

Personality in dogs

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Kenth Svartberg



SUMMARY

Introduction – setting the stage

The study of personality is closely related to the assessment of feelings, thoughts and beliefs, issues that by tradition have been addressed to humans exclusively (e.g. Matthews & Deary 1998). Within the study of animal behaviour, internal processes – such as feelings and thoughts – have been considered unobservable (e.g. Dawkins 1986), or even scientifically irrelevant (Skinner 1938). Researchers have striven towards explanations of animal behaviour in the simplest possible way, in accordance with Lloyd Morgan's Canon, and have avoided the use of human emotions and intentions as behavioural explanations (Martin & Bateson 1993). As a result of this, it seems that scientists interested in individual differences in animal behaviour also have avoided the concept of personality because of fear of anthropomorphism (Gosling 2001).

However, besides feelings and thoughts, personality also includes an issue that is possible to study in animals – behaviour. Personality traits can be described as dispositional factors that regularly and persistently determine behaviour in many different types of situations (Eysenck and Eysenck 1985). Thus, an individual's personality can be inferred from the individual's behaviour in different situations, and/or over periods of time, and personality traits can be suggested on the basis of correlations between behavioural reactions. This makes the study of animal personality no different from any other studies of animal behaviour. A label of a suggested trait - such as 'fearfulness' or 'aggressiveness' – may only be a short description for a disposition of the individual to act in a certain way, and does not necessarily imply the existence of any feelings or thoughts.

In contrast to what was proposed above about the avoidance of the concept of person-

ality in animals, studies of individual differences in animal behaviour have a long history, but under the label of 'animal temperament' (see Hall 1941). Temperament has been considered as biologically rooted individual differences in behaviour tendencies that are presented early in life and are relatively stable over time and across situations (e.g. Strelau 1983), or as 'the raw stuff of individuality' (Hall 1941). However, the difference between personality and temperament is far from distinct. According to Matthews & Deary (1998), the study of temperament in humans is simply the investigation of personality in infancy and childhood using behavioural measurements. The difference between the two areas seems mostly to be due to historical differences in research goals. Personality trait psychologists focused their attention on creating descriptive taxonomies of personality traits, whereas researchers of temperament were interested in biological explanations for individual differences (Clark & Watson 1999). Today, the two areas of research have very much converged. Substantial correlations have been found between temperament traits and personality traits. For example, Extraversion and Neuroticism, which are considered to be two of the five major human personality traits, are also considered to be two of the major temperament traits in humans (Clark & Watson 1999).

Even though the study of personality in animals is reduced to the assessment of 'outer traits', i.e. behaviour (Johnson 1997), it may also include inferring of inner traits. During the latest decades there has been an increased interest in animal cognition, and the study of internal processes in animals has become scientifically respectable (Griffin 1992; Shettleworth 1998). Theories and methods have been developed that allow researchers to make sci-

entifically valid assumptions about consciousness and emotions in animals (e.g. Dennett 1983; Boissy 1995; LeDoux 1996; Désiré *et al.* 2002). This makes the concept of personality even more applicable in animals.

Personality constructs in animals

In the study of animal personality, several constructs have been suggested that describe individual differences. These are almost exclusively traits, which broadly can be defined as dimensions of individual differences (McCrae & Costa 1997). There have also been some suggestions of personality types - i.e. the division of individuals into distinctive categories based on behavioural reactions in different situations. This view could be found already in the ancient Greece. According to Hippocrates (fifth century BC) and Galen (second century AD), humans could be separated into one of four basic personality types: choleric (irritable, angry), melancholic (depressed, gloomy), sanguine (optimistic, cheerful), and phlegmatic (calm, passive; Zuckerman 1991; Clark & Watson 1999). Pavlov used this typology to describe four basic personality types of dogs, based on observations in conditioning experiments (described in Strelau 1983). However, the dogs' behaviour was also noted in other situations. The sanguine dogs seemed 'bored' by repetitious conditioned stimuli, but were outside the laboratory active, curious and friendly towards humans. In contrast, the melancholic dogs were described as attentive and hyperalert in experimental conditions, but passive and fearful of humans outside the laboratory.

More recently, a more scientifically valid theory of distinctive styles has emerged, in which an animal can be said to be either proactive or reactive, according to its behavioural and physiological reactions in challenging and threatening situations. Behaviourally, proactive individuals are suggested to be more active and aggressive, and they easily develop rou-

tines, whereas reactive animals are non-aggressive, and are more prone to show immobile behaviour when challenged (Benus *et al.* 1991; Koolhaas *et al.* 1999). Reactive individuals are also suggested to be adjustable to circumstances and reactive to environmental cues. These differences may reflect two distinct types of strategies, where proactive individuals are more successful under stable colony conditions, and reactive individuals are better adapted for unpredictable environments. Coping styles have been predominately studied in rodents (Benus *et al.* 1991), but a similar bimodal distribution of the related characteristics has been suggested for pigs (Hessing *et al.* 1993; Ruis *et al.* 2002) and great tits (Verbeek *et al.* 1994; 1996). However, the coping style concept has met some criticism, especially regarding the suggestions of a bimodal distribution, i.e. the existence of distinct styles (Jensen *et al.* 1995; Forkman *et al.* 1995). Instead, most of the results from research on animal personality suggest trait constructs - that individual differences can be described according to normally distributed continuums.

One of the most suggested traits in animals is fearfulness, which has also been labelled emotionality, timidity, shyness, nervousness and anxiousness (e.g. Hall 1941; Wilson *et al.* 1994; Boissy 1995). A broad definition of this trait is the animal's general tendency to react to a variety of potential threatening stimuli, and is behaviourally expressed by withdrawal, flight, attack and/or immobility (Boissy 1995). Fearfulness has been found in a range of species from several taxa, such as rodents (Hall 1941), wolves (Fox 1972), hens (Jones 1988), octopuses (Mather & Anderson 1993), cattle (Boissy & Bouissou 1995), guppies (Budaev 1997), as well as in humans (Kagan *et al.* 1988).

Besides fearfulness, there are other commonly reported dimensions. One is related to aggressive and hostile behaviour. Such traits have been suggested in several species, e.g. rodents (Hall 1941), rhesus monkeys (Chamowe *et al.* 1972), cats (Feaver *et al.* 1986), and pigs

(Forkman *et al.* 1995). Another is sociability, which describes the animal's interest in and attitude towards another member of the same species, or towards humans in domestic species. A sociability-related trait has been suggested in species such as cats (Feaver *et al.* 1986), pigs (Forkman *et al.* 1995), hyenas (Gosling 1998), and rhinoceros (Carlstead *et al.* 1999). Two additional traits that have been suggested in animals of different species are activity (e.g. Hall 1941; Royce 1955; Mather & Anderson 1993) and dominance (e.g. King & Figueredo 1997; Gosling 1998).

Gosling and John (1999) have reviewed results from animal personality studies, and proposed that the concept of the "big five" can be applied to animals as well as humans. The 'big five' refers to the five human personality traits Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness that show a high degree of stability, heritability, consensual validation, and cross-cultural invariance (e.g. John & Srivastava 1999). According to Gosling and John (1999), it seems like three of the five major traits can be found in a range of species - Neuroticism (related to fear and anxiety), Extraversion (sociability, activity) and Agreeableness (cooperation, lack of aggression). These cross-species similarities have been taken as evidence of evolutionary stability of the major traits found in humans (e.g. Bouchard & Loehlin 2001; Gosling 2001).

Why study animal personality?

Even though individual differences in behaviour have been studied since the beginning of the 20th century (Hall 1941), there has been an increase in interest during the latest two decades in this area. There are at least four reasons for this. The first concerns welfare in animals. Stable individual differences have been found in constructs such as fear and coping style that influence the animal's reaction to the environment and ability to cope with challenges (Boissy 1995; Koolhaas *et al.* 1999),

findings that are important to consider from a welfare point of view. The second reason concerns applied use of behavioural predictions. Information about differences in personality can be useful in such areas as in the selection of potential guide dogs (Goddard & Beilharz 1986) and in predictions of future behavioural problems (van der Borg *et al.* 1991; Hennesy *et al.* 2001). Furthermore, personality has also become a topic within behavioural ecology. Personality seems to play a role in life-history patterns such as in establishing territories (Benus *et al.* 1991) and dominance hierarchies (Verbeek *et al.* 1996), in risk-taking (Wilson *et al.* 1994), and in reproductive success (Armitage 1986; Réale *et al.* 2000). Finally, a reason to study animal personality has been to increase the understanding of the evolution of human personality. The results suggesting that the major personality traits that are found in humans also can be detected in animals indicate links between animal and human behaviour (Gosling & John 1999; Bouchard & Loehlin 2001). Thus, the study of animal personality may be important for the understanding of the evolution of behaviour in general, as well as in providing important insights into the genetic, biological, and environmental determinants of human personality that are difficult to achieve by human research alone (Gosling 2001).

How to measure animal personality?

According to reviews by Manteca and Deag (1993) and Gosling (2001), personality in animals is assessed using two distinct methods, which are related to different levels of analysis. Behavioural reactions can be observed according to strict objective criteria (i.e. frequency, duration, and/or latency). This is also the most common method in ethological studies in general (Martin & Bateson 1993). This method has been used in theoretical approaches, where behaviour measurements are used as indicators for a suggested personality type (Benus *et al.* 1991; Verbeek *et al.* 1994) or for the magnitude

of a trait (Jones 1988; Maestripieri 2000). Objective measures of behaviour have also been used in more empirical and exploratory approaches, where clusters of correlated behavioural variables that presumably represent personality traits are searched for by the use of factor analysis or other multivariate analysis methods (e.g. Budaev 1997; Grignard *et al.* 2001; Visser *et al.* 2001).

Animal personality may also be measured at a more comprehensive level, where individuals are described according to predefined traits (e.g. Feaver *et al.* 1986; Gosling 1998; Morris *et al.* 2002). Observers, who assess the personality of an individual by observing it in different situations, are here used as data recording instruments. Commonly, the animal is described according to adjectives, such as 'curious', 'motherly', 'playful', and 'understanding' (Stevenson-Hinde *et al.* 1980). This method provides a higher level of description, and may capture the overall pattern of an individual's behaviour that remains elusive when discrete events are measured (Martin & Bateson 1993). However, direct assessment of personality is sensitive for subjective interpretations, and may easily be biased by the observer. Therefore, the accuracy of this method rests on the use of several independent observers, together with high criteria of inter-observer agreement for the suggested traits (Gosling 2001).

Besides these two general methods of assessing animal personality suggested by Manteca and Deag (1993) and Gosling (2001), there is one additional approach that is commonly used – behavioural rating scales. In this method, the animal's behaviour is rated in a specific situation or moment according to a predefined scale with a number of steps. For example, aggressive behaviour in dogs have been rated according to a four-point scale, where the lowest score equals no aggression observed and the highest equals biting and/or attacking with bite intention (Netto & Planta 1997). Besides observations using criteria such as frequency and time, behavioural rating

scales were highly used in assessments of fearfulness and aggressiveness in the early animal personality studies, according to a review by Hall (1941). Some additional assumptions are made when rating scales are used compared to strict objective criteria (e.g. categories of behaviour). However, descriptions of behaviour at a more general level may be more predictive than specific measures of behaviour (Funder & Colvin 1991).

Independent of method chosen to measure a personality construct, two requirements that should be met regarding the construct are reliability and validity (West & Finch 1997). Reliability refers to the accuracy with which the trait is measured, and concerns the repeatability and consistency of the measurement (Martin and Bateson, 1986). Some different reliability measures are used in personality research. One of them is test-retest reliability, which typically is used to address questions on the stability of the personality construct over time and repetitions of a test (West & Finch 1997). Another measure of reliability is internal consistency, where the degree of relationship between items that constitute a construct is measured. This could either be between behavioural variables that are assumed to be expressions of a trait (West & Finch 1997), or between the ratings of two or more observers (inter-observer agreement; e.g. Gosling 2001). Once it is established that a measure has adequate reliability, the issue of validity arises. Validity concerns how well an instrument, such as a behavioural test or a questionnaire, measures what it is meant to measure, and how well it provides information that is relevant to the questions asked (Martin and Bateson, 1998). Thus, for a validation analysis data from two or more independent situations is needed.

Within human personality research, where the study of personality traits has a long tradition, reliability and validity are criteria that must satisfactorily be met for any trait to be considered relevant (Matthews and Deary, 1998). Also in the early study of traits in ani-

mals, these criteria were considered important (Hall 1941). However, more recent researchers of animal personality do not seem to strictly follow this tradition. According to a review by Gosling (2001) these issues are often ignored in animal studies today, but they are important to consider in order to maintain the scientific validity in the study of animal personality.

Why study personality in dogs?

The dog is a highly interesting species regarding the study of animal personality. It has been put under strong selection pressure during at least 14 000 years, according to archaeological evidence (Nobis 1979, in Clutton-Brock 1999), but probably much longer, which DNA studies suggest (Vilá *et al.* 1997; Savolainen *et al.* 2002). During the domestication there have been a variety of selective pressures in different places and in different time periods (Clutton-Brock 1999), which have resulted in a unique variation in morphology, behaviour as well as in the genome seen in few other species (e.g. Scott & Fuller 1965; Wayne 1986; Wayne & Ostrender 1999). This makes the dog a suitable model for genetic and evolutionary studies of personality. Another reason to study personality in the dog is because of its close relationship to humans and as an important part of the society. Only in Sweden, there are approximately 700 000 dogs, mainly living as pets (according to the Swedish Kennel Club). A dog's personality is an issue not only for the owner. It is also a concern for the society in general, which the recent debate regarding dangerous dogs and banning of dog breeds illustrates only too well (e.g. Netto & Planta 1997). Furthermore, personality is of importance in the use of dogs for different purposes. In spite of large cultural changes in the Western society during the latest century, dogs are still used in some practical functions. Dogs help us in hunting and herding, in guiding blind people, in detection of various chemicals, in protection, and in some other func-

tions. Knowledge about dog personality is important for early selection of potential individuals, in choice of training methods and in dog breeding (e.g. Goddard & Beilharz 1986; Slabbert & Odendaal 1999). A final reason for the study of dog personality is the welfare aspect. We are responsible for the dogs' living conditions, as well as for the other domesticated species. To avoid suffering and other negative states in dogs, it is important to understand how individual dogs differ in needs and abilities to cope with environmental challenges.

Previous knowledge about dog personality

Even though there are early indications of personality traits and types in the dog (Thorne 1940; Strelau 1983), an important step in the scientific study of personality in dogs was taken in a project at Jackson laboratories in Bar Harbor during the 50's (described in Scott & Fuller 1965). Dogs of five breeds, and mixes between them, were bred and studied, both behaviourally and physiologically, in order to investigate the genetic influences on behaviour. By the use of factor analysis, several factors associated to fearfulness were suggested. These factors related to different strategies in potentially dangerous situations (e.g. tendency to inhibit or 'freeze' and active avoidance: Royce 1955; Cattell and Korth 1973) and to reactions to different categories of stimuli (e.g. humans, noise and novel situations: Royce 1955; Cattell and Korth 1973). In addition, factors describing aggressiveness towards humans and dogs, reactivity or impulsiveness, and general activity were found (Royce 1955; Brace 1961, in Scott & Fuller 1965; Cattell and Korth 1973).

Other more recent studies using similar methods of analysis also indicate the existence of personality traits in dogs. In the 80's, Goddard and Beilharz (1984; 1985) carried out analyses on behaviour of potential guide dogs. They found several stimuli-specific fear-related

dimensions (e.g. suddenness, sounds, threats, moving objects), and one general dimension of fear, related to avoidance behaviour in a range of situations. In addition, the general fear dimension was found to correlate with low social confidence in meetings with other dogs (Goddard & Beilharz 1985), which indicates the existence of a broad shyness dimension in the dog. This dimension, however, was not associated with aggressiveness towards unknown dogs.

Hart and Miller (1985) carried out a study in which they used a more unconventional method in the collection of behavioural data. They asked 'authorities' in the USA (veterinarians, obedience judges, etc.) to rate breed-typical behaviour according to predefined behavioural dimensions for a large number of breeds. Factor analyses of these data (Hart & Hart 1985) produced three relevant traits: reactivity (related to e.g. affection demand, excitability and general activity), aggressiveness (e.g. territorial defence, watchdog barking, and aggression to dogs), and trainability (obedience training and housebreaking ease). A study using a similar method has also been done in the UK with approximately the same results (Bradshaw & Goodwin 1998). The exception was that an "immaturity"-factor appeared, related to playfulness and destructiveness, instead of a trainability factor. In a reanalysis of the data of Hart and Miller (1985), Draper (1995) found three factors that were suggested to correspond with three of the five major traits found in humans - Extraversion, Agreeableness and Openness.

There are also more recent studies where factor analysis based on behavioural data have been used. Hennesy *et al.* (2001) tested dogs admitted to an animal shelter in a behavioural test including novel arena test, strangers, a moving object, and sounds. Six factors were extracted: two factors related to social interest in humans, three fear-related factors (timidity, flight and wariness) and one related to general locomotor activity. Reactions to a stranger, a

moving object and noise was also investigated by Christiansen *et al.* (2001). In addition, the dogs, which were of hunting breeds, were tested in two situations with sheep. Approach behaviour and reactions to electric shocks administered by an electronic collar were recorded. A factor analysis suggested three factors reflecting predatory motivation, general fear of novelty, and fear of sheep in combination with sensitivity to electric shocks, respectively.

In conclusion, these results indicate the existence of major dimensions in the dog's personality. It seems that fearfulness and aggressiveness are the two most commonly suggested traits, and the existence of such traits are supported by other studies. Fearfulness in dogs, described as a general tendency to avoid potential sources of danger together with reduced exploration, has also been described by Thorne (1940), Mahut (1958) and Murphree *et al.* (1969). Netto & Planta (1997) investigated aggressive behaviour in dogs, and found stable tendencies of aggressiveness towards different aggression-eliciting stimuli.

Aims with the present thesis

Even though we have some understanding of the personality of the dog, there are unresolved issues. I have considered some of them in this thesis. The first concerns the generality of personality traits in dogs. Only one or a few breeds have been investigated in each of the above reviewed studies, with the exception of the studies carried out by Hart and Miller (1985) and Bradshaw & Goodwin (1998). However, they used breed as category, and did not study personality within breeds. Thus, our knowledge is limited about the generality of personality traits in dogs of different types and breeds. Related to the question of *structure* of personality in different breeds is the question whether breeds in general differ in *magnitude* of personality traits. Besides the question about how artificial selection have influenced the be-

haviour in the domestic dog, knowledge about breed-typical personality can help potential dog owners in the choice of a dog from a suitable breed. Furthermore, information about breed-typical personality can benefit the

breeding of dogs. Even though this issue has been addressed previously (Hart & Hart 1985), knowledge about breed differences based on behavioural data would be of great value.

Table 1. The subtests in the personality test; names and a short description of each test.

| Subtest | Description |
|-------------------|--|
| Social contact | A stranger greets, walks with, and makes a brief physical examination of the dog. Variables: greeting, cooperation, and handling. |
| Play 1 | The dog is invited to play with a rag by the stranger. Variables: interest in play, grabbing, and tug-of-war. |
| Chase | A small prey-like object is rapidly pulled away from the dog, who is free to run after. This is repeated once. Variables: following 1 & 2 and grabbing 1 & 2. |
| Passive situation | The handler remains in the same position during 3 minutes with the dog in a leash. Variable: activity. |
| Distance play | A stranger invites the dog to play at a distance, after some initial threat postures. Variables: interest, aggression, exploration, interest in play, and play invitation. |
| Sudden appearance | A human-sized dummy is suddenly pulled up in front of the dog. Variables: startle reaction, aggression, exploration, avoidance (x2), and approach (x2). |
| Metallic noise | A chain of metal is pulled over a sheet of corrugated metal close to the dog. Variables: startle reaction, exploration, avoidance (x2), and approach (x2). |
| Ghosts | Two strangers covered in white sheets are slowly approaching the dog during several minutes. Variables: aggression, attention, avoidance, exploration, and contact. |
| Play 2 | Repetition of the first part of Play 1. Variables: interest in play and grabbing. |
| Gunshot | Gunshots are fired when dog is active (playing with handler) and passive. Variable: avoidance. |

There are only a few studies on the test-retest reliability and the consistency over time of personality traits in the dog. Some studies have concerned the predictability of puppy behaviour to adult behaviour (Goddard & Beilharz 1986; Wilsson & Sundgren 1998; Slabbert & Odendaal 1999), but studies of consistency of personality in adult dogs are scarce (but see Netto & Planta 1997). The theory of personality rests on the fact that the behaviour of an individual can be predicted from one time to another. Therefore, it is crucial that the consistency of suggested personality traits is investigated.

Besides reliability, the validity and relevancy of a trait are highly important. It may be possible to reliably measure a trait in a specific situation, but it is of low theoretical and practical importance if the trait is expressed in that situation exclusively. Some attempts have been done to use behavioural measures from tests to predict success in potential service dogs (Goddard & Beilharz 1986; Wilsson & Sundgren 1997; Weiss & Greenberg 1997) and predict behavioural problems in dogs (van der Borg *et al.* 1991; Hennesy *et al.* 2001). However, considering the importance of relevancy, the knowledge about how personality traits in

dogs are expressed in different situations is limited.

Finally, from an applied point-of-view, it would be important if a dog's basic personality could be measured in a standardized behavioural test accessible to a large number of dogs. This would have great practical benefits for the breeding of dogs, where such a test could be used in evaluation of the progeny and as an instrument for selection of breeding animals.

The behavioural test

The behavioural data in this thesis are collected in a standardised behavioural test, which has been named 'Dog Mentality Assessment' - DMA. This test is used by the Swedish Working Dog Association (SWDA) and was developed during the 80's and 90's as a tool for breeding of working dogs. The idea behind it was that behavioural reactions in several different situations of sires and dams, as well as of the progenies, could be quantified, and the results could be compared in order to evaluate breeding success. Today the test has become somewhat of a 'general behavioural test' in Sweden, and a large number of dogs of different breeds and breed groups have carried out the test.

In the test, the dog is exposed to several different stimuli during ten subtests (table 1), which are ordered along a path in a semi-covered surrounding. A handler, usually the owner, leads the dog. The handler is instructed before and during the test by a test-leader what to do and how to act, according to a standardized procedure. Two or three persons assist the test-leader, who is responsible for the practical aspects during the test. The dog's behavioural reactions are described according to 33 variables by an authorized observer in a standardised score sheet. The score sheet includes rating scales for the 33 variables from 1 to 5 according to the intensity of the measured reaction where a low score equals a low-

intensity reaction, and a high score a high-intensity reaction. Each of the scales for the 33 reactions, which are measured at specific moments during the test, describes the reaction as objectively as possible, without inferring subjective opinions.

Even though there are only one test-leader and observer, together with two to three assistants, for each test occasion, the total number of functionaries used in the tests around the country is high. This may cause biases in the test procedure and decrease the accuracy of the behavioural measurements. However, there are two factors that make the behavioural data that is collected in the test trustworthy. First, the test is highly standardized, both regarding the equipment used and the test procedure, and the description of the dogs' behaviour during the test. Secondly, all functionaries are well trained and certified by the SWDA. For example, the observers, who have the most solid training of the functionaries, have carried out a five-step training programme during 95 hours, and have passed several tests including tests on inter-observer reliability. These two factors minimize the risk that test related factors influence the dogs' scores.

Suggestions of general personality traits in the dog – Paper I

The aim of the first study in the thesis was to investigate the pattern of correlation between the 33 variables, to see if there were any underlying factors that could be used as suggestions of personality traits. Furthermore, we – Björn Forkman and I – were interested in the generality of these traits, i.e. if the same patterns of correlations between variables could be found in different types of dogs with different selection history. To answer these questions, data from 15 329 dogs, both males and females, of 164 breeds were collected. The data were analysed using common factor analysis (Hair *et al.* 1998). To avoid the poten-

tial bias from numerous large breeds, and to investigate the generality of the results, two types of samples were used. First, factor analysis was carried out on a dataset using data from 25 randomly sampled dogs in each breed from 47 breeds. Secondly, data from eight

breed groups, according to the nomenclature by the Federation Cynologique Internationale (FCI), were factor analysed separately in order to compare the pattern of correlations within the breed groups.

Table 2. Results from the factor analysis on data from 47 breeds. Factor loadings >0.40 are in bold.

| Subtest | Variable | <i>Playfulness</i> | <i>Curiosity/ Fearlessness</i> | <i>Chase-proneness</i> | <i>Sociability</i> | <i>Aggressiveness</i> |
|--------------------------------------|------------------|--------------------|------------------------------------|------------------------|--------------------|-----------------------|
| Social contact | Greetings | 0.06 | 0.06 | 0.07 | 0.59 | 0.11 |
| | Cooperation | 0.11 | 0.02 | 0.04 | 0.59 | 0.05 |
| | Handling | 0.09 | 0.08 | 0.01 | 0.61 | -0.01 |
| Play 1 | Interest in play | 0.70 | 0.04 | 0.16 | 0.18 | 0.16 |
| | Grabbing | 0.72 | 0.02 | 0.12 | 0.06 | 0.11 |
| | Tug-of-war | 0.66 | 0.12 | 0.12 | 0.18 | 0.12 |
| Chase | Following 1 | 0.09 | 0.11 | 0.71 | 0.10 | 0.07 |
| | Grabbing 1 | 0.15 | 0.14 | 0.72 | 0.06 | 0.06 |
| | Following 2 | 0.16 | 0.10 | 0.72 | 0.11 | -0.01 |
| | Grabbing 2 | 0.23 | 0.12 | 0.70 | 0.07 | 0.04 |
| Passive sit. | Activity | 0.09 | -0.03 | 0.04 | 0.04 | 0.10 |
| Distance play | Interest | 0.19 | 0.11 | 0.13 | 0.14 | 0.32 |
| | Aggression | -0.02 | -0.08 | -0.09 | -0.13 | 0.46 |
| | Exploration | 0.34 | 0.23 | 0.23 | 0.50 | -0.09 |
| | Tug-of-war | 0.57 | 0.20 | 0.17 | 0.48 | -0.05 |
| | Play invitation | 0.51 | 0.17 | 0.12 | 0.47 | -0.02 |
| Sudden appearance | Startle reaction | 0.01 | -0.53 | -0.01 | -0.09 | -0.11 |
| | Aggression | 0.10 | -0.07 | 0.04 | 0.01 | 0.50 |
| | Exploration | 0.09 | 0.63 | 0.05 | 0.11 | -0.10 |
| | Rem. avoidance | -0.08 | -0.62 | 0.02 | -0.06 | 0.02 |
| | Rem. approach | 0.06 | -0.13 | 0.14 | 0.03 | 0.12 |
| Metallic noise | Startle reaction | -0.04 | -0.56 | -0.06 | -0.02 | -0.03 |
| | Exploration | 0.11 | 0.52 | 0.13 | 0.04 | 0.17 |
| | Rem. avoidance | -0.07 | -0.54 | -0.01 | -0.03 | -0.11 |
| | Rem. approach | 0.06 | -0.19 | 0.06 | 0.08 | 0.05 |
| Ghosts | Aggression | 0.06 | 0.05 | 0.04 | -0.01 | 0.64 |
| | Attention | 0.01 | 0.05 | 0.04 | 0.12 | 0.50 |
| | Avoidance | -0.03 | -0.27 | 0.03 | -0.19 | 0.14 |
| | Exploration | 0.02 | 0.43 | 0.03 | 0.25 | -0.07 |
| Play 2 | Greeting | 0.04 | 0.26 | 0.07 | 0.43 | 0.08 |
| | Interest in play | 0.78 | 0.10 | 0.16 | 0.04 | 0.13 |
| | Grabbing | 0.78 | 0.09 | 0.16 | -0.01 | 0.11 |
| Gunshot | Avoidance | -0.13 | -0.18 | -0.13 | -0.05 | -0.04 |
| Proportion of explained variance (%) | | 11.0 | 7.8 | 7.2 | 6.7 | 4.3 |

In general, the results from the analyses of the two samples were similar. The analyses based on data from 47 breeds suggested five factors, which were related to 27 of the 33

variables (table 2). After interpretation of the factor loadings, we labelled these 'Playfulness', 'Curiosity/Fearlessness', 'Chase-proneness', 'Sociability' and 'Aggressiveness'.

These factors were also found within the breed groups, with a few exceptions. These exceptions were found in the group of Retrievers and water dogs (FCI 8), where Sociability and Playfulness were merged into one dimension, and in the breed groups Pointers (FCI 7) and Companion dogs (FCI 9), where an additional factor was found labelled 'Playfulness at distance' (or 'Distance-playfulness').

In order to investigate whether there were any broader constructs to which the factors were related, higher-order factor analyses were carried out. The results of these analyses suggest that there is one broad factor to which all the specific factors, with the excep-

tion of Aggressiveness, were related. This was found in the dataset of 47 breeds, as well as within several of the breed groups. Three exceptions were found: (1) Terriers (FCI 3) and Scent hounds (FCI 6), in which Curiosity/Fearlessness were less related to the broad factor compared to the general pattern, (2) Pointers (FCI 7) and Companion dogs (FCI 9), where Curiosity/Fearlessness and Sociability had relatively low relationships with the broad factor (instead, the factor Playfulness at distance was related to the higher-order factor), and (3) Primitive dogs (FCI 5), in which two broad factors emerged. The results from the higher-order factor analyses are presented in table 3.

Table 3. Results from the higher-order factor analyses. Factor loadings >0.40 are in bold.

| Sample | Playfulness | Curiosity/ Fearlessness | Chase- proneness | Aggressive- Sociability | ness | Playfulness at distance |
|---------------------------------|----------------------------|----------------------------|---------------------|----------------------------|----------------------|----------------------------|
| Dataset 1 (47 breeds) | 0.74 | 0.54 | 0.56 | 0.70 | 0.30 | - |
| Sheepdogs (FCI 1) | 0.77 | 0.60 | 0.63 | 0.58 | 0.24 | - |
| Pinschers <i>et al.</i> (FCI 2) | 0.74 | 0.52 | 0.61 | 0.64 | 0.28 | - |
| Terriers (FCI 3) | 0.70 | 0.35 | 0.58 | 0.64 | 0.21 | - |
| Primitive dogs (FCI 5) | 0.53 0.51 | 0.63 -0.16 | 0.17 0.60 | 0.67 0.15 | -0.16 0.51 | - - |
| Scent hounds (FCI 6) | 0.71 | 0.31 | 0.61 | 0.71 | 0.14 | - |
| Pointers* (FCI 7) | 0.63 | 0.22 | 0.56 | 0.38 | -0.16 | 0.69 |
| Retrievers** (FCI 8) | 0.63 | 0.55 | 0.50 | - | 0.10 | - |
| Companion dogs (FCI 9) | 0.75 | 0.20 | 0.51 | 0.24 | 0.07 | 0.71 |

*) Two higher-order factors were extracted in this breed group: One resembling the pattern found in other breed groups (presented here) and one with loadings from mainly two specific factors; "Curiosity/Fearlessness" and a factor specific for this group (loadings from the two variables Remaining approach in addition to Activity)

***) "Playfulness" and "Sociability" were in this breed group merged into one factor, here presented as "Playfulness"

These results suggest that five specific personality traits and one broad dimension can be

detected in dogs using a standardised behavioural test. These dimensions seem to be

highly general among dog types, which the similarity between breed groups indicates. The exceptions from the general pattern were foremost found in breed groups with relatively few dogs tested. This can lead to unstable matrixes of correlations, which, in turn, may have caused these deviations. Four of the five specific dimensions found in the dataset of the 47 breeds (the exception was Chase-proneness) were related to behavioural reactions in more than one subtest. This implies that these factors are not caused by experimental dependence between variables from the same subtest (see Royce 1955). On the contrary, they seem to be measures of traits that influence behaviour in several test situations. Furthermore, these four dimensions have counterparts in the literature of personality in dogs (e.g. Hart & Miller 1985; Goddard & Beilharz 1986; Hennesy *et al.* 2001) and other species (Gosling & John 1999), which support the suggestion that these factors represent personality traits in the dog. Broad dimensions similar to the one found in this study, which seem to describe a general shyness-boldness continuum, has also been suggested previously in dogs (Brace 1961, in Scott & Fuller 1965; Goddard

& Beilharz 1984; 1985), as well as in other animal species (Wilson *et al.* 1994) and in humans (Kagan *et al.* 1988).

The consistency and repeatability of the personality traits – Paper II

One of the most important aspects in the investigation of a presumed personality trait is how consistent the expressions of the trait are. This can be studied in repetitions of the test in which the trait is measured. The result of such a study also tells something about the reliability of the personality construct used, i.e. how accurate the measurement is (Martin and Bateson, 1986). In the study of dog personality, there are only a few reports on the consistency of traits. Some studies have been carried out on the predictability of behaviour in puppies for behaviour in the adult dog (Goddard & Beilharz 1986; Wilsson & Sundgren 1998; Slabbert & Odendaal 1999), but studies on consistency in the adult dog's personality are very scarce (but see Netto & Planta 1997). Therefore, my colleagues and I carried out a study on the consistency of the traits that the factor analyses in Paper I had suggested.

Table 4. Correlations of trait scores between tests.

| Trait | Test 1 x 2 | | Test 2 x 3 | | Test 1 x 3 | |
|------------------------|------------|---------|------------|---------|------------|---------|
| | r_s | P-value | r_s | P-value | r_s | P-value |
| Boldness | 0.90 | <0.001 | 0.91 | <0.001 | 0.83 | <0.001 |
| Playfulness | 0.79 | <0.001 | 0.88 | <0.001 | 0.77 | <0.001 |
| Chase-proneness | 0.70 | <0.001 | 0.80 | <0.001 | 0.61 | <0.001 |
| Curiosity-Fearlessness | 0.78 | <0.001 | 0.78 | <0.001 | 0.59 | <0.001 |
| Sociability | 0.73 | <0.001 | 0.60 | <0.001 | 0.58 | <0.001 |
| Aggressiveness | 0.69 | <0.001 | 0.78 | <0.001 | 0.73 | <0.001 |

We recruited a total of 81 privately owned dogs between 12 and 24 months of age for the study, which consisted of two repetitions of the behavioural test (i.e. three trials) with approximately one month in between. After the first test a selection process was carried out with the aim to decrease the number of dogs for the next two tests, but with maintained variation in the behaviour. This process resulted in 44 dogs that carried out the second

test, of which 40 dogs fulfilled the third and last test series (20 males and 20 females of 29 breeds). The area in which we carried out the test varied between tests, but the observer and the equipment were the same. The other functionalities were also the same, but with a few exceptions. After the test series were carried out, we calculated the dogs' trait scores in each test based on the representative variables for each trait (see table 2).

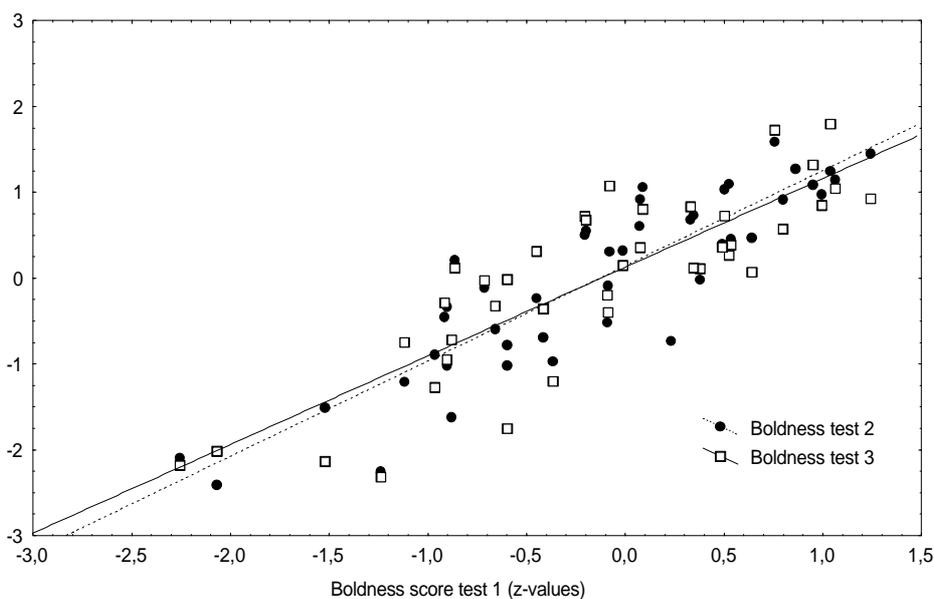


Figure 1. Boldness scores for each dog from test 1 plotted against the Boldness scores in test 2 (black dots) and test 3 (open squares). The correlation coefficient of Boldness between test 1 and 2 is $r_s=0.90$, and between tests 1 and 3 $r_s=0.83$, both with P-values lower than 0.001 (Spearman).

The results of the repetitions showed high consistency in rank orders of trait scores over the test series – i.e. dogs that were ranked high in one trait in one test were very likely among the highest in the next two tests, and vice versa. The correlation coefficients (Spearman Rank Order Correlation analysis) for the rank orders between tests, which are presented in table 4, were all above 0.58 and significant at a level of $P<0.001$. The trait with the highest rank order consistency was the broad Boldness dimension, with correlation coefficients between 0.83 and 0.91 (Figure 1).

Another way to measure consistency is to compare the magnitude of the trait scores be-

tween tests instead of the individuals' rank order. This measurement is more sensitive to repeated exposure of the same test situation due to habituation effects, especially in novel situation tests. However, the consistency of Playfulness, Chase-proneness, Sociability, and the broad Boldness dimension was high also according this measurement, with no significant differences between tests. Two traits were found to differ between tests: Aggressiveness decreased from test one to test two, and Curiosity/Fearlessness increased over the test series (Fig. 2).

Consistency in rank order, the most relevant measure of consistency (Funder & Colvin

1991), has previously been reported for traits in the dog: activity during handling of pups (Goddard & Beilharz 1986), fear/submission in adult dogs (Weiss & Greenberg 1997), and aggressive behaviour in adults (Netto & Planta 1997). However, the rank order consistency in the present study is for all traits higher than what has been reported in these studies, with the exception of the study of Weiss and Greenberg (1997), who used only a few dogs in their study.

Also in comparisons with consistency in personality traits in other domesticated spe-

cies, the correlations found are high. Examples of traits with similar or lower consistency are docility in cattle ($r=0.56$, Grignard *et al.* 2001); fear in hens ($W=0.52-0.77$, Jones 1988); flightiness in horses ($r=0.40-0.48$, Visser *et al.* 2001); response to novel object in pigs ($r=0.26$, v. Erp-v.d. Kooij *et al.* 2002) and boldness in cats ($r=0.50$, Lowe & Bradshaw 2001). The highest correlations found in the present study are even comparable to the coefficients of repeatability for highly controlled measures of fearfulness in laboratory rats, reported by Hall (1941).

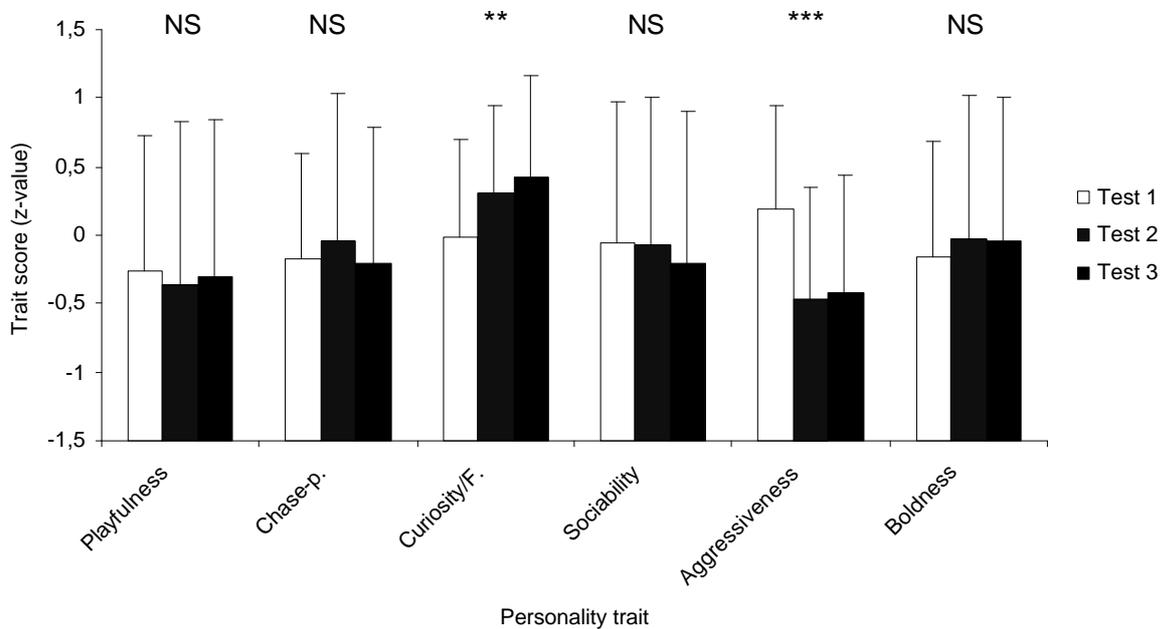


Figure 2. The average trait scores in each of the three tests for the specific traits Playfulness, Chase-proneness, Curiosity/Fearlessness, Sociability and Aggressiveness, and for the broad Boldness trait. Significant differences in the scores between tests are shown (NS indicates no difference, ** $P < 0.01$, *** $P < 0.001$). Error bars indicate standard deviations.

With the procedure used in this study, it was also possible to find out if there were individual differences in consistency, and if these were related to personality measured in the first test, when the situation was novel for the dogs. Previous results have suggested that the most stable individuals most probable are found at the extremes along a personality dimension, whereas the intermediate scoring individuals should be more variable and adjustable (Bem & Allen 1974; Kagan *et al.* 1988;

Wilson *et al.* 1994). Also in dogs such results have been found. Martínek *et al.* (1975) reported an inverted U-relationship between excitability and habituation rate. In the present study two measures of consistency were used: 1) degree of habituation from test 1 to test 3, and 2) degree of variability between tests (the sum of all changes in trait scores between tests). The results of these analyses suggested that there were individual differences in consistency regarding Playfulness, Curios-

ity/Fearlessness and Sociability. These were linearly related to trait scores: dogs' low in Playfulness were more variable than high-scoring dogs, dogs with low Curiosity/Fearlessness developed a more curious and fearless attitude over the series compared to high scoring dogs, and for Sociability it seemed that high scoring dogs decreased in trait score over the series, whereas low scoring dogs increased in Sociability score over the series. There were some indications of an U-relationship between trait score and consistency in Chase-proneness, Aggressiveness and Boldness, but these were non-significant. These results indicate that there are individual differences in consistency in the dog, and that individual style of habituation and variability might be related to the major personality traits in the dog.

Personality and performance – Paper III

One aspect of individual differences is the relationship between personality and performance in situations that put demands on the individual regarding memory, attention or other cognitive capacities. This issue has attracted interest within the study of human personality since the 50's (e.g. Eysenck 1981). Besides applied importance, such as the use of personality tests in predicting suitability for a certain occupation, these studies contribute to establishing the predictive validity of personality traits (Matthews & Deary 1998). In contrast, these questions have relatively seldom been addressed in animals. The exceptions from this can be found in the early studies on individual differences in rodents, where learning experiments in controlled situations were carried out in order to test hypotheses based on Eysenck's arousal theory of Extraversion and Emotional stability (e.g. Sing 1959; Sing & Eysenck 1960; Broadhurst & Levine 1963). In conclusion, these results suggested few general relationships. Instead, the influence of personality

upon performance seemed to be highly test specific and sensitive for differences in experimental circumstances. However, Scott & Fuller (1965) reported an interesting exception. A factor analysis based on data from 40 dogs of different breeds from a range of behavioural tests suggested the existence of one broad dimension (Brace 1961, in Scott & Fuller 1965). This dimension, which was labelled "Activity-Success", indicated that general good performance in several learning tests (e.g. a maze test, spatial orientation, tracking) was related to active and confident behaviour. This dimension, which by Scott and Fuller (1965) was described as going from 'general good performance, and active confident behaviour' to 'timidity, or fear, particularly of strange apparatus but also involving some fear of human beings' (pp. 374-375), is highly similar to the Boldness dimension that we found in the DMA (Paper I).

I was then interested in finding out if the Boldness dimension was related to performance in situations where several aspects of trainability are involved. For this purpose I chose to study the relationship between performance in working dog trials and Boldness. The tests included in working dog trials can be regarded as civilian counterparts to the tasks that police dogs and some military dogs are trained for, and include tests of obedience and tests of function (tracking, searching, bringing messages, and handler protection). These trials are given at different levels, and in different varieties according to what type of function is tested.

Besides testing the hypothesis that bold and confident dogs are better performers than shy and timid dogs in tasks that put demands on different capacities, this study could also give information about one aspect of the predictive validity of the behavioural test – i.e. if the DMA is a suitable tool for predicting the dog's capacity for working dog use.

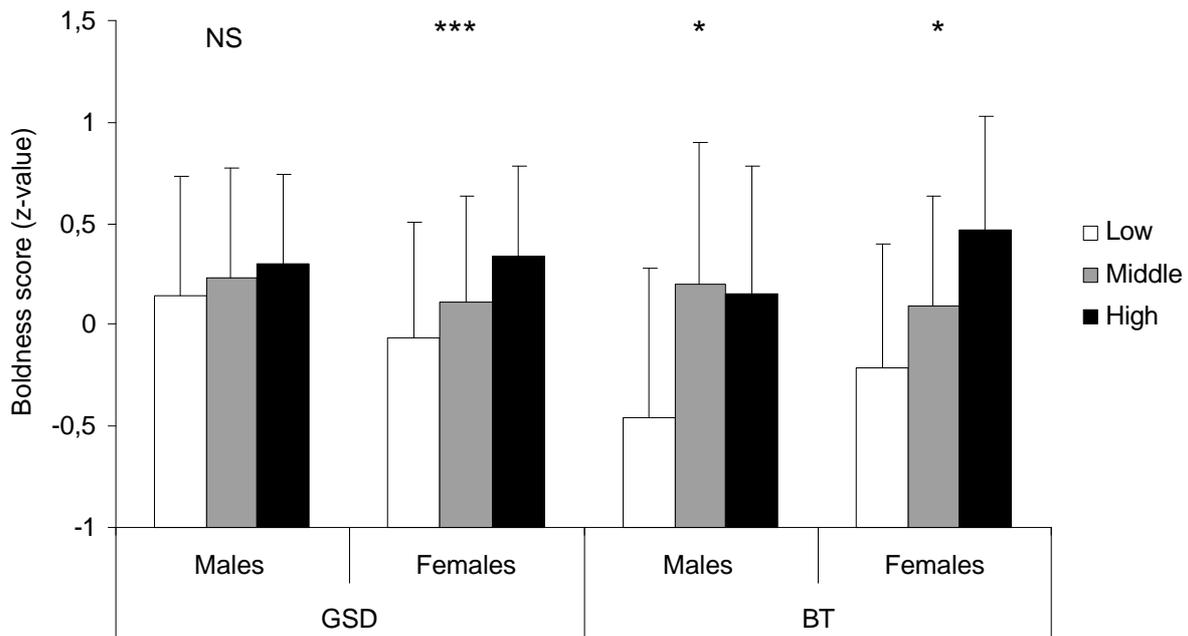


Figure 3. Boldness scores for German Shepherds (GSD) and Belgian Tervurens (BT) that reached different performance levels (error bars representing standard deviation).

I used data from dogs of two breeds – German Shepherd Dog (GSD) and Belgian Tervuren (BT). Dogs of these breeds are relatively often trained for participation in working dog trials, and are also commonly tested in the behavioural test (DMA). The initial sample included 2 219 GSD and 436 BT of both sexes that had carried out the behavioural test at an age of 12-18 months. Based on the test result, a Boldness score for each dog was calculated. An investigation of the dog owners' previous experience of working dog trials showed that there was a positive relationship between owner experience and Boldness score. Furthermore, a relationship between the owners' experience and success in working dog trials was also found. This could indicate the existence of a confounding variable related to the owner, either by early environmental influences or in the selection of the dog. To avoid this potential source of bias, all dogs with owners that had previous experience from success in working dog trials were excluded from the sample. This resulted in a final sam-

ple of 1641 GSD (875 males, 766 females) and 353 BT (191 males, 162 females). Of these dogs, 782 GSD and 122 BT had participated at a working dog trial at least once. These dogs were grouped in three groups according to the best performance at working dog trial: Low, Middle and High.

The results showed that there were differences in Boldness scores between the performance groups, and that these differences were in accordance with the hypothesis. In general, there were a stepwise pattern in each breed and sex, where High-performing dogs had higher Boldness scores than Middle dogs, and these dogs, in turn, had higher score than Low-performing dogs (Fig. 3). Significant differences between performance groups were found in BT males and females, and GSD females, but not in GSD males.

A comparison of Boldness between breeds and sex in all dogs independent of participation or success in working dog trials suggested that GSD were bolder than BT, and that males were bolder than females (Fig. 4). In a com-

parison between the groups of successful dogs (i.e. Middle and High), however, no such breed or sex differences were found. Therefore, I pooled all middle dogs and all high dogs, respectively. Analyses showed that both of these groups were significantly bolder than the average for both breeds and sex (Fig. 4). This indicates that for a dog to be successful, irrespective of breed and sex, it ought to have

a certain Boldness level. Because of the general sex and breed differences, this effect should be more pronounced in the BT and in females. A well-performing German Shepherd Dog ought to be above average regarding Boldness, whereas a Belgian Tervuren, especially if it is a female, has to be extraordinary in the same aspect.

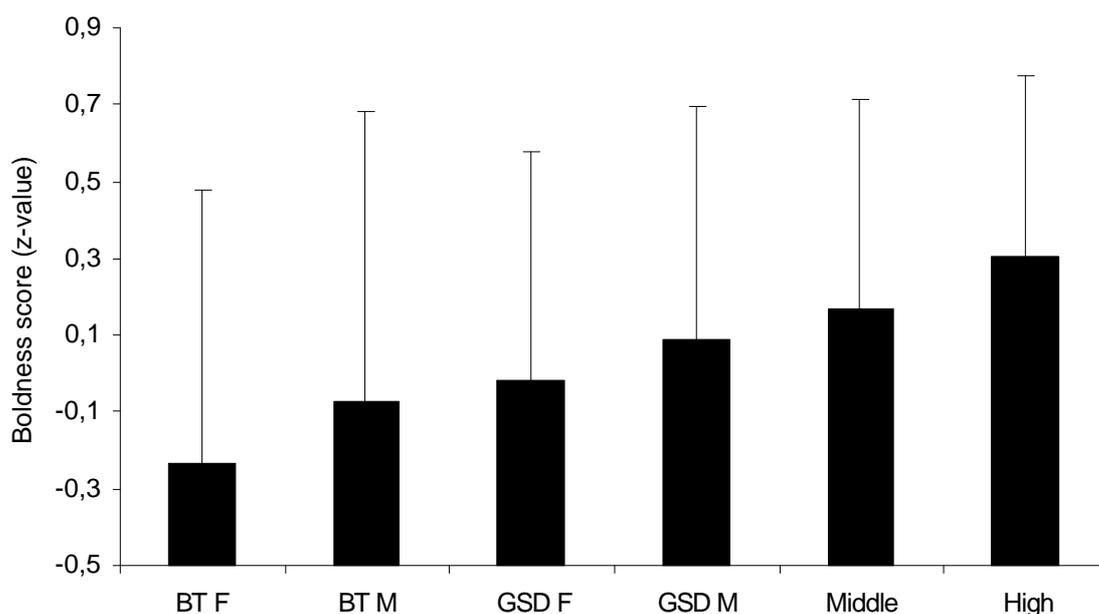


Figure 4. The figure shows the average Boldness scores in German Shepherds (GSD) and Belgian Tervurens (BT) males (M) and females (F), as well as the average score for all dogs in the Middle and High groups (error bars representing standard deviation).

Furthermore, a positive relationship between Boldness and age when the dogs were successful at working dog trials was found: bolder dogs succeeded earlier than shyer dogs. However, this relationship was statistically significant only in the GSD. No relationships were found between Boldness and number of attempts before success was reached. Nor were any differences in Boldness found between dogs successful in different functions. The latter indicate that the relationship between Boldness and success is general and independent of type of function test.

In conclusion, these results imply that there are general relationships between Boldness and an ability to be trained for performance in working dog trials. This is in accordance with the findings in the laboratory that active and confident dogs generally perform better in tasks requiring different cognitive capacities, compared to shy and timid dogs (Scott & Fuller 1965). The mechanisms behind these relationships, however, cannot be revealed by the results in the present study.

Personality in test and in everyday life – Paper IV

Knowledge about the validity of the Boldness dimension against performance in working dog trials is important. However, the majority of dogs today are pet dogs, and not working dogs. Furthermore, even though the behavioural test used here was developed as a tool in breeding of working breeds, today the test is used for a range of breeds from different

breed groups. Therefore, it is probably even of greater importance to validate the test and the suggested personality dimensions against behaviour in everyday life. If relationships were found between personality traits expressed in the test situation and typical behaviour in the home environment, this should not only strengthen the validity of the traits, but also indicate that the test could be used as a predictive instrument for behavioural problems in pet dogs.

Table 5. The result from the correlation analysis (Spearman) on the factor scores and personality traits that were expected to be correlated.

| Behavioural test | Questionnaire | Males | | Females | | Pooled | |
|----------------------------|--------------------------------|-------|-----------------------|---------|-----------------------|--------|----------------|
| | | N | R _s | N | R _s | N | R _s |
| Playfulness | “play interest” | 352 | 0.321*** | 345 | 0.435*** | 697 | 0.377*** |
| Curiosity/ Fearlessness | “non-social fear” | 352 | -0.303*** | 345 | -0.252*** | 697 | -0.278*** |
| | “stranger-directed fear” | 352 | -0.128NS | 344 | -0.149NS | 697 | -0.137* |
| Chase-proneness | “chasing” | 352 | 0.026NS | 344 | 0.073NS | 696 | 0.047NS |
| Sociability | “stranger-directed fear” | 352 | -0.266*** | 344 | -0.270*** | 697 | -0.268*** |
| | “stranger-directed interest” | 352 | 0.396*** | 343 | 0.347*** | 695 | 0.370*** |
| | “stranger-directed aggression” | 352 | -0.184 ^(*) | 345 | -0.215** | 697 | -0.198*** |
| Distance- playfulness | “play interest” | 352 | 0.311*** | 345 | 0.252*** | 697 | 0.286*** |
| | “stranger-directed fear” | 352 | -0.141NS | 344 | -0.179NS | 697 | -0.164** |
| | “stranger-directed interest” | 352 | 0.147NS | 343 | 0.207* | 695 | 0.170*** |
| Aggressiveness | “stranger-directed aggression” | 352 | 0.064NS | 345 | 0.178NS | 697 | 0.119NS |
| | “territorial aggression” | 352 | 0.059NS | 345 | 0.124NS | 697 | 0.090NS |
| Boldness | “play interest” | 352 | 0.306*** | 345 | 0.326*** | 697 | 0.316*** |
| | “non-social fear” | 352 | -0.258*** | 345 | -0.189 ^(*) | 697 | -0.223*** |
| | “stranger-directed fear” | 352 | -0.244*** | 344 | -0.223** | 697 | -0.235*** |
| | “stranger-directed interest” | 352 | 0.235** | 343 | 0.242*** | 695 | 0.236*** |
| | “chasing” | 352 | 0.020NS | 344 | 0.046NS | 696 | 0.028NS |

(*) P<0.1, * P<0.05, ** P<0.01, *** P<0.001, after adjustments for the number of tests (Bonferroni, $P=\alpha/k$; k=133 in each analysis)

Measuring animal behaviour in natural situations may be very difficult, and dog behaviour is no exception from this even though the dog is a domesticated species. Each ani-

mal's behaviour has to be studied in the animal's own home area, which makes it difficult for the observer who has to move between as many situations as animals. Beside this, it is

also a risk that a standardization of the situation in the home environment creates just a second test situation, and does not unravel the animal's typical behaviour in everyday life. As a solution for this, I chose to use a questionnaire in which dog owners described their dog's typical behaviour in the home environment. This method has obvious disadvantages, e.g. as many observers as dogs, but has, on the other hand, possibilities that I considered important. For example, there was a low risk of test-artefacts, and large number of dogs from several breeds could be studied, which was important for the generality of the results.

I used a questionnaire that was based on a prototype developed by James A. Serpell (described in Serpell & Hsu 2001), which was kindly put at my disposal. The questionnaire included 122 items in nine sections that covered a range of typical situations in everyday life. Several items had correspondence with behaviour described in the DMA. The owners were asked to describe their dog's typical behaviour in the recent past in a specified situation (e.g. 'quick to respond to other dogs' play invitations') according to a intensity or a frequency rating scale. The owners were not informed about the purpose of the study, in order not to bias the result.

The questionnaire was sent out to owners of 981 dogs of 16 breeds. These dogs had previously carried out the behavioural test (DMA) at an age of 12 to 24 months within a period of one to two years before the questionnaire was sent out. Within three months 697 questionnaires were returned, which corresponded to a response rate of 73.3%. Factor analysis was used in order to reduce the number of variables. This analysis yielded 19 interpretable factors, and scores for each dog and factor was calculated. Corresponding factors were found for all personality traits from the behavioural test, and these were used in the validation analysis. Several factors were also found besides these that described typical behavioural problems.

ious problems. Correlation analysis with adjustment of the significance level for the number of tests was used in the comparison between test behaviour and typical behaviour in the home environment.

The results from the correlation analyses suggested that the Boldness dimension and four of the six investigated traits – Playfulness, Curiosity/Fearlessness, Sociability and Distance-playfulness - had significant correlations with factors from the questionnaire that were expected to be corresponding (Table 5). Chase-proneness was not related to interest in chasing or predation as expected, but was instead correlated with play interest. Aggressiveness was the only trait with no significant correlations to behaviour in the home environment. However, analyses of the variables that are related to Aggressiveness indicated a weak relationship with aggressive behaviour towards strangers and territorial aggression, but only in females. Otherwise, essentially the same pattern of correlations was found in males and in females.

A summary of all correlations found in the pooled sample (Table 6) suggests that the Playfulness dimension from the standardized behavioural test correspond to the dog's typical interest in playing with familiar or unfamiliar humans. Sociability is related to the dog's attitude towards unfamiliar humans, and seems to describe a continuum from fear and timidity when close to a stranger, to social boldness and friendliness. There is also a component of social aggression, including aggression towards unfamiliar dogs, which is negatively related to social interest and positively related to social fear. Curiosity/Fearlessness is predominately related to the questionnaire factor "non-social fear", which was associated to fear reactions towards novel non-social stimuli in general. In addition, this factor was related to fear or anxiety when walking in stairs and exposed to heavy traffic and thunderstorms, which may

Table 6. A summary of the significant correlations found between questionnaire factor scores and personality trait scores from the behavioural test in the pooled sample.

| Questionnaire factor | Personality trait from behavioural test | | | | | |
|---|---|-------------|-----------------|----------------------------|-------------|----------------------|
| | Boldness | Playfulness | Chase-proneness | Curiosity/ Fearlessness | Sociability | Distance-playfulness |
| "play interest" | ++++ | ++++ | +++ | + | | +++ |
| "stranger-directed interest" | +++ | | | | ++++ | ++ |
| "stranger-directed fear" (inverted) | +++ | | | + | +++ | + |
| "stranger-directed aggression" (inverted) | | | | | ++ | + |
| "territorial aggression" (inverted) | | | | | + | |
| "dog-directed fear" (inverted) | + | | | + | | |
| "dog-directed aggression" (inverted) | | | | | + | |
| "non-social fear" (inverted) | +++ | | + | +++ | | ++ |

+= $R_s > 0.135$, $P < 0.05$; ++= $R_s > 0.170$, $P < 0.01$; +++= $R_s > 0.200$, $P < 0.001$; ++++= $R_s > 0.300$, $P < 0.001$
P-values are adjusted for the large number of comparisons (Bonferroni technique, $k=133$)

indicate a tendency to develop phobias. The correlations with the remaining two traits that were found to be associated with questionnaire factors – Chase-proneness and Distance-playfulness – suggest that these traits are mixed measures of Sociability, Curiosity/Fearlessness and Playfulness, at least regarding behaviour in everyday life.

From these results, it seems that three components of the dog's personality is measured in the standardized behavioural test

DMA, which all are related to the broad Boldness dimension: 1) interest in playing with humans, 2) behaviour towards unfamiliar persons, and to some degree dogs (interest, fear, and aggression), and 3) non-social fear. Thus, the suggestion in Paper I that the Boldness dimension is related to fearlessness and confidence in a range of situations is supported by these results. Because of the time between behavioural test and questionnaire, 1-2 years, the results indicate long-term consistency of the

personality components. The low correlations found for Aggressiveness could be explained by lower consistency for this trait compared to the other traits, or that it is related to a different type of aggressiveness than what was described in the questionnaire. Thus, it is still possible that the Aggressiveness trait could be important for everyday life, even though the results in this study supported this poorly.

Based on these results, the DMA seems to be useful in predicting behavioural problems that are related to social and non-social fear, and aggression towards strangers, which are common sources of problems for pet dogs and owners (e.g. Beaver 1999; Lindsay 2001). However, a range of other potential behavioural problems that were measured in the questionnaire was not related to the personality traits from the behavioural test. It is probable that additions of subtests related to specific problems in the behavioural test could increase the use of the test as a predictive tool for behavioural problems in the dog (see van der Borg 1991).

Breed differences in personality – Paper V

Breed differences have been reported in several behavioural categories, such as in aggression (Cattell *et al.* 1973), approach and withdrawal behaviour (Plutchik 1971), and predatory behaviour (Coppinger *et al.* 1987; Christianson *et al.* 2001). It has been suggested that behavioural differences between breeds, at least to some degree, can be explained by differences in historical selection during the breeds' origin. For example, breeds selected for rat hunting and fighting – like the Terriers – have been shown to be less fearful and more aggressive than breeds selected for other purposes (Mahut 1958; Roll & Unshelm 1997). Differences between breed types have also been reported for other personality traits, such as reactivity, immaturity and sociability, which

have been explained by differences in historical use between breeds (Bradshaw *et al.* 1996; Seksel *et al.* 1999). However, major cultural changes, at least in the modern Western society, have changed the use of dogs today compared to use in the breeds' origin. The dog's role as a companion and an object of affection has become more important, and new selection criteria, such as selection for physical appearance, have replaced breeding for function (Willis 1995; Lindsay 2000). Previous studies have shown that basic emotional traits, such as fearfulness, can be altered rapidly in canids, given that the selection is intense (Murphree *et al.* 1969; Belyaev 1979; Kenttämies *et al.* 2002). Thus, recent changes in selection may have led to changes in personality in the domestic dog, and differences between dog breeds may be due to differences in recent selection.

With this background, I investigated if differences in breed-typical personality are due to differences in historical selection or differences in recent selection. I used data from dogs of 31 breeds that had carried out the behavioural test (DMA). The investigated breeds had at least 40 dogs per breed that had carried out the test at an age of 12-24 months. As in paper III, I controlled the factor of owner experience by excluding all dogs with owners who had previous dogs with merits from working dog trials. As a measure of historical selection, I grouped the breeds according to original selection and use, a similar classification as the international kennel clubs use. This resulted in a classification of the breeds in five groups, of which four were used in the analyses (Herding dogs, Working dogs, Terriers and Gun dogs). As a measure of recent selection I used data on participation in different tests, trials and shows of the breeds' breeding stock. The personality traits investigated were the three validated traits from Paper IV - Sociability, Curiosity/Fearlessness and Playfulness – in addition with Aggressiveness.

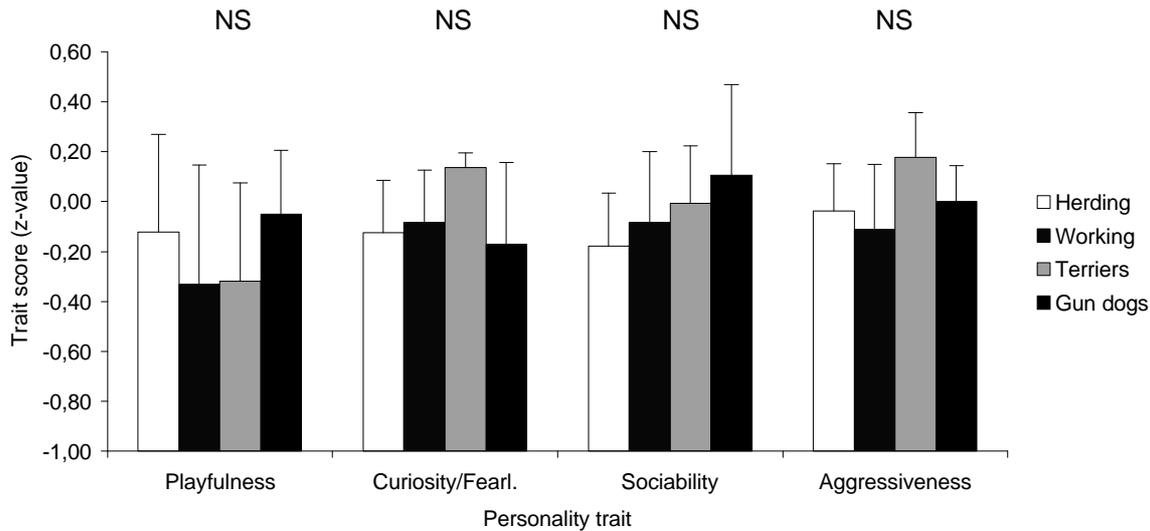


Figure 5. Average breed trait scores for Herding dogs (N=11), Working dogs (N=9), Terriers (N=3) and Gun dogs (N=6). Kruskal-Wallis tests showed no significant differences between breed groups for any of the traits (bars represents standard deviations).

The results suggested large differences between breeds regarding all investigated traits, even though considerable within-breed variation was found. In the comparison of personality between groups of breeds with similar history – Herding dogs, Working dogs, Terriers and Gun dogs - no differences in trait scores were found (Fig. 5). This result suggests that classification according historical use is a poor predictor for breed-typical personality today. A cluster analysis based on the breeds' typical personality suggests a classification that differed significantly from the classification based on historical selection and use (Table 7).

Also the use of the breeding stocks of the investigated breeds differed compared to what should be expected from the classification of breeds. For example, only two of eleven breeds in the Herding group had merits from herding trials. Also the Terrier breeds seem to be scarcely used in their original use as hunting dogs. Instead, new uses have arisen. The most common use today of the breeding stock over all seems to be in dog shows. To investigate if recent selection, which could be inferred from the current use of the breeding stocks, was related to breed-typical personality, correlation analyses were carried out. The results show

that use in dog shows was negatively related to trait scores for all the investigated traits - Sociability, Curiosity/Fearlessness and Playfulness and Aggressiveness (Fig. 6). This indicates that selection for use in dog shows is related to a decrease in curiosity, interest in playing and aggressiveness, but an increase in social and non-social fearfulness. Furthermore, relationships were found between the breeds' sire merits in working dog trials and breed-typical personality: use in working dog trials was positively correlated with trait scores for Playfulness and Aggressiveness. Thus, selection towards working dog use seems to be associated with high interest in playing and aggressiveness. No other uses were investigated, due to the few number of breeds that had these types of merits.

Breeds differ in number of registered dogs per year, and the range is considerable. In this sample of 31 breeds there were some breeds that had more than 2 000 annual registrations, whereas there also were some breeds with less than 100 registrations per year. This figure may indicate how popular a breed is, which gives opportunity to study the relationships between popularity and personality. Correlation analyses suggested two such relationships:

popularity, measured as the breed's yearly number of registration 2000-2002, was positively correlated with breed scores for Playfulness and Sociability. Thus, it seems that breeds that are positive in general towards strangers

and interested in playing with humans are more popular compared to breeds that in general show low tendencies in these regards, but are, instead, fearful and hostile towards unfamiliar humans and dogs.

Table 7. The result of cluster analysis (a four cluster solution) of 29 dog breeds based on similarities in Playfulness, Curiosity/Fearlessness, Sociability and Aggressiveness. A description of the average trait scores for each cluster are presented.

| Cluster | Breed | Breed group | Playfulness | Curiosity/ Fearlessness | Sociability | Aggressiveness |
|------------|------------------------------|-------------|-------------|----------------------------|-------------|----------------|
| 1 | Australian Kelpie | Herding | | | | |
| | Australian Shepherd | Herding | | | | |
| | Belgian Malinois | Herding | | | | |
| | Belgian Tervuren | Herding | | | | |
| | Border Collie | Herding | | | | |
| | German Shepherd Dog | Herding | High | Medium | Medium | High |
| | Giant Schnauzer | Working | | | | |
| | Golden Retriever | Gun dog | | | | |
| | Hovawart | Working | | | | |
| | Nova Scotia Duck Tolling R. | Gun dog | | | | |
| | Parson Russell Terrier | Terrier | | | | |
| Rottweiler | Working | | | | | |
| 2 | Beauceron | Herding | | | | |
| | Belgian Groenendael | Herding | | | | |
| | Briard | Herding | Medium | Medium | Low | Low |
| | Dobermann Pinscher | Working | | | | |
| | Poodle | Gun dog | | | | |
| 3 | American Staffordshire T. | Terrier | | | | |
| | Boxer | Working | High | High | Very high | High |
| | Flat-coated Retriever | Gun dog | | | | |
| | Labrador Retriever | Gun dog | | | | |
| 4 | Bernese Mountain Dog | Working | | | | |
| | Bouvier des Flandres | Herding | | | | |
| | Collie (smooth) | Herding | | | | |
| | English Springer Spaniel | Gun dog | Very low | Low | Medium | Low |
| | Great Swiss Mountain Dog | Working | | | | |
| | Irish Soft Coated Wheaten T. | Terrier | | | | |
| | Leonberger | Working | | | | |
| | Pinscher | Working | | | | |

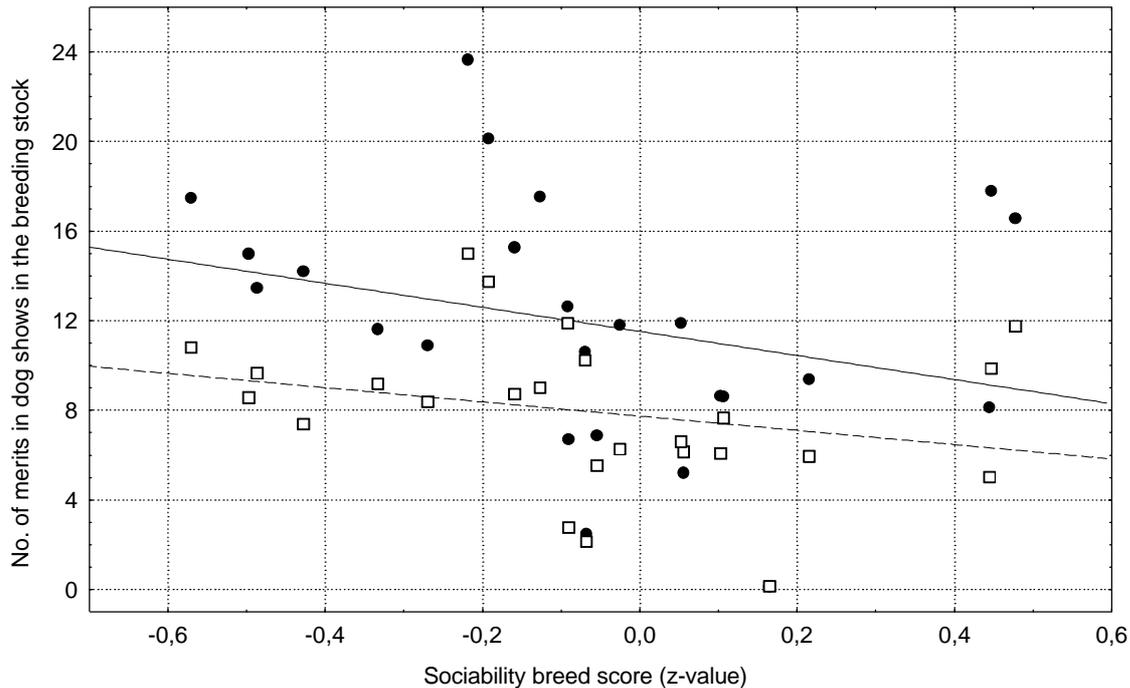


Figure 6. The relationship between breed Sociability scores and dog show use in the breeds' breeding stock. Filled dots represent sires (continuous line), and open squares (dashed line) dams.

Although there are limitations in the low number of breeds and personality traits investigated in this study, the results suggest that use and selection in the origin of a dog breed is of low relevance for the personality of the breed today. Instead, there are indications that more recent selection has influenced breed-typical personality. The most pronounced of these new uses is use in dog shows, which seems to be the dominating selection criteria in all breeds with a few exceptions. Selection for this new use seems to be related to low interest in playing, low curiosity, and low aggressiveness, and related to an increase in social and non-social fearfulness. Thus, selection for use in dog shows seems to partly be in conflict with selection for a popular dog type, which is characterized by high Sociability and high Playfulness.

General discussion and conclusions

The results in this thesis suggest the existence of personality traits in the dog that are stable

over time and across situations. Five specific traits were suggested from the first factor analyses of the data from the behavioural test – 'Playfulness', 'Curiosity/Fearlessness', 'Chase-proneness', 'Sociability' and 'Aggressiveness' – and a possibly sixth trait, labelled 'Distance-playfulness'. The reliability of five of them was tested by repeated tests, which showed high test-retest reliability for all of them. The validation test against typical behaviour in everyday life suggested relevance for five of six tested traits. The exception was Aggressiveness, which was found to have no or low relevance in the home environment. Furthermore, two of the other five traits – Chase-proneness and Distance playfulness – seemed to be mixed measures of Playfulness, Sociability and Curiosity/Fearlessness. Thus, the behavioural test seems to measure three 'pure' specific personality traits in the dog, which in this thesis have shown to fulfil both the criterion of reliability and the criterion of validity: Playfulness, Sociability and Curiosity/Fearlessness. In addition, one broad trait –

Boldness – related to these specific traits has shown high consistency over repetitions of the behavioural test, and has been found to be relevant for the performance in working dog trials and for everyday life of pet dogs. A closer look at the variables that relate to each trait (Paper I), and the results from the questionnaire study (Paper IV), makes it possible to define and describe the nature of the traits.

Curiosity/Fearlessness is in the test related to exploratory behaviour in different novel situations, and lack of withdrawal and/or immobility. According to the questionnaire study, this trait is (negatively) related to fearful behaviour in novel situations and towards visual and auditory salient stimuli, and is possibly negatively related to a tendency to develop phobias. Furthermore, there seems to be a negative relationship between Curiosity/Fearlessness and fear of unfamiliar persons and dogs.

Sociability is in the test situation related to greeting behaviour towards a stranger, willingness to follow the stranger and acceptance of physical contact by the stranger. This trait is related to a positive attitude towards strangers also in everyday life (approaches strangers eagerly and enjoys being petted), and is negatively related to social fearfulness shown to unfamiliar humans at home and elsewhere. Furthermore, there seems to be a component of hostility in this trait, according to negative correlations with aggressive behaviour towards approaching strangers and unfamiliar dogs in and outside the home.

The Playfulness trait is in the test related to interest in playing with a stranger, where a play object is used. This is also expressed in everyday life, according to Paper IV: Playfulness was positively correlated with interest in playing with humans – both strangers and family members – and in social play with play object in particular (running after balls and playing tug-of-war). Thus, this trait seems to be the most narrow of the specific traits found in this thesis.

The traits found here have been suggested previously in dogs, as well as in other species. Dimensions describing fear of strangers, or the opposite – social boldness and friendliness have been reported in dogs by Royce (1955) and Hennesy *et al.* (2001), and in other canids (Belyaev 1979; Kenttämies *et al.* 2002). Similar traits have also been suggested in other domestic species (pigs: Thodberg *et al.* 1999; cattle: Grignard *et al.* 2001; cats: Lowe & Bradshaw 2001) as well as in non-domesticated species in captivity (hyena: Gosling 1998; rhinoceros: Carlstead *et al.* 1999). The Curiosity/Fearlessness trait, which seems to describe general non-social fearfulness, is probably the most suggested trait in dogs (Brace 1961, in Scott & Fuller 1965; Murphree *et al.* 1969; Goddard & Beilharz 1984; 1985), as well as in other species. According to a review by Gosling and John (1999), traits with high similarity with Curiosity/Fearlessness were found in ten of the twelve investigated species. Playfulness seems to be the one of the three traits that has the least correspondence with other reported personality traits (but see Bolig *et al.* 1992; McGuire *et al.* 1994), even though play is a characteristic and often described behaviour in dogs (but see Hart and Hart 1985).

Similar traits as the broad Boldness dimension, which is related to all of the three above described traits, have been suggested previously in dogs (Brace 1961, in Scott & Fuller 1965; Murphree *et al.* 1969; Goddard & Beilharz 1984; 1985). However, the relationship between general fearfulness and social playfulness has not been reported previously. A similar trait has also been suggested in wolves (Fox 1972). This, together with the high generality of Boldness in different breed groups, indicates that this trait evolved long before the domestication of the dog took place and has survived the varied selection pressures encountered during the domestication process. Furthermore, boldness related traits have also been found in several other species from dif-

ferent taxa (Wilson *et al.* 1988), which suggests a high evolutionary stability of this dimension.

The high correspondence between the traits reported in this thesis and what has been suggested in several other species, makes it tempting to compare them with major human traits. Curiosity/Fearlessness seems to correspond well with Neuroticism, one of the human 'Big Five'. This trait is in humans related to general fearful behaviour, nervousness and anxiousness (John & Srivastava 1999). Sociability, with its pro-social aspects, seems to share facets with Extraversion. The sociability component of Extraversion, which is characterized by warm and friendly feelings towards others and preferences of having others' company, is a prominent aspect of this trait (Watson & Clark 1997). Even though this is less clear in a comparison with major human traits, the Playfulness dimension described in this thesis seems to have some correspondence to Extraversion as well. Extraverts are prone to have positive mood states, are strongly motivated toward social interactions, and are lively and energetic (Watson & Clark 1997). These aspects can be considered as corresponding to a high interest in social playing in dogs (see also Gosling & John 1999).

In conclusion, the behavioural test used in this thesis seems to be able to quantify aspects of the personality of the dog that correspond to the human supertraits Extraversion (Sociability & Playfulness) and Neuroticism (Curiosity/Fearlessness). Thus, the Boldness dimension seems to be related to both Extraversion and Neuroticism, which implies that these two traits are correlated in the dog. There is evidence of the same type of relationship in our own species, with a common denominator in the shyness-boldness dimension (Kagan *et al.* 1988; Zuckerman 1991; Matthews and Deary 1998). According to this view, the shyness-boldness dimension runs from neurotic-introvert to stable extravert. This implies that the shyness dimension found in children (Ka-

gan *et al.* 1988) serves as a base for Neuroticism or Introversion, or both, in adulthood. Even though the dimension in humans develops further into two separate traits, they seem to maintain some degree of relationship. One possibility is that dogs and humans share this basic shyness-boldness axis due to similar evolutionary processes. However, dogs may never reach these stages in the development of personality that produces a distinct separation of the traits Extraversion and Neuroticism, which could explain the strong support for one major dimension in dogs.

The results in this thesis suggest that the personality in dogs may be described at different levels in a hierarchical fashion, similar to what has been suggested in humans (Eysenck & Eysenck 1985; Bouchard & Loehlin 2001). At the top of the hierarchy there is a set of global traits, with more specialized levels below. An example of this is presented in figure 8, which is supported by results in this thesis. One major trait has been suggested at a broad level – Boldness. The more specific traits Playfulness, Sociability and Curiosity/Fearlessness can be seen as aspects of the Boldness dimension. Below this are facets of these specific traits. For example, Paper IV suggests that Sociability is related to three separate components: Fear of strangers, hostility towards strangers and interest in strangers. Similar facets are likely to be found of the other specific traits. For example, results from Goddard and Beilharz (1984) suggested several types of non-social fear – corresponding to Curiosity/Fearlessness in this thesis - which were related to different non-social stimuli (e.g. suddenness, sounds, moving objects). Personality can probably be described at even more specific levels, for example at a response level. Individual dogs can differ in behavioural strategy when exposed to a fear-eliciting stimulus, for example immobility or withdrawal (Royce 1955; Cattell & Korth 1973), which is suggested in figure 8.

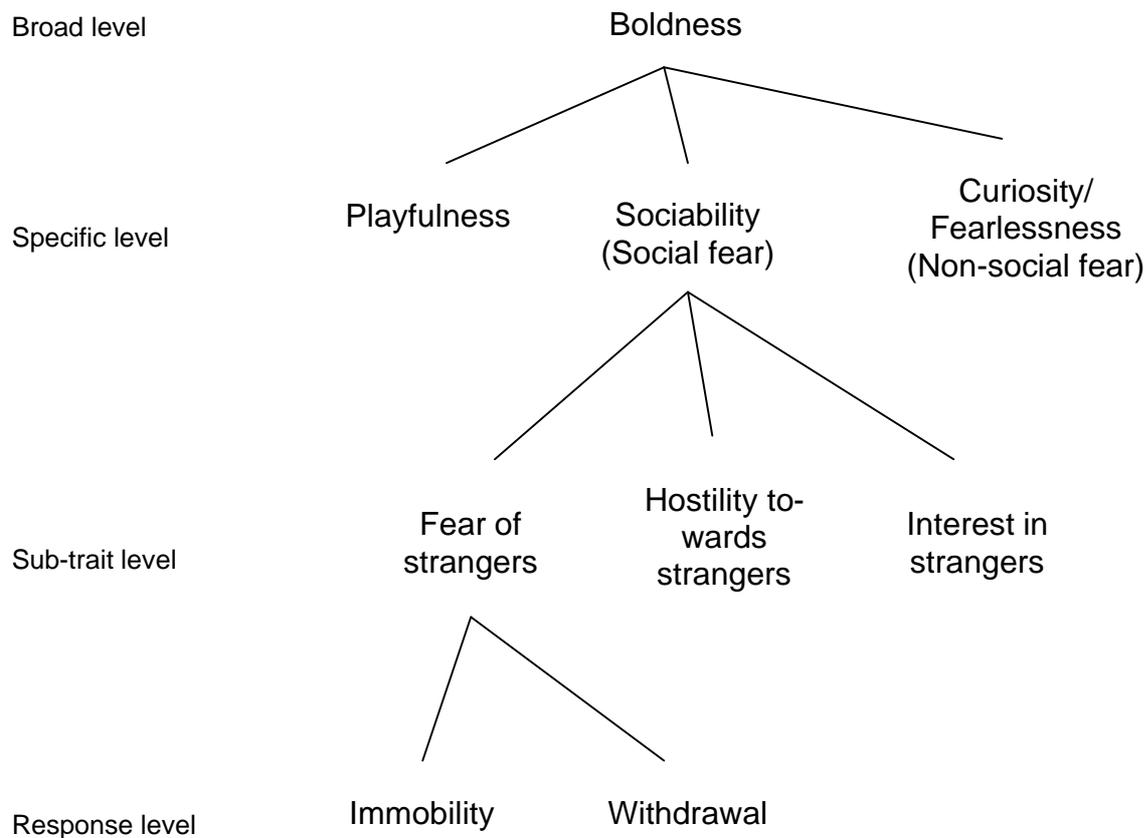


Figure 8. The results suggest a hierarchical organization of the personality in dogs, as shown in this figure.

From an applied point-of-view, the standardized behavioural test used in this thesis seems to be useful in measuring aspects of dog personality, which is relevant for working dogs and pet dogs. This implies that the test may be useful in two aspects: in predicting future behaviour of individual dogs, and as an instrument useful in dog breeding. Regarding prediction of future behaviour, two applications are obvious. First, the DMA seems to be useful in predicting of future performance of working dogs (Paper III). Even though the demands in working dog trials, which have been investigated in this thesis, and as a working dog in the Police or military forces are not identical, there is probably a considerable correspondence at a general level. Previous results on selection of potential working dogs have indicated the usefulness of general behavioural

tests, in which similar aspects of dog personality as in the DMA have been measured (Paffenberger *et al.* 1976; Goddard & Beilharz 1984; 1985; Wilsson & Sundgren 1997). Thus, the DMA, which in this thesis has shown to reliably and validly measure personality constructs in the dog, may be useful as a test of potential police or military dogs. However, the test seems to measure general aspects of dog personality, and there are likely other, subtler aspects of the personality of a potential working dog that are relevant to measure. For example, behavioural aspects during searching or tracking such as attention and persistence are possibly consistent personality components that are highly important for a functional working dog.

The DMA may also be useful in prediction of pet dog behaviour in general, and of behav-

itorial problems in particular. Even though the test seems to fail in predicting potential problems like separation distress, dominance problems and inappropriate chasing, it may be useful in predicting fear- and aggression related problems in meetings with unfamiliar humans, dogs and situations (Paper IV). These are common sources of problems for pet dog owners, and for the dog itself (e.g. Lindsay 2001). A test that predicts future problems of this type may guide the owner to appropriate training of the dog, which can minimize future problems. Thus, the DMA can be a helpful tool in prediction and evaluation of certain behavioural problems, and hence increase the welfare of the dog and the well-being of dog owners.

Naturally, a second suggested use of the test is in dog breeding. If the DMA is to be useful in this regard, the traits measured in the test have to have genetic bases. This is implied from the results in Paper V, which suggest that

different selective pressures during recent time have influenced breed-specific personality. Even though the personality dimensions are evolutionary stable, rapid changes along these dimensions seem to be possible during relatively few generations. Furthermore, unpublished results of the heritability of the traits support the suggestion of genetic bases of the traits. The heritability has been estimated to 0.20-0.35 for Playfulness, Curiosity/Fearlessness and Aggressiveness (Saetre *et al.* 2002), to 0.36-0.52 for all specific traits (P.-E. Sundgren, unpublished results), and to approximately 0.40 for the Boldness dimension (L. Laikre, unpublished results). This suggested genetic base of the traits, together with the considerable variation found within breeds (Paper V), are prerequisites for selective breeding upon the personality traits investigated in this thesis.

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