Available online at www.sciencedirect.com
SCIENCE DIRECT
ELSEVIER
Applied Animal Behaviour Science 91 (2005) 103–128
APPLIED ANIMAL BEHAVIOUR SCIENCE
www.elsevier.com/locate/applanim

A comparison of behaviour in test and in everyday life: evidence of three consistent boldness-related personality traits in dogs

Kenth Svartberg*

Department of Zoology, Stockholm University, Sweden

Accepted 30 August 2004
Available online 11 November 2004

Abstract

Six specific personality traits – playfulness, chase-proneness, curiosity/fearlessness, sociability, aggressiveness, and distance-playfulness – and a broad boldness dimension have been suggested for dogs in previous studies based on data collected in a standardized behavioural test (''dog mentality assessment'', DMA). In the present study I investigated the validity of the specific traits for predicting typical behaviour in everyday life. A questionnaire with items describing the dog's typical behaviour in a range of situations was sent to owners of dogs that had carried out the DMA behavioural test 1–2 years earlier. Of the questionnaires that were sent out 697 were returned, corresponding to a response rate of 73.3%. Based on factor analyses on the questionnaire data, behavioural factors in everyday life were suggested to correspond to the specific personality traits from the DMA. Correlation analyses suggested construct validity for the traits playfulness, curiosity/fearlessness, sociability, and distance-playfulness. Chase-proneness, which I expected to be related to predatory behaviour in everyday life, was instead related to human-directed play interest and non-social fear. Aggressiveness was the only trait from the DMA with low association to all of the behavioural factors from the questionnaire. The results suggest that three components of dog personality are measured in the DMA: (1) interest in playing with humans; (2) attitude towards strangers (interest in, fear of, and aggression towards); and (3) non-social fearfulness. These three components correspond to the traits playfulness, sociability, and curiosity/fearlessness, respectively, all of which were found to be related to a higher-order shyness–boldness dimension.

* Present address: Department of Anatomy and Physiology, Faculty of Veterinary Medicine and Animal Science, Swedish University of Agricultural Sciences, Box 7011, SE-750 07 Uppsala, Sweden.
Tel.: +46 18 67 28 21; fax: +46 18 67 21 11.
E-mail address: kenth.svartberg@afys.slu.se.

0168-1591/$ – see front matter
doi:10.1016/j.applanim.2004.08.030

Chase-proneness and distance-playfulness seem to be mixed measures of these personality components, and are not related to any additional components. Since the time between the behavioural test and the questionnaire was 1–2 years, the results indicate long-term consistency of the personality components. Based on these results, the DMA seems to be useful in predicting behavioural problems that are related to social and non-social fear, but not in predicting other potential behavioural problems. However, considering this limitation, the test seems to validly assess important aspects of dog personality, which supports the use of the test as an instrument in dog breeding and in selection of individual dogs for different purposes.

Keywords: Dogs; Personality; Temperament; Boldness; Aggression; Validity; Questionnaire; CBARQ

1. Introduction

The study of temperament, or personality, in animals has during the last few decades generated several personality constructs, which have been found useful in explaining individual behavioural differences. Aggressiveness, fearfulness, and boldness are examples of traits that have been suggested for a range of animal species (e.g. Wilson et al., 1994; Boissy, 1995; Gosling and John, 1999). Two requirements that should be met regarding personality constructs, as for all behavioural measures, are reliability and validity (Martin and Bateson, 1993; Gosling, 2001). Reliability refers to the repeatability and consistency of the measurement, whereas validity concerns how accurately an instrument measures what it is meant to measure, and how well it provides information that is relevant for the questions asked (Martin and Bateson, 1993). Within human personality research, where the study of personality traits has a long tradition, reliability and validity are criteria that must be satisfactorily met for any trait to be considered relevant (Matthews and Deary, 1998). In the study of animal personality on the other hand, these requirements have been assessed for only a few trait constructs and species, at least when behaviour-coding methods have been used (Gosling, 2001).

Behavioural tests are, besides ratings and behavioural observations in natural situations, a common approach in animal personality research. The advantages of this method are the possibility to study the animal's responses to environmental challenges and to control the situation (Manteca and Deag, 1993). Personality constructs from behavioural tests – often suggested from data reduction methods such as factorial analyses – can be validated by correlation with external and independent measures. One way of doing this is to test for correlations between behaviour in different tests. Fearfulness, for example, is one construct that has been validated by this methodology (e.g. Jones, 1988; Boissy and Bouissou, 1995; Durr and Smith, 1997). However, the controlled test situation might be inappropriate, resulting in abnormal and maladaptive behaviour, which is specific to the test situation (Boissy, 1995; Timberlake, 1997). To avoid this, it is of major importance to validate test results with information on the animal's behaviour in its home environment. Furthermore, knowledge of how trait constructs in animals are related to outcomes in the ''real world'' is necessary for the understanding of the evolution of animal personality. It is also of great importance for applied reasons in domesticated species and zoo animals.

Related to the evolution of personality traits, a few studies have investigated the relationship between personality assessments and life history traits, such as reproductive success, in wild-living species. For example, Armitage (1986) investigated the validity of personality constructs from mirror image stimulation in trapped yellow-belled marmots using measures of social behaviour and lifetime reproductive success, although without finding any significant correlations. A similar approach was used for wild bighorn ewes in a study by Réale et al. (2000), who found some correlations between boldness in a trapping situation and measures of reproductive success. There are also some studies where assessments of individual differences have been validated against behavioural data in zoo animals. For example, ratings of assertiveness in spotted hyena have been found to correlate with dominance status (Gosling, 1998), and assessments of sociability and confidence were found to correlate with measures of affiliative and aggressive behaviour, respectively, in a study of rhesus macaques (Capitanio, 1999).

Validation of personality traits against behavioural data from the home environment has also been done in farm animals (i.e. sheep: Syme, 1981; cattle: Schrader, 2002; pigs: Thodberg et al., 2002). However, when it comes to constructs suggested for companion species, such as cats and dogs, there are problems associated with this validation methodology. The cause for this is the highly specific home environment that each individual lives in, which creates insurmountable obstacles if a construct is to be validated by behavioural observations in each animal's home environment. This is a paradox, considering the general suitability of companion animals in the study of animal personality due to their availability, variability and population sizes, as well as for the applied importance. Thus, other methods than direct observation have to be used to collect information about the pet animal's behaviour in the home environment. One such is the use of the owners or carers knowledge of the animal's typical behaviour, collected by interview or in a questionnaire. This method is frequently used in human personality research, where judgements made by informants well acquainted with the subject, like friends or parents, are used to describe the person's characteristic behaviour (i.e. Kolar et al., 1996; Halverson et al., 2003). The use of questionnaires in behavioural studies of companion animals, where the owner assesses the animal's typical behaviour in relevant situations, seems to be more and more common. Especially in studies of dog behaviour, this trend is pronounced. For example, questionnaires have been used during the latest years to evaluate dog temperament (Goodloe and Borchelt, 1998; Serpell and Hsu, 2001), describe dog-owner relationship (Topal et al., 1997; Rooney et al., 2000), evaluate training methods (Hiby et al., 2004), investigate behavioural problems in dogs (Overall et al., 2001; Guy et al., 2001; Kobelt et al., 2003) and to study breed-typical behaviour (Bradshaw and Goodwin, 1999). Even though this method of data collecting has grown in popularity, the use of questionnaires has some inherent problems. One such is the large number of observers, which may bias the data. Therefore, it is of great importance that questionnaires used are examined regarding reliability and validity. Fortunately, these issues have, at least in some studies, been addressed and considered, resulting in a critical use of questionnaires that have yielded important knowledge of dog behaviour (e.g. Serpell and Hsu, 2001; Sheppard and Mills, 2002; Hsu and Serpell, 2003; Gosling et al., 2003). Thus, the use of questionnaires, where the owner or the carer assesses the typical behaviour of the animal in specific situations, may be a useful method in investigations of how personality is expressed in the companion animal's home environments.

A previous study based on data from a standardized behavioural test (''dog mentality assessment'', DMA) has suggested five or six specific personality traits in addition to one broad higher-order trait – interpreted as a shyness–boldness dimension – in dogs (Svartberg and Forkman, 2002). Results from a study where 40 dogs carried out the test three times (one month between the tests) showed high test-retest reliability for all of the traits, with correlations between 0.57 and 0.90 (Svartberg et al., in press). The shyness–boldness continuum has been found to be valid for working dogs, according to results showing positive correlations between boldness and success in working dog trials (Svartberg, 2002). However, the standardized behavioural test is also used as an instrument in assessing pet dog personality, which makes a validation of the traits against behavioural data from the dogs' home environments important.

In the present study, the construct validity of the six specific personality traits found in the DMA is investigated by using a questionnaire that was sent to owners of dogs that had previously carried out the behavioural test. The questionnaire was a Swedish version of a questionnaire developed at the University of Pennsylvania—CBARQ (Hsu and Serpell, 2003), with the addition of items covering social and playful behaviour. To test for the construct validity of the personality traits, the dogs' trait scores from the behavioural test were correlated with the corresponding typical behavioural reactions from the questionnaire. Besides investigating the validity of the traits, the relationship between the personality traits and different potential behavioural problems was investigated.

2. Methods

2.1. Subjects and procedure

The subjects of the present study were chosen from a large number of dogs that had carried out a standardized behavioural test for dogs, the ''dog mentality assessment'', which is given and organized by the Swedish Working Dog Association (SWDA). Data was collected for dogs that had carried out the behavioural test during the last year (24 September 2000 to 23 September 2001), and were between 12 and 24 months of age when the test was carried out. The database included 16 breeds with data from 50 dogs or more, and 10 breeds with at least 70 dogs. In order to avoid breed-specific biases, seventy dogs were randomly sampled from each of the 10 breeds with at least that number of dogs tested, and all dogs were included in the sample from the six other breeds with at least 50 tested dogs.

The dog-owners' addresses were obtained from the Swedish dog-owner register, with kind help from the Swedish Kennel Club (permission for the use of the owner register was given from the Swedish Board of Agriculture). However, due to missing addresses and owners living outside of Sweden (this was regarded as disqualifying because of possible language problems with the questionnaire), the questionnaire was for some of the 16 breeds sent to less than 50 dog-owners. In total, the questionnaire was sent to 981 owners. Twenty-nine dogs were excluded for different reasons (unknown addressee, dog reported dead, or dog reported to have a new owner). Within three months, questionnaires for 697 dogs were

answered by the owners and returned in the pre-paid return envelope. This corresponded to a general response rate of 73.3%. The response rate for the breeds ranged from 50.0 to 89.8%. In the sample were 50.5% males and 49.5% females. The age of these 697 dogs when they carried out the behavioural test ranged from 368 to 729 days (average 501.4 days, S.D. = ±77.0). The time between the behavioural test and the sending of the questionnaire ranged from 352 to 716 days (average 521.1 days, S.D. = ±121.1). The numbers of dogs per breed, sex ratios and return ratios are presented in Table 1.

2.2. The behavioural test

The behavioural test used in this study (DMA) was developed by the Swedish Working Dog Association as a tool in dog breeding, in which the behaviour of parents, as well as the progeny, can be tested (Fält, 1997a, 1997b). The test is now used for other breeds than working dog breeds, and has in many breed clubs in Sweden become a general behavioural test, in which the dog's reactions to a range of different stimuli are described.

The test consisted of 10 subtests (described below), which were carried out consecutively without any breaks except for the time it took to move from the station of one subtest to the next. The owner of the dog (handler) accompanied the dog during the test. A test-leader informed the handler how to act before the test, and guided the handler through the test. The dogs' behavioural reactions were scored by one authorized observer

Table 1
A presentation of the sample used in the study, with breeds, number of dogs per breed and sex ratios

Breed	Questionnaires				
	Sent out	Missing[a]	Returned		Males
	N	*N*	*N*	%	%
Australian Shepherd	52		38	73.1	52.6
Belgian Malinois	42		23	54.8	52.2
Belgian Tervuren	70		55	78.6	49.1
Briard	55		43	78.2	55.8
Collie (rough)	70	2	53	77.9	58.5
Bernese Mountain Dog	70	2	52	76.5	59.6
Boxer	70	2	43	63.2	41.9
Dobermann Pinscher	68	4	41	64.1	58.5
Flat-coated Retriever	46		40	87.0	57.5
German Shepherd	69	4	41	63.1	53.7
Giant Schnauzer	70	4	52	78.9	46.2
Golden Retriever	60	1	53	89.8	45.3
Hovawart	70	2	54	79.4	50.0
Irish Soft Coated Wheaten Terrier	55	1	43	79.6	41.9
Rhodesian Ridgeback	43	2	31	75.6	45.2
Rottweiler	70	5	35	53.8	37.1
Total	980	29	697	73.3	50.5

[a] These missing dogs were either reported dead or had new owners, or the questionnaire was returned due to unknown addressee.

for each dog (a total of 119 observers scored the 697 dogs), using a standardized score sheet. The sheet contained scales for 33 pre-defined variables, which were, as far as possible, free from subjective opinions. The variables were scored from 1 to 5 according to the intensity of the reaction, where a low score equalled a low intensity in the dog's behavioural reaction. Besides the test-leader and the observer, two or three assistants were used in each test.[1] The data were collected in 291 behavioural tests (152 test arenas). For a more detailed description of the behavioural test and the behavioural variables, see Svartberg and Forkman (2002).

2.3. The subtests

2.3.1. 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 (behavioural variables: greeting reaction, cooperation and reaction to physical handling).

2.3.2. Play 1

The dog was unleashed, whereafter a rag was thrown between the handler and the test-leader, and further away from the dog. If the dog run after and caught the rag, the test-leader tried to call the dog back. This was repeated once. After the repetition the dog was invited to play tug-of-war with the test-leader (behavioural variables: interest in playing, intensity in grabbing and interest in playing tug-of-war).

2.3.3. Chase

A rag was fixed to a long cord that was put in a course around 10 small wheels at the ground in a zigzag pattern. By pulling the cord, the rag could rapidly "flee" away from the dog. When the rag started to move the dog was released and could freely run after and bite the rag (which stopped after the tenth wheel). The test was repeated once (behavioural variables: interest in chasing the object and grabbing it in both trials).

2.3.4. Passive situation

The handler and the leashed dog were positioned by the test-leader approximately 10 m from the observer, where they remained during three minutes. The handler was instructed not to make any movements or sounds during the subtest (behavioural variable: activity level during this period).

[1] All functionaries that are involved in the organization of the DMA are trained and certified by the SWDA: assistants in two or three training steps (24–38 h of education), test-leaders in four steps (64 h), and the observer in five steps (94 h). To be certified, all types of functionaries have to pass tests at each level. In the authorization of the observers, tests on inter-observer reliability are included. Ten dogs are scored, and the criterion to pass is a minimum of 72% of the scored variables (239 scores of 330) identical to the scores of a reference observer (the teacher, authorized by the SWDA). A maximum of 25% of the scores (81 of 330) can deviate one step on the five-point scale, and a maximum of 3% of the scores (10 scores of 330) can deviate more than one step. The reference observer, in turn, is supervised during the test by one of a few central reference observers.

2.3.5. Distance play

A stranger, dressed in a cape with a hood, moved and crouched several times at a distance (approximately 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 un-leashed, and was free to approach the assistant. If so happened, the assistant played with the dog using the rag, whereafter he was passive for 10 s. The play and passivity was repeated once (behavioural variables: interest in the stranger, aggressive behaviour, exploratory behaviour, interest in playing tug-of-war and play invitations to the stranger).

2.3.6. Sudden appearance

A human-like dummy was suddenly pulled up in front of the dog at a distance of 2 m from the dog during a walk (handler and leashed dog). The handler was instructed to release the leash when the dummy was pulled up. Thus, the dog was free to escape from the dummy and/or explore it. If the dog did not approach the dummy by itself, the handler supported the dog according to four successive standardized steps (described in Svartberg and Forkman, 2002) or until the dog had investigated the dummy. Thereafter, handler and dog walked close by the dummy four times (behavioural variables: startle reaction, aggressive behaviour, exploratory behaviour, and remaining avoidance behaviour and approach behaviour during walks).

2.3.7. Metallic noise

A chain with large links was dragged over a sheet of corrugated metal at a distance of 2 m from the dog during a walk (handler and leashed dog). Thereafter, the same procedure as in the subtest ''Sudden appearance'' was carried out (behavioural variables: startle reaction, exploratory behaviour, and remaining avoidance behaviour and approach behaviour during walks).

2.3.8. Ghosts

Two strangers that wore white sheets, each with a white plastic bucket over their head (''ghosts''), moved slowly towards the leashed dog and the handler. The distance between the two ''ghosts'', who were positioned 25 m from each other, and the dog was at the beginning 20 m (in a triangle pattern). The ''ghosts'' moved in short intermittent stages towards the dog during approximately 3 min, until they were close to the handler and dog. Thereafter, the dog was released and could freely investigate the assistants, who removed the sheets and buckets when the dog had approached them (behavioural variables: aggressive behaviour, attention towards ghosts, avoidance behaviour, exploratory behaviour and greeting behaviour).

2.3.9. Play 2

This subtest was a repetition of the second subtest, play 1, with one exception: the tug-of-war part was excluded (behavioural variables: interest in playing and intensity in grabbing).

2.3.10. Gunshots

In this subtest the dog's reaction to gunshots (from a 9 mm handgun, 25 m) that were fired during activity (handler played with the dog) and passivity (handler and dog were

standing passive) were tested. Two gunshots were fired in each phase (behavioural variable: avoidance reaction).

2.4. Calculation of the trait scores

In a previous study (Svartberg and Forkman, 2002) based on data from a large number of dogs ($N = 15{,}329$) that had carried out the same behavioural test as the one used in the present study, five specific personality traits and one high-order dimension – ''boldness'' – were found. The specific traits were labelled ''playfulness'', ''curiosity/fearlessness'', ''chase-proneness'', ''sociability'', and ''aggressiveness''. They were, together with boldness, found in all breed groups. One more specific trait, ''distance-playfulness'', was found in some of the breed groups. The aim of this study was to validate these six suggested specific personality constructs. The first step was to calculate the trait scores. The representative variables (i.e. variables with high loadings on a factor), according to the results in Svartberg and Forkman (2002), were used to calculate the dogs' trait scores for each of the six specific traits in the present study. For the playfulness score, the variables from subtests ''play 1'' and ''play 2'' were used, five variables in total. The curiosity/fearlessness score was based on startle reactions, exploratory behaviour, and avoidance behaviour from the two subtests ''sudden appearance'' and ''metallic noise'', together with the exploration variable in the subtest ''ghosts''. 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''. For the calculation of the sociability score, the three variables in subtest ''social contact'' were used. The trait score for 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''. The score for the last specific trait – distance-playfulness – was based on exploratory behaviour, interest in playing tug-of-war, and play invitations in the subtest distance play. The dog's score (1–5) on each variable that represented a trait was standardized (by subtracting the mean and dividing by the standard deviation). The standardized values for the representative variables for each trait were then averaged, creating individual trait scores for the personality traits.

2.5. The questionnaire

The questionnaire used in this study was based on the Canine behavioural assessment and research questionnaire (CBARQ) developed by Dr. James A. Serpell and Dr. Yuying Hsu. The CBARQ was developed based on data from a large number of dogs (Hsu and Serpell, 2003[2]). A factor analysis suggested that eleven categories of dog behaviour were covered in the questionnaire, which were labelled ''stranger-directed aggression'', ''owner-directed aggression'', ''stranger-directed fear'', ''non-social fear'', ''dog-directed fear or aggression'', ''separation-related behaviour'', ''attachment or attention-seeking behaviour'', ''trainability'', ''chasing'', ''excitability'', and ''pain sensitivity'' (Hsu and Serpell, 2003; the behavioural categories and the representative items in the CBARQ are

[2] The questionnaire was in Hsu and Serpell (2003) named PennBARQ.

presented in Appendix). The internal consistency of the factors was found to be satisfactory with the exception of ''pain sensitivity'', and seven of the factors were found to be valid according to owner-reports of behavioural problems (the first seven of the factors listed above).

It seemed that the CBARQ covered aspects of behaviour that were related to the traits curiosity/fearlessness, chase-proneness and aggressiveness at least, which made a Swedish version of this questionnaire suitable for a validation analysis of these traits. The translation into Swedish was made by the author with help from colleagues, and the intelligibility of the items was tested on a number of Swedish dog-owners before the study. To ensure that the questionnaire should cover behaviour related to playfulness, sociability and distance-playfulness I added 17 items to the translated CBARQ items. In total, there were 122 items in the questionnaire that were divided into nine sections according to behavioural category with a short description of each category (I used a former version of the CBARQ that included a few additional items compared to the version presented in Hsu and Serpell (2003)). These additional items were, however, not analysed in the present study). Seven of the sections were from the CBARQ: Training and obedience (eight items describing the dog's trainability and tendency to obey commands), Aggression (27 items describing the dog's aggressive responses such as growling, biting and snapping in different situations), Fear and anxiety (19 items describing signs of fear and anxiety in the dog, such as crouching, freezing, avoidance and escape attempts, in different situations), Separation-related behaviour (nine items describing signs of anxiety and abnormal behaviour in the dog when left alone), Excitability (six items describing the dog's excitability, such as heightened alertness, barking and over-reactivity, in different situations), Attachment and attention-seeking (seven items describing signs of attachment and attention-seeking in the dog towards the owner and other household members), and Miscellaneous (29 items covering other behavioural responses, such as tendency to chase, interest in own and other animals' faeces, patterns of urinating and defecation, and signs of stereotypy). In addition, there were two more sections in the questionnaire: playfulness (nine items describing playful behaviour in the dog towards humans and other dogs) and Social contact (eight items describing the dog's social behaviour towards strangers and unfamiliar dogs, such as greetings and approach behaviour). For each section there was a brief explanation of typical signs of the particular behavioural category that the respondent could use as a guide. The respondents were requested to score the typical behaviour of their dog in the recent past (i.e. the latest 1–2 months).

Two forms of five-point rating scales were used in the different sections in the questionnaire, which allowed for quantitative assessments of the dogs' typical responses in the described situations. One was a semantic differential-type rating scale (Osgood et al., 1957) used in CBARQ sections aggression, fear and anxiety, and excitability. The owners were asked to rate their dog's typical behaviour on a scale from 0 to 4, where 0 equalled no signs of the actual behavioural reaction (e.g. ''no visible signs of aggression'') and 4 equalled extreme reactions (e.g. ''serious aggression: snaps, bites, or attempts to bite''). The other rating scale used included five options, graded ''never'', ''seldom'', ''sometimes'', ''usually'', and ''always'', referring to a frequency description of the specific reaction (used in the CBARQ sections training and obedience, separation-related behaviour, attachment and attention-seeking, miscellaneous, and in the sections playfulness and social contact).

In the cover letter that followed the questionnaire, the owner was instructed to answer the questions as objectively as possible. The owners were also instructed to avoid spending long time answering the questions, and that the questions were meant to give a rough description of the dog's behaviour rather than a precise one. In the cover letter, nothing was mentioned about the planned analyses on the relationships between test behaviour and the owners' assessments via the questionnaire. Thus, the dog-owners were unaware of the purpose of the study, something that otherwise could have biased the owners' opinions.

The average response rate for the questionnaire items was 97.6% (median 99.4%), and all items that were included in the analysis had a response rate of 92.8% or higher. If there were one or two missing values in the calculation of scores for the questionnaire factors the average of the remaining representative variables – if the number of these were >3 – was used as the dog's factor score. If there were more than two representative variables missing, or if one or two were missing with less than four remaining representative variables, the factor score was not calculated for that dog and factor.

2.6. Statistical analyses

Analyses of data from the CBARQ by Hsu and Serpell (2003) yielded eleven behavioural factors. Based on the results of that study, I calculated summated scales for these factors. This was done by averaging the representative items for each factor in accordance with scale calculation for the CBARQ (James A. Serpell, personal communication). The items in the sections playfulness and Social contact were analysed using common factor analysis. The communalities were estimated by computing the multiple R^2 of the respective variable with all other variables (Hair et al., 1998). Mean substitution was used when data was missing. As the selection criteria for the number of factors extracted, the latent root, or Kaiser, criterion was used (where all factors with eigenvalues >1 are extracted; Hair et al., 1998). The factor solution was rotated using the Varimax normalized rotation method. Scores for each of the factors that the factor analysis yielded were calculated. The average of variables with loadings of 0.50 or higher on each factor, and with low cross-loadings on other factors (<0.30), was used as the factor's score.

The internal consistency of the scales for each questionnaire factor, as well as for the traits from the behavioural test, was examined by calculating the Cronbach's alpha (α). I used Spearman rank order correlation analysis with adjustments for tied ranks for all correlation analyses (the significance level was set to $P < 0.05$). To investigate whether there were any relationships between the personality trait from the DMA, which could indicate a broader personality dimension, I used Spearman rank order correlation analysis and principal component analysis (PCA). The factor solution was rotated using the Varimax normalized rotation method, and factors with eigenvalues >1 were extracted. Adjustments for the large number of correlations in each analysis were done with the standard Bonferroni technique, where the significance level is divided with the number of correlations in the analysis in order to calculate adjusted significance levels ($P = \alpha/k$, were k is the number of correlations; Sokal and Rohlf, 1995). The statistical package used in all analyses was STATISTICA™.

3. Results

3.1. Factor analysis of items covering social and playful behaviour

The factor analysis based on the 17 items that related to social and playful behaviour yielded three factors with eigenvalue >1, which explained 46.9% of the total variance (Table 2). According to the loadings it seemed that the first factor was related to social interest in and approach behaviour towards unfamiliar adults and children (labelled ''stranger-directed interest''). The second factor was related to play behaviour directed to humans, especially object-play, according to the highly loading variables (''human-directed play interest''). The third factor seemed to be related to social and playful behaviour towards other dogs (''dog-directed interest'').

3.2. Internal consistency

The internal consistency of the traits from the behavioural test, as well as of the factors from the questionnaire, was examined by calculating the Cronbach's α for each trait and factor. The α-values for five of the six traits were above 0.7 – playfulness (0.85), chase-proneness (0.82), curiosity/fearlessness (0.74), sociability (0.75) and distance-playfulness (0.87) – which suggests that these traits have an adequate internal consistency (Hair et al., 1998). Aggressiveness had an α-value of 0.56, which suggests a somewhat lower correlation between the representative variables for this trait.

The α-values for the CBARQ factors ranged from 0.60 to 0.84 (see Table 3), with two factors with α-values below 0.7 (''pain sensitivity'' and ''attachment or attention-seeking

Table 2
The result of a factor analysis of questionnaire item describing the dogs' typical behaviour in playful and social situations that were added to the CBARQ questionnaire

Item	Factor 1	Factor 2	Factor 3
Eager to play with family members	0.06	**0.67**	0.08
Eager to play with strangers	0.39	**0.59**	0.11
Retrieves play objects and initiates play	0.02	**0.61**	0.06
Eager to play with other male dogs	0.12	0.10	**0.62**
Eager to play with other female dogs	−0.02	0.13	**0.63**
Enjoys play-wrestling	0.01	0.31	0.23
Quick to respond to other dogs play invitations	0.01	0.22	**0.71**
Enjoys tug-of-war with familiar persons	−0.05	**0.75**	0.08
Eager to run after thrown balls	0.02	**0.69**	0.05
Loves being the center for attention	0.42	0.29	0.11
Greets visiting adults in a friendly manner	**0.70**	−0.11	0.06
Greets visiting children in a friendly manner	**0.72**	−0.12	0.07
Greets visiting dogs in a friendly manner	0.27	−0.07	**0.53**
Eager to approach adults away from home in a friendly manner	**0.78**	0.16	0.19
Eager to approach children away from home in a friendly manner	**0.79**	0.10	0.16
Eager to approach dogs away from home in a friendly manner	0.30	0.06	**0.65**
Enjoys being petted by strangers	**0.75**	0.12	0.07
Proportion of explained variation (%)	19.4	14.9	12.6

Table 3
The correlations between the personality trait scores from the behavioural test and the factor scores from the questionnaire

Personality trait from test	Factor from the questionnaire													
	SDA[a]	ODA[a]	DDFA[a]	TRAIN[a]	CHASE[a]	SDF[a]	NSF[a]	SRB[a]	PS[a]	EX[a]	AAS[a]	SDI	HDPI	DDI
Playfulness	0.01	−0.01	−0.05	**0.20**	0.04	**−0.15**	−0.12	0.05	−0.06	0.06	0.10	0.05	***0.36***	0.01
Chase-proneness	0.01	0.01	0.03	0.09	*0.05*	0.09	**−0.14**	−0.03	−0.03	0.04	0.02	0.06	**0.22**	0.01
Curiosity/fearlessness	0.03	0.05	−0.05	0.03	0.02	**−0.16**	***−0.26***	−0.01	0.01	0.01	0.06	0.08	**0.14**	0.05
Sociability	**−0.21**	0.03	−0.13	0.07	−0.05	***−0.27***	−0.07	−0.10	−0.12	−0.07	0.01	***0.36***	0.07	0.12
Aggressiveness	*0.12*	−0.03	0.06	0.12	0.04	0.04	−0.03	−0.03	−0.04	0.06	0.07	−0.05	0.05	−0.02
Distance-playfulness	**−0.14**	0.05	−0.05	**0.16**	0.01	***−0.19***	**−0.17**	0.01	−0.07	0.01	0.02	***0.16***	***0.29***	0.07
Boldness	−0.10	0.02	−0.13	**0.15**	−0.01	**−0.28**	**−0.21**	−0.03	−0.10	−0.01	0.07	**0.25**	**0.29**	0.10
Cronbach α-values	0.84	0.71	0.73	0.70	0.76	0.83	0.71	0.74	0.60	0.75	0.66	0.85	0.79	0.79

Values in italics represent expected significant correlations, whereas coefficients in bold indicate statistically significant correlations at $P < 0.05$ after correction for the number of comparisons. SDA: stranger-directed aggression, ODA: owner-directed aggression, SDF: stranger-directed fear, NSF: non-social fear, DDFA: dog-directed fear or aggression, SRB: separation-related behaviour, AAS: attachment or attention-seeking behaviour, TRAIN: trainability, CHASE: chasing, EX: excitability, PS: pain sensitivity, SDI: stranger-directed interest, HDPI: human-directed play interest, and DDI: dog-directed interest.

[a] Indicates factors from the CBARQ (Hsu and Serpell, 2003).

behaviour''). These values are roughly in line, though somewhat lower, with the α-values that were obtained by Hsu and Serpell (2003), and suggest high internal consistency for all factor scores with the exception of the scores for ''pain sensitivity'' and ''attachment/attention-seeking''. The α-values for the remaining three questionnaire factors (''stranger-directed interest'', ''human-directed play interest'' and ''dog-directed interest'') indicated adequate internal consistency (0.79–0.85, see Table 3).

3.3. Validation analysis of the personality traits

Based on similarities between characteristics of the traits and the questionnaire factors, following correlations were expected to be significant (convergent validity):

- Playfulness with ''human-directed play interest'' (positively).
- Curiosity/fearlessness with ''non-social fear'' (negatively).
- Chase-proneness with ''chasing'' (positively).
- Sociability with ''stranger-directed fear'' (negatively) and ''stranger-directed interest'' (positively).
- Distance-playfulness with ''human-directed play interest'' (positively), ''stranger-directed fear'' (negatively), and ''stranger-directed interest''(positively).
- Aggressiveness with ''stranger-directed aggression'' (positively).

Correlation analyses between trait scores from the behavioural test and corresponding factor scores from the questionnaire were carried out. After adjustments for the large number of comparisons ($k = 84$) the results showed that playfulness, curiosity/fearlessness, sociability, and distance-playfulness correlated significantly with their respective corresponding questionnaire factors (Table 3). In contrast, the correlations that were expected for chase-proneness and aggressiveness were not significant.

Besides the correlations that were expected, significant correlations between trait scores and questionnaire factor scores were found for five of the personality traits (Table 3). Playfulness was positively correlated with ''trainability'' and negatively with ''stranger-directed fear''. Chase-proneness, which did not correlate with its expected corresponding factor ''chasing'', was significantly and positively correlated with ''human-directed play interest'' and negatively with ''non-social fear''. Curiosity/fearlessness correlated positively with ''human-directed play interest'' and negatively with ''stranger-directed fear''. Sociability was negatively correlated with ''stranger-directed aggression''. Furthermore, distance-playfulness was negatively correlated with ''non-social fear'' and ''stranger-directed aggression'', and positively correlated with ''trainability''. A summary over all significant correlations is presented in Table 4.

3.4. Validation analysis of the behavioural test measures describing aggressive behaviour

The results from the correlation analyses showed no relationships between the aggressiveness trait and the dogs' typical behaviour according to the questionnaire data. This could indicate that the aggressiveness trait does not correspond to the behaviours in

Table 4
A summary of the significant correlations found between questionnaire factor scores and personality trait scores from the behavioural test

Factor from the questionnaire	Personality trait					
	Playfulness	Chase-proneness	Curiosity/ fearlessness	Sociability	Distance-playfulness	Boldness
Stranger-directed aggression[a,b]				+++	+	
Trainability[a]	++				+	+
Stranger-directed fear[a,b]	+		+	+++	++	+++
Non-social fear[a,b]		+	+++		++	+++
Stranger-directed interest				++++	+	+++
Human-directed play interest	++++	+++	+		+++	+++

[a] Indicates factors from the CBARQ (Hsu and Serpell, 2003).
[b] Indicate inverse relationships between traits and questionnaire factor.
[+] $Rs \geq 0.14$, $P < 0.05$.
[++] $Rs \geq 0.18$, $P < 0.001$.
[+++] $Rs \geq 0.21$, $P < 0.001$.
[++++] $Rs \geq 0.30$, $P < 0.001$. P-values are adjusted for the number of comparisons (Bonferroni; $P = \alpha/k$; $k = 90$).

the dogs' everyday life covered by the questionnaire. Another possibility, which the low α-value for aggressiveness indicates, is that this trait includes different components of aggressive behaviour. These components could relate separately to different aspects of the dog's typical aggressive behaviour. In order to investigate this further, correlation analyses were carried out between the three aggression variables from the behavioural test that relate to the aggressiveness trait (aggression variables in subtests ''distance play'', ''sudden appearance'', and ''ghosts'') and the three aggression-related questionnaire factors (''stranger-directed aggression'', ''owner-directed aggression'' and ''dog-directed fear or aggression''). After adjustments for the number of comparisons ($k = 9$), the aggression variable in subtests ''distance play'' and ''ghosts'' were found to correlate significantly and positively with ''stranger-directed aggression'', although with low correlations coefficients (0.11 and 0.15, respectively; see Table 5). No significant correlations or tendencies were found for the aggression variable in subtest ''sudden appearance''.

3.5. The shyness–boldness dimension and its correspondence to questionnaire factors

According to the results of Svartberg and Forkman (2002), all specific traits from the DMA with the exception of aggressiveness were related to each other. This indicates that playful, curious, fearless and stranger-friendly behaviour in the test seems to be under influence of a broad personality dimension, interpreted as a shyness–boldness continuum. In order to investigate if this dimension was valid for the present sample, I studied the relationships between the specific traits by principal component analysis. The PCA extracted two components with eigenvalues >1 (Fig. 1). The first component, which

Table 5
The correlations between the variable scores from the behavioural test related to aggressiveness and the scores for the aggression-related questionnaire factors

Variable from test	Factor from questionnaire		
	Stranger-directed aggression	Owner-directed aggression	Dog-directed fear or aggression
Aggression in "distance play"	**0.11**	−0.05	0.05
Aggression in "sudden appearance"	0.05	−0.02	0.01
Aggression in "ghosts"	**0.15**	−0.03	0.08

Bold coefficients indicate significance at $P < 0.05$ after adjustment for the number of comparisons (Bonferroni; $P = \alpha/k$; $k = 9$).

explained 36.3% of the total variance, had high loadings from two traits: distance-playfulness and playfulness (0.76). Also chase-proneness, curiosity/fearlessness and sociability had relevant loadings (0.53–0.63) on the first component, whereas aggressiveness had a loading of 0.14. In contrast, aggressiveness was highly loaded on the second component, which explained 17.2% of the total variance, where the other traits all had loadings <0.40 (Fig. 1). This pattern was supported by the results of a cross-correlation analysis of the specific traits. The mean correlation between the trait score for each trait and the scores for the (other) traits that are presumed to be related to the shyness–

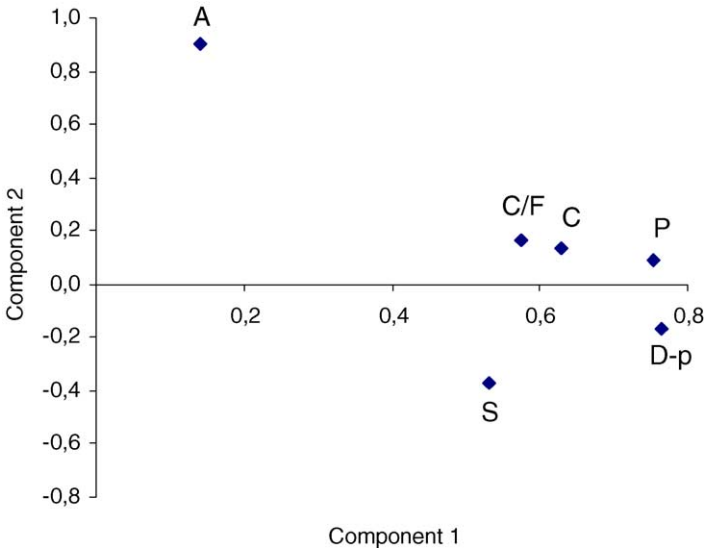

Fig. 1. The result of the principal component analysis of the scores from the six specific personality traits. The first component, which explains 36.3% of the variation, had high or moderate loadings from distance-playfulness (D-p), playfulness (P), chase-proneness (C), curiosity/fearlessness (C/F), and sociability (S). Aggressiveness (A) had low loadings on the first component, but was instead the only trait that loaded high on the second component (explaining 17.2% of the variation).

boldness dimension were 0.35 for distance-playfulness (range 0.29–0.47), 0.32 for playfulness (0.22–0.47), 0.26 for chase-proneness (0.11–0.34), 0.25 for curiosity/fearlessness (0.14–0.31), 0.19 for sociability (0.11–0.29) and 0.06 for aggressiveness (0.02–0.12). Thus, even though sociability seems to be less correlated with the other presumed boldness-traits, it seems that the suggestion by Svartberg and Forkman (2002) of a broad shyness–boldness dimension in the DMA unrelated to aggressiveness is valid also for this sample. Therefore, I calculated a boldness score, by averaging the scores for playfulness, curiosity/fearlessness and sociability, which could be correlated with the factor scores from the questionnaire (the scores for chase-proneness and distance-playfulness were not used due to the results in the present study that indicated that they are mixed measures of playfulness, curiosity/fearlessness and sociability). Using the same significance level as in the analysis of the specific traits, five significant correlations between the boldness score and the questionnaire factor scores were found: ''human-directed play interest'' (positively), ''stranger-directed fear'' (negatively), ''stranger-directed interest'' (positively), ''non-social fear'' (negatively) and ''trainability'' (positively; Tables 3 and 4).

4. Discussion

The results from this study suggest that four of the six specific personality traits in dogs previously found in a behavioural test (Svartberg and Forkman, 2002) – playfulness, curiosity/fearlessness, sociability and distance-playfulness – are associated with corresponding behaviour in the dogs' home environment, which was assessed by the dogs' owners in a questionnaire. Thus, convergent validity was shown for these traits. The chase-proneness trait was related to play interest and non-social fear in everyday life, and not, as expected, to predatory behaviour. The only trait that had no obvious association with the dogs' typical behaviour was aggressiveness, even though weak associations were found between two of its representative variables and aggression directed to strangers. The results also indicate discriminant validity. For example, none of the personality traits from the DMA were correlated with separation-related behaviour, predatory behaviour, owner-directed aggression, or any dog-directed behaviour in the home environment. The pattern of correlations in this study suggests that three components in the personality of dogs, all related to a broad boldness dimension, are validly measured in the test—playfulness, behaviour towards strangers, and non-social fear. Furthermore, the results indicate long-term consistency (1–2 years) for these components in adult dogs.

Even though the significant correlations that were found validate all traits with the exception of chase-proneness and aggressiveness, the correlations seem to be relatively low: from 0.14 to 0.36. One cause for this could be the time span between behavioural test and questionnaire. According to previous results in studies on long-term consistency in animals, correlations of behavioural traits over time (1–2 years) rarely exceed 0.45 (Goddard and Beilharz, 1986; Carlstead et al., 1999; Lowe and Bradshaw, 2001; Visser et al., 2001). This implies that even though consistencies in traits are found, some changes over time can be expected. Such changes in behaviour over time may be due to maturation. In a domestic species like the dog, factors such as castration, training and drug therapy may

also cause stable changes in behaviour (e.g. Beaver, 1999; Lindsay, 2001). The relatively low correlations in the present study might indicate that there are some changes over time in the traits studied, even though the correlations also imply that playful, stranger-friendly and fearful behaviour in dogs show long-term consistency in the adult dog.

A second cause for the relatively low correlations is probably the measurement error in the owners' assessments of their dogs. The method used to validate the personality constructs – a questionnaire by which the owner can describe the typical behaviour of their dog – involves nearly as many observers as dogs. This brings variation between different owners and their opinions into the data, which may contribute to the low correlation coefficients (see Lewis, 2001, for a discussion of this issue in human personality research). In addition, the number of test arenas, assistants and observers used in the testing of the dogs may have influenced the correlations. Even though the test was highly standardized and the assistants were well trained, some variation due to this should be expected. In total, considering the time between the test and the questionnaire, and the probable measurement errors, the correlations are not remarkably low. The problem with this is the low statistical power—there might be other relationships between test behaviour and behaviour in the home environment than the ones found in this study.

The lack of correlations between aggression-related questionnaire factors and the aggressiveness trait is notable. This could be due to the relatively low internal consistency for this trait that was found ($\alpha = 0.56$), i.e. that the trait construct has low reliability. However, also on the variable level there were only weak associations found between aggressive behaviour in test and in everyday life. One possible explanation could be that this trait is more difficult to assess by the dog-owners, compared to other aspects of dog behaviour. However, the factors that were related to aggression in the CBARQ have previously been validated against data from clinical behavioural problems (Hsu and Serpell, 2003). This indicates that these CBARQ factors are reliable in measuring the dog's tendency to be aggressive, at least towards strangers, the owner, and other dogs. Another possible explanation is that aggressiveness in dogs is less consistent than the other traits investigated in this study. Results from a study by Goddard and Beilharz (1985) give some support for this. They reported that dominance-related aggression was less stable in dogs from age 6 months to 12–18 months, compared to ''confidence'', a measure of dog-related fearfulness. However, in the results from a study on the test-retest reliability and short-time consistency (2 months) of the investigated personality traits, the aggressiveness trait was as consistently measured as the other specific traits (Svartberg et al., in press). If the low association between the aggressiveness trait and the owners' reports of the dogs' typical behaviour is not due to measurement errors or low consistency, the cause is probably found in the nature of the aggressive behaviour observed in the test. It is possible that the aggressiveness trait is related to the first exposure of aggression-eliciting stimuli. Repetitions of the DMA have shown that, even though the rank-order consistency is high, the aggressiveness scores in general drop significantly from tests 1 to 2 (Svartberg et al., in press). This may indicate that the trait aggressiveness is a measurement of aggression towards novel stimuli – a ''first time-aggression'' – that was not covered by the items in the questionnaire.

According to the correlations found (summarized in Table 3) the sociability trait is related to the dog's attitude towards unfamiliar humans, and seems to describe a continuum

from fear of being close to and approached by strangers, to social boldness and friendliness. Corresponding traits have been reported in several animal species, both domesticated (Belyaev, 1979; Hansen, 1996; Thodberg et al., 1999; Grignard et al., 2001; Lowe and Bradshaw, 2001) and non-domesticated species in captivity (Gosling, 1998; Carlstead et al., 1999), as well as in humans (Kagan et al., 1988). Similar dimensions have also been described previously in dogs (Royce, 1955). However, there is also a component of aggression in the sociability trait according to the present results, which is negatively related to social interest and positively related to fear of strangers. Fear related aggression has been found to be one of the most common types of behavioural problems in dogs (Beaver, 1999). In contrast, there are relatively few results from studies of dog personality or temperament where positive relationships between social shyness and aggressiveness are reported. Goddard and Beilharz (1984, 1985) reported that fearfulness and aggressiveness were independent traits, which is supported by results from studies on breed or strain differences in behaviour (Thorne, 1944; Scott and Fuller, 1965; Murphree et al., 1969). Royce (1955) found a relationship between fear and aggression, but this relationship was negative. It should be noted, however, that Hsu and Serpell (2003) reported finding that questionnaire items relating to sociability loaded negatively on both stranger-directed fear and stranger-directed aggression CBARQ factors.

The trait curiosity/fearlessness is mostly associated with the CBARQ factor ''non-social fear''. This factor is related to fear of novel non-social stimuli in general, but also to fearful behaviour when exposed to heavy traffic and thunderstorms (see Appendix). This suggests that curiosity/fearlessness is a measure of general non-social fearfulness in novel situations, which also seems to indicate a tendency to develop certain phobias. This tendency to behave fearfully is also to some degree expressed in social situations, which the correlations to ''stranger-directed fear'' and ''human-directed play interest'' indicate. Similar relationships have been found previously in dogs (Brace, 1961, in Scott and Fuller, 1965; Murphree et al., 1969; Goddard and Beilharz, 1984, 1985).

Playfulness seems to be a measure of the dog's interest in playing with humans, especially with objects such as balls and rags, including pursuit and retrieval. No relationships with playful behaviour towards conspecifics were found suggesting that the play interest measured in the trait playfulness is restricted to play with humans. Play is a characteristic behaviour in the domestic dog, often directed towards the owner (e.g. Stallones et al., 1988). In contrast, there are few reports on playfulness as a trait in dogs. One exception is a study by Goodloe and Borchelt (1998) based on data from a questionnaire similar to the one used in the present study where three different owner-related play factors where found. There are some reports on playfulness in primates, but mostly regarding play with conspecifics (Bolig et al., 1992; McGuire et al., 1994; Capitanio, 1999). These traits may be analogous to the playfulness trait in this study, considering that pet dogs are socialized to humans, and may see us as conspecifics in this respect (Rooney et al., 2001). The present results, together with previous studies (Svartberg, 2002; Svartberg and Forkman, 2002; Svartberg et al., in press), suggest that the tendency to play with humans can be regarded as a personality trait in dogs.

The remaining two specific traits that were correlated with the dogs' typical behaviour in every day life – chase-proneness and distance-playfulness – seem to be mixed measures of components of dog personality that are more specifically captured by the traits

sociability, curiosity/fearlessness and playfulness. Chase-proneness seems to be influenced by the dog's interest in playing with objects and its degree of non-social fearfulness. Distance-playfulness seems to be a mix of different tendencies, which was suggested in Svartberg and Forkman (2002) based on the results of the factor analyses in that study. This implies that three components of dog personality may be validly measured in the DMA: (1) interest in playing with humans (playfulness); (2) attitude towards strangers (interest in, fear of and aggression towards; sociability); and (3) non-social fearfulness (curiosity/fearlessness). According to the present results that show inter-correlations between playfulness, sociability and curiosity/fearlessness, these components seem to be facets of the higher-order boldness dimension that were suggested in Svartberg and Forkman (2002). Thus, the boldness dimension seems to be related to fearlessness and confidence in a range of situations. A similar dimension has been suggested previously in dogs (Brace, 1961, in Scott and Fuller, 1965) and in other species (Wilson et al., 1994). One question that may be addressed is whether this dimension is analogous to any of the human supertraits. It includes behavioural reactions as exploration, sociability and playfulness, which in animals have been interpreted in terms of the human supertrait extraversion (Gosling and John, 1999). The boldness dimension also relates (negatively) to inhibition and avoidance, which are reactions associated with neuroticism in animals (Zuckerman, 1991; Gosling and John, 1999). A possible explanation is that these two human traits do exist in dogs as well, but that they are correlated with each other. Interestingly, it seems that the two traits also correlate in human adults to some degree. For example, a mean correlation of -0.27 between extraversion and neuroticism was found in a comparison between three questionnaires that are used to measure the five major supertraits (John and Sristava, 1999). Suggestions have been made that this relationship indicates a shyness–boldness dimension in humans, which runs from neurotic-introversion to stable extraversion (Kagan et al., 1988; Zuckerman, 1991; Matthews and Deary, 1998). This view implies that the shyness dimension found in children serves as a base for neuroticism or extraversion, or both, in adulthood. However, the suggestion that extraversion and neuroticism are correlated in humans is far from generally accepted (e.g. John and Sristava, 1999), and there are recent results that suggest that these personality traits are independent in dogs (Sheppard and Mills, 2002; Gosling et al., 2003). Thus, further studies are needed to elucidate the structure of and the relationships between the basic personality dimensions in dogs.

In a previous study (Svartberg, 2002), a positive relationship was found between the broad boldness dimension and success in working dog trials. The results suggested that boldness may predispose the dog to success in training situations in general, and not to a specific task or ability. This relationship is supported by other results, which indicate that confident and fearless behaviour in dogs is related to success in several different training tasks (Scott and Fuller, 1965). In the present study, the CBARQ factor ''trainability'' was correlated with two traits from the DMA: playfulness and distance-playfulness. No significant correlations were found between ''trainability'' and the three other boldness-related specific traits curiosity/fearlessness, chase-proneness and sociability. This indicates that a playful attitude may be more important in training situations than a stranger-friendly and fearless attitude. A plausible explanation is that play can be used as an efficient

reinforcer in dog training, especially for dogs with a playful personality. However, an examination of the items that are related to the CBARQ factor ''trainability'' indicates that it mostly describes the dog's trainability in obedience situations close to its owner (see Appendix). Trainability in complex tasks, like problem-solving, or tasks that require performance independently from its owner is not covered in ''trainability''. Thus, it is possible that social and non-social fearlessness may be more important when a dog is trained to perform in working dog trials, which, besides obedience tasks, involve tasks like tracking, searching for hidden persons and running long distances far from the owner or handler.

According to the present results the behavioural test can be used to predict social fearfulness, non-social fearfulness related to novelty and a tendency to develop certain phobias, and to some degree fear-related aggression towards unfamiliar humans. These are common sources of problems for pet owners, and for the dog itself (e.g. Beaver, 1999; Lindsay, 2001). However, other behaviour that can cause problems for dogs and owners that was included among the CBARQ factors – separation distress, excessive excitability, owner-directed aggression, and inappropriate chasing – are not related to any of the traits measured in the behavioural test. This can be compared with a study of van der Borg et al. (1991), who used a behavioural test to successfully predict future behavioural problems like pulling on leash, play-aggression, jumping up and mounting at people, disobedience, separation anxiety, and aggression over food. However, the behavioural test used in van der Borg et al. (1991) was to a higher degree developed for predictions of behavioural problems. It is possible that the DMA can be similarly successful in predicting behavioural problems other than fear- and aggression-related, if subtests corresponding to the behavioural problems that are to be predicted are added.

5. Conclusions

The present results suggest that the DMA is a useful instrument in describing three components of a dog's personality that are expressed in everyday life, which all are related to a broad boldness dimension: (1) attitude towards strangers – interest in, fear of, and aggression towards – measured in the trait sociability; (2) non-social fearfulness measured in the trait curiosity/fearlessness; and (3) interest in playing with humans, measured in the trait playfulness. The results suggest that the two traits chase-proneness and distance-playfulness are mixed measures of these components, and are not associated with any additional aspect of the dog's personality. The aggressiveness trait was not validated by this study, and seems to be a poor predictor of aggressive behaviour in a dog's everyday life. The present results also validate several of the CBARQ factors, and indicate that this questionnaire reliably captures several important aspects of a pet dog's personality.

From an applied point of view, these results show that the standardized behavioural test used in this study validly assesses several important aspects of dog personality, as it is expressed in the home environment. Given that these traits are genetically based, as heritability studies suggest (Saetre et al., 2002; Strandberg et al., in press), the behavioural test seems to be a useful tool for breeding of pet dogs. The correlation between playfulness

and trainability, together with previous results that suggests a relationship between boldness and success in working dog trials (Svartberg, 2002), indicate that the DMA may be useful in selection of potential working or service dogs, as well as in breeding of this type of dogs. Furthermore, the results suggest that the test is a potential instrument for the prediction of behavioural problems related to social and non-social fear.

Acknowledgements

Many thanks to Dr. James A. Serpell and Dr. Yuying Hsu, who kindly put the CBARQ questionnaire at my disposal, and let me use it in this study, and for valuable comments during the preparation of the manuscript. Thanks to the Swedish Kennel Club for helping me with the dog-owners addresses. Thanks also to Susanne Stenius for the help with data treatment, and to Tommy Radesäter, Björn Forkman and Niina Svartberg for advice during the preparation of the manuscript. I am also very grateful to an anonymous referee, who gave me many valuable comments on a previous version of this manuscript. Finally, I am grateful to all volunteering dog-owners, who carried out the behavioural test with their dogs and described their dog's behaviour in the questionnaire.

Appendix

The items and behavioural factors of the CBARQ (from Hsu and Serpell, 2003).

Behavioural factor	Questionnaire item	
Stranger-directed aggression	Dog acts aggressively	When approached directly by an unfamiliar male adult while being walked or exercised
		When approached directly by an unfamiliar female adult while being walked or exercised
		When approached directly by an unfamiliar child while being walked or exercised
		Toward unfamiliar persons approaching the dog while it is in the owner's car
		When an unfamiliar person approaches the owner or a member of the owner's family at home
		When an unfamiliar person approaches the owner or a member of the owner's family away from home
		When mailmen or other delivery workers approach the home
		When strangers walk past the home while the dog is in the yard
		When joggers, cyclists, roller skaters, or skateboarders pass the home while the dog is in the yard
		Toward unfamiliar persons visiting the home

Appendix (*Continued*)

Behavioural factor	Questionnaire item	
Owner-directed aggression	Dog acts aggressively	When verbally corrected or punished by a member of the household
		When toys, bones, or other objects are taken away by a member of the household
		When bathed or groomed by a member of the household
		When approached directly by a member of the household while it is eating
		When food is taken away by a member of the household
		When stared at directly by a member of the household
		when stepped over by a member of the household
		When a member of the household retrieves food or object stolen by the dog
Stranger-directed fear	Dog acts anxious or fearful	When approached directly by an unfamiliar male adult while away from the home
		When approached directly by an unfamiliar female adult while away from the home
		When approached directly by an unfamiliar child while away from the home
		When unfamiliar persons visit the home
Non-social fear	Dog acts anxious or fearful	In response to sudden or loud noises
		In heavy traffic
		In response to strange or unfamiliar objects on or near the sidewalk
		During thunderstorms
		When first exposed to unfamiliar situations
		In response to wind or wind-blown objects
Dog-directed fear or aggression	Dog acts aggressively	When approached directly by an unfamiliar male dog while being walked or exercised on a leash
		When approached directly by an unfamiliar female dog while being walked or exercised on a leash
		Toward unfamiliar dogs visiting the home
	Dog acts anxious or fearful	When approached by an unfamiliar dog of the same size
		When approached by an unfamiliar dog of a smaller size

Appendix (*Continued*)

Behavioural factor	Questionnaire item	
Separation-related behaviour	Dog displays	Shaking, shivering, or trembling when left or about to be left on its own
		Excessive salivation when left or about to be left on its own
		Restlessness, agitation, or pacing when left or about to be left on its own
		Whining when left or about to be left on its own
		Barking when left or about to be left on its own
		Howling when left or about to be left on its own
		Chewing or scratching at doors, floor, windows, and curtains when left or about to be left on its own
		Loss of appetite when left or about to be left on its own
Attachment or attention seeking behaviour	Dog	Displays a strong attachment for a particular member of the household
		Tends to follow a member of the household from room to room about the house
		Tends to sit close or in contact with a member of the household when that individual is sitting down
		Tends to nudge, nuzzle, or paw a member of the household for attention when that individual is sitting down
		Becomes agitated when a member of the household shows affection for another person
		Becomes agitated when a member of the household shows affection for another dog or animal
Trainability	Dog	Returns immediately when called while off leash
		Obeys a sit command immediately
		Obeys a stay command immediately
		Will fetch or attempt to fetch sticks, balls, and other objects
		Seems to attend to or listen closely to everything the owner say or does
		Is slow to respond to correction or punishment*
		Is slow to learn new tricks or tasks*
		Is easily distracted by interesting sights, sounds, or smells[a]

Appendix (*Continued*)

Behavioural factor	Questionnaire item	
Chasing	Dog	Acts aggressively toward cats, squirrels, and other animals entering the yard
		Chases cats if given the chance
		Chases birds if given the chance
		Chases squirrels and other small animals if given the chance
Excitability	Dog overreacts or is excitable	When a member of the household returns home after a brief absence
		When playing with a member of the household
		When the doorbell rings
		Just before being taken for a walk
		Just before being taken on a car trip
		When visitors arrive at its home
Pain sensitivity	Dog acts anxious or fearful	When examined or treated by a veterinarian
		When having its claws clipped by a household member
		When groomed or bathed by a household member

[a] Indicates negative loading, i.e. a negative correlation between item and behavioural category.

References

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

Beaver, B.V., 1999. Canine Behavior: A Guide for Veterinarians. W.B. Saunders Company, Philadelphia.

Belyaev, D.K., 1979. Destabilizing selection as a factor in domestication. J. Heredity 70, 301–308.

Boissy, A., 1995. Fear and fearfulness in animals. Q. Rev. Biol. 70, 165–191.

Boissy, A., Bouissou, M.-F., 1995. Assessment of individual differences in behavioural reactions of heifers exposed to various fear-eliciting situations. Appl. Anim. Behav. Sci. 46, 17–31.

Bolig, R., Price, C.S., O'Neill, P.L., Suomi, S.J., 1992. Subjective assessment of reactivity level and personality traits of rhesus monkeys. Int. J. Primatol. 13, 287–306.

Brace, C.L., 1961. Physique, physiology, and behavior: an attempt to analyze a part of their roles in the Canine biogram. Ph.D. thesis, Harvard University.

Bradshaw, J.W.S., Goodwin, D., 1999. Determination of behavioural traits of pure-bred dogs using factor analysis and cluster analysis; a comparison of studies in the USA and UK. Res. Vet. Sci. 66, 73–76.

Capitanio, J.P., 1999. Personality dimensions in adult male rhesus macaques: prediction of behaviors across time and situation. Am. J. Primatol. 47, 299–320.

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 Biol. 18, 17–34.

Durr, R., Smith, C., 1997. Individual differences and their relation to social structure in domestic cats. J. Comp. Psychol. 111, 412–418.
Fält, L., 1997a. Anvisningar mentalbeskrivning. Svenska Brukshundklubben.
Fält, L., 1997b. Kompendium mentalitet. Svenska Brukshundklubben.
Goddard, M.E., Beilharz, R.G., 1984. A factor analysis of fearfulness in potential guide dogs. Appl. Anim. Behav. Sci. 12, 253–265.
Goddard, M.E., Beilharz, R.G., 1985. Individual variation in agonistic behaviour in dogs. Anim. Behav. 33, 1338–1342.
Goddard, M.E., Beilharz, R.G., 1986. Early prediction of adult behaviour in potential guide dogs. Appl. Anim. Behav. Sci. 15, 247–260.
Goodloe, L.P., Borchelt, P.L., 1998. Companion dog temperament traits. J. Appl. Anim. Welf. Sci. 1, 303–338.
Gosling, S.D., 1998. Personality dimensions in spotted hyenas (*Crocuta crocuta*). J. Comp. Psychol. 112, 107–118.
Gosling, S.D., 2001. From mice to men: what can we learn about personality from animal research? Psychol. Bull. 127, 45–86.
Gosling, S.D., John, O.J., 1999. Personality dimension in nonhuman animals: a cross-species review. Curr. Directions Psychol. Sci. 8, 69–75.
Gosling, S.D., Kwan, V.S.Y., John, O.P., 2003. A dog's got personality: a cross-species comparative approach to evaluating personality judgments. J. Pers. Soc. Psychol. 85, 1161–1169.
Grignard, L., Boivin, X., Boissy, A., Le Neindre, P., 2001. Do beef cattle react consistently to different handling situations? Appl. Anim. Behav. Sci. 71, 263–276.
Guy, N.C., Luescher, U.A., Dohoo, S.E., Spangler, E., Miller, J.B., Dohoo, I.R., Bate, L.A., 2001. Demographic and aggressive characteristics of dogs in a general veterinary caseload. Appl. Anim. Behav. Sci. 74, 15–28.
Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C., 1998. Multivariate Data Analysis. Prentice-Hall, Upper Saddle River.
Halverson, C.F., Havill, V.L., Deal, J., Baker, S.R., Victor, J.B., Pavlopoulos, V., Besevegis, E., Wen, L., 2003. Personality structure as derived from parental ratings of free descriptions of children: the inventory of child individual differences. J. Pers. 71, 995–1026.
Hansen, S.W., 1996. Selection for behavioural traits in farm minks. Appl. Anim. Behav. Sci. 49, 137–148.
Hiby, E.F., Rooney, N.J., Bradshaw, J.W.S., 2004. Dog training methods: their use, effectiveness and interaction with behaviour and welfare. Anim. Welf. 13, 63–69.
Hsu, Y., Serpell, J.A., 2003. Development and validation of a questionnaire for measuring behavior and temperament traits in pet dogs. J. Am. Vet. Med. Assoc. 223 (9), 1293–1300.
John, O.P., Sristava, S., 1999. The big five trait taxonomy: history, measurement, and theoretical perspectives. In: Pervin, L.A., John, O.P. (Eds.), Handbook of Personality: Theory and Research. Guilford, New York, pp. 102–138.
Jones, R.B., 1988. Repeatability of fear ranks among adult laying hens. Appl. Anim. Behav. Sci. 19, 297–304.
Kagan, J., Reznick, J., Snidman, N., 1988. Biological bases for childhood shyness. Science 240, 167–171.
Kobelt, A.J., Hemsworth, P.H., Barnett, J.L., Coleman, G.J., 2003. A survey of dog ownership in suburban Australia—conditions and behaviour problems. Appl. Anim. Behav. Sci. 82, 137–148.
Kolar, D.W., Funder, D.C., Colvin, C.R., 1996. Comparing the accuracy of personality judgments by the self and knowledgeable others. J. Pers. 64, 311–337.
Lewis, M., 2001. Issues in the study of personality development. Psychol. Inq. 12, 67–83.
Lindsay, S.R., 2001. Handbook of Applied Dog Behavior and Training, vol. 2: Etiology and Assessment of Behavioural Problems. Iowa State University Press, Ames.
Lowe, S.E., Bradshaw, J.W.S., 2001. Ontogeny of individuality in the domestic cat in the home environment. Anim. Behav. 61, 231–237.
Manteca, X., Deag, J.M., 1993. Individual differences in temperament of domestic animals: a review of methodology. Anim. Welf. 2, 247–268.
Martin, P., Bateson, P., 1993. Measuring Behaviour: An Introductory Guide. Cambridge University Press, Cambridge.
Matthews, G., Deary, I.J., 1998. Personality Traits. Cambridge University Press, Cambridge.
McGuire, M.T., Raleigh, M.J., Pollack, D.B., 1994. Personality features in vervet monkeys: the effect of sex age, social status, and group composition. Am. J. Primatol. 33, 1–13.

Murphree, O.D., Peters, J.E., Dykman, R.A., 1969. Behavioral comparisons of nervous, stable, and crossbred pointers at age 2, 3, 6, 9, and 12 months. Conditional Reflex 4, 20–23.

Osgood, C.E., Suci, G.J., Tannenbaum, P.H., 1957. The Measurement of Meaning. University of Illinois Press, Urbana.

Overall, K.L., Dunham, A.E., Frank, D., 2001. Frequency of nonspecific clinical signs in dogs with separation anxiety, thunderstorm phobia, and noise phobia, alone or in combination. J. Am. Vet. Med. Assoc. 219, 467–473.

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

Rooney, N.J., Bradshaw, J.W.S., Robinson, I.H., 2000. A comparison of dog–dog and dog–human play behaviour. Appl. Anim. Behav. Sci. 66, 235–248.

Rooney, N.J., Bradshaw, J.W.S., Robinson, I.H., 2001. Do dogs respond to play signals given by humans? Anim. Behav. 61, 715–722.

Royce, J.R., 1955. A factorial study of emotionality in the dog. Psychol. Monogr. 69, 1–27.

Saetre, P., Strandberg, E., Sundgren, P.-E., Petterson, U., Jazin, E., Bergström, T., 2002. The genetic basis of behaviour patterns in dogs. In: Proceedings of the Workshop on Dog Genetics, Uppsala, Sweden, 22–23 May 2002.

Schrader, L., 2002. Consistency of individual behavioural characteristics of dairy cows in their home pen. Appl. Anim. Behav. Sci. 77, 255–266.

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

Serpell, J.A., Hsu, Y., 2001. Development and validation of a novel method for evaluating behaviour and temperament in guide dogs. Appl. Anim. Behav. Sci. 72, 347–364.

Sheppard, G., Mills, D.S., 2002. The development of a psychometric scale for the evaluation of the emotional predispositions of pet dogs. Int. J. Comp. Psychol. 15, 201–222.

Sokal, R.R., Rohlf, F.J., 1995. Biometry. W.H. Freeman Company, New York.

Stallones, L., Marx, M., Garrity, T.F., Johnson, T.P., 1988. Attachment to companion animals among older pet owners. Anthrozoös 2, 118–124.

Strandberg, E., Jacobsson, J., Saetre, P., in press. Direct and maternal effects on behaviour in German Shepherd dogs in Sweden. Livestock Production Science.

Svartberg, K., 2002. Shyness–boldness predicts performance in working dogs. Appl. Anim. Behav. Sci. 79, 157–174.

Svartberg, K., Forkman, B., 2002. Personality traits in the domestic dog (*Canis familaris*). Appl. Anim. Behav. Sci. 79, 133–155.

Svartberg, K., Tapper, I., Temrin, H., Radesäter, T., Thorman, S., 2000. Consistency of personality traits in dogs. Anim. Behav.

Syme, L.A., 1981. Social disruption and forced movements in orders in sheep. Anim. Behav. 29, 283–288.

Thodberg, K., Jensen, K.H., Herskin, M.S., 1999. A general reaction pattern across situations in prepubertal gilts. Appl. Anim. Behav. Sci. 63, 103–119.

Thodberg, K., Jensen, K.H., Herskin, M.S., 2002. Nest building and farrowing in sows: relation to the reaction pattern during stress, farrowing environment and experience. Appl. Anim. Behav. Sci. 77, 21–42.

Thorne, F.C., 1944. The inheritance of shyness in dogs. J. Genet. Psychol. 45, 275–279.

Timberlake, W., 1997. An animal-centered, causal-system approach to the understanding and control of behavior. Appl. Anim. Behav. Sci. 53, 107–129.

Topal, J., Miklosi, A., Csanyi, V., 1997. Dog–human relationship affects problem solving behavior in the dog. Anthrozoös 10, 214–224.

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. Appl. Anim. Behav. Sci. 32, 237–251.

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. Appl. Anim. Behav. Sci. 74, 242–258.

Wilson, D., Clark, A., Coleman, K., Dearstyne, T., 1994. Shyness and boldness in humans and other animals. Trends Ecol. Evol. 9, 442–446.

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