2000. Consistency of temperament in bighorn ewes and correlates with behaviour and life history. *Animal Behaviour*, **60**, 589–597.

Ruis, M. A. W., te Brake, J. H. A., Engel, B., Buist, W. G., Blokhuis, H. J. & Koolhaas, J. M. 2002. Implications of coping characteristics and social status for welfare and production of paired growing gilts. *Applied Animal Behaviour Science*, **75**, 207–231.

Scott, J. P. & Fuller, J. L. 1965. *Genetics and the Social Behavior of the Dog*. Chicago: University of Chicago Press.

Slabbert, J. M. & Odendaal, J. S. J. 1999. Early prediction of adult police dog efficiency: a longitudinal study. *Applied Animal Behaviour Science*, **64**, 269–288.

Slater, P. J. B. 1981. Individual differences in animal behaviour. In: *Perspectives in Ethology, Vol. 4. Advantages of Diversity* (Ed. by P. P. G. Bateson & P. H. Klopfer), pp. 35–49. New York: Van Nostrand Reinhold.

Svartberg, K. 2002. Shyness–boldness predicts performance in working dogs. *Applied Animal Behaviour Science*, **79**, 157–174.

Svartberg, K. & Forkman, B. 2002. Personality traits in the domestic dog (*Canis familiaris*). *Applied Animal Behaviour Science*, **79**, 133–155.

Svartberg, K. In press. A comparison of behaviour in test and in everyday life: evidence of three consistent boldness-related personality traits in dogs. *Applied Animal Behaviour Science.*

Van der Borg, J. A. M., Netto, W. J. & Planta, D. J. U. 1991. Behavioural testing of dogs in animal shelters to predict problem behaviour. *Applied Animal Behaviour Science*, **32**, 237–251.

Verbeek, M. E. N., Drent, P. J. & Wiepkema, P. R. 1994. Consistent individual differences in early exploratory behaviour of male great tits. *Animal Behaviour*, **48**, 1113–1121.

Visser, E. K., van Reenen, C. G., Hopster, H., Schilder, M. B. H., Knaap, J. H., Barnevald, A. & Blokhuis, H. J. 2001. Quantifying aspects of young horses' temperaments: consistency of behavioural variables. *Applied Animal Behaviour Science*, **74**, 242–258.

Voisinet, B. D., Grandin, T., Tatum, J. D., O'Connor, S. F. & Struthers, J. J. 1997. Feedlot cattle with calm temperaments have higher average daily gains than cattle with excitable temperaments. *Journal of Animal Science*, **75**, 892–896.

Weiss, E. & Greenberg, G. 1997. Service dog selection tests: effectiveness for dogs from animal shelters. *Applied Animal Behaviour Science*, **53**, 297–308.

Wilson, D., Clark, A., Coleman, K. & Dearstyne, T. 1994. Shyness and boldness in humans and other animals. *Trends in Ecology and Evolution*, **9**, 442–446.

Wilsson, E. & Sundgren, P.-E. 1998. Behaviour test for eight-week old puppies: heritabilities of tested behaviour traits and its correspondence to later behaviour. *Applied Animal Behaviour Science*, **58**, 151–162.

Zuckerman, M. 1991. *Psychobiology of Personality*. Cambridge: Cambridge University Press.