Everyday Behaviour in Dogs. Breed Differences and Genetic Analysis

Abstract

The absolute majority of dogs are kept as companion animals. Dogs kept as family pets are frequently exposed to noisy and crowded environments, and often have to interact with unfamiliar dogs and humans. In Sweden, we have a long history of recording behaviour in dogs on a large scale. The Swedish Working Dog Association (SBK) has, since 1989, carried out a standardized behavioural test called Dog Mentality Assessment (DMA). Results from the DMA can be condensed into five personality traits: playfulness, sociability, curiosity/fearlessness, chase-proneness and aggression.

The aim of this thesis was to investigate the possibility to use information from the DMA to select for improved everyday life in dogs and to study the genetic background of everyday behaviour. This was done by estimating factors affecting everyday life behaviour as well as the genetic background of behaviour assessed either through a questionnaire or measured in the DMA.

In the first study (I) we investigated factors affecting everyday behaviour in 20 dog breeds. The analysis was based on records from a total of 3,591 dogs. In the second study (II) we estimated genetic parameters for behaviour in the Rough Collie both for everyday behaviour assessed through a questionnaire and for behaviour assessed in the DMA. The analysis included records for 1,738 dogs on everyday behaviour and records for 2,953 dogs from the DMA.

Results from the studies showed that age, sex, breed and breed group (working vs non-working breeds) had a significant effect on everyday behaviour. Working dog breeds were overall more interested in playing with humans and more trainable. Phenotypic correlations showed, for example, that more fearful dogs were more aggressive and dogs that were more eager to play with humans were easier to train. The estimated heritabilities for both everyday behaviour and DMA behaviour traits ranged between 0.06 and 0.36. The genetic correlations between everyday behaviour traits and DMA results indicate that the DMA could be used as an effective tool for selection of everyday behaviour in the Rough Collie.

Keywords: Behaviour, dog, genetic analysis, questionnaire, dog mentality assessment, companion dog, temperament

Author's address: Helena Eken Asp, SLU, Department of Animal Breeding and Genetics, P.O. Box 7023, 750 07 Uppsala, Sweden
E-mail: Helena.Eken@ slu.se

Dedication

To Albert for always expecting more from me.

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List of Publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

I Eken Asp H., Fikse W. F., Nilsson K. and Strandberg E. (2015). Breed Differences in Everyday Behaviour of Dogs. *Journal of Applied Animal Behaviour Science* 169, 69-77.

II Arvelius P., Eken Asp H., Fikse W. F., Strandberg E. and Nilsson K. (2014). Genetic Analysis of a Temperament Test as a Tool to Select Against Everyday Life Fearfulness in Rough Collie. *Journal of Animal Science* 92(11), 4843-4855.

Abbreviations

BPH	Behaviour and Personality Assessment in Dogs
BSS	Behavioural subscale score
C-BARQ	Canine Behavioural Assessment and Research Questionnaire
DMA	Dog Mentality Assessment
SKK	Swedish Kennel Club
SWDA	Swedish Working Dog Association

1 Introduction

The majority of dog breeds originate from working dogs with an important role in hunting, herding, guarding etc. Today most dogs are kept as companion animals and not used for working purposes (Kobelt et al., 2003; Bennett et al., 2007; King et al., 2012). As companion animals, the dogs are often exposed to crowded surroundings with unfamiliar dogs and people, sudden noises (Sherman and Mills, 2008), and long days alone at home (Norling and Keeling, 2010; PAW, 2013). To avoid unnecessary negative stress for the dog, limitations in the dog owners' life and risks of aggressive dogs in the society it is important that the temperament of the dog is match the lifestyle of the owner. There is an increasing problem with dogs showing unwanted behaviour today. Some examples of this are the extensive use of calming drugs during firework seasons (Hedhammar, 1999) and that the most common reason for relinquishing a dog is unwanted behaviour (Wells and Hepper, 2000; Weng et al., 2006; Khoshnegah et al., 2011). Improvement of everyday behaviour is therefore important for the welfare of the dog, the dog owner and the society as a whole. Despite the clear welfare aspects of improved everyday behaviour in dogs, few studies have focused on the everyday behaviour of dogs and even fewer have focused on breeding for everyday behaviour.

An increased focus on everyday behaviour in the selection of breeding animals could be an important part in decreasing the unwanted fearful and aggressive behaviour in dogs. If the temperament of the dogs should be included in the breeding goal we must first know the current status of behaviour in the breed, if there is genetic variation in the behaviour, what behaviour is desired in the specific breed and how the behaviour can be recorded. Many people have strong ideas about the status of the temperament in a given breed, however, because there is often a lack of consensus, it is important to have a broad and objective description of the current level of various behaviour traits, so that the breeding can focus on traits where improvement is of great need.

One way to assess behaviour in order to investigate the current behavioural status in a breed is through a behavioural test. There is a great number of behaviour tests used all over the world (Jones and Gosling, 2005). According to Jones and Gosling (2005) most of these tests are designed to test the dog's suitability as a working dog for a specific purpose (e.g. herding, hunting etc.) or more generally as a working dog. This is commonly done by recording the dog's reaction to specific stimuli but it is questionable how well they generalize to other stimuli. These assessments provide high quality information of the dog's reaction to various stimuli. For this type of test there are, for practical reasons, limitations in the number of dogs that is feasible to test and also in the type of situations that can be tested. The number of tested dogs is limited by the number of test occasions, which is depending on number of test sites and organisation of the tests. The situations that can be tested are limited by the welfare of the tested dog as well as the welfare of other animals and persons involved in the test. For example testing a dog's aggression level towards children could include a risk of hurting the child, which is not acceptable.

In Sweden, the Dog Mentality Assessment (DMA), a standardized behavioural assessment, was originally designed to help Swedish working dog breeders in their selection of dogs. The assessment was introduced in the 1980s and is organised by the Swedish Working Dog Association (SWDA). The DMA consists of 10 test situations and the intensity of the dog's reaction, in each situation, is scored by a judge. The judge as well as other volunteers working with the test are trained and certified by the SWDA. Svartberg and Forkman (2002) showed that the recordings from DMA can be condensed into five broader behavioural traits, so-called personality traits. How these personality traits genetically correlate to the everyday behaviour of the dog has not previously been studied.

To assess everyday behaviour, a questionnaire in which the respondent is asked to describe the dog's recent behaviour can be used (Jones and Gosling, 2005). According to Jones and Gosling (2005) some previous studies have used expert ratings, e.g., by veterinarians, judges or dog-trainers, to assess the general behaviour of a breed or a sex. There is, however, a risk that the cultural background of the expert is reflected in the response, thereby increasing the bias in the result. In their review, Jones and Gosling (2005) found that more recent studies often used dog owner questionnaires. According to their review the bias from the dog owners can be limited by the large number of independent responses (Jones and Gosling, 2005). The questionnaire can provide information on situations that, for reasons mentioned previously, cannot be tested in a standardized test for, say, animal welfare reasons. The

questionnaire can also provide information over a longer period of time compared with the standardized tests. The dog owner questionnaires can therefore provide good information regarding the current behavioural status in the breed, however, for breeding purposes one crucial criterion is that the measurement method is as objective as possible and the behavioural test could therefore be more suitable for breeding purposes.

One breed in which behavioural problems in terms of fear have been identified, both by dog owners and overall breed results in the DMA, is the Rough Collie. This breed was therefore selected for paper II to estimate genetic correlations between everyday behaviour and results from the DMA. These results could be used to evaluate if the DMA could be used to select for improved everyday behaviour in the Rough Collie. In order to investigate the current status of behaviour in some other dog breeds, a total of 20 breeds from different origins (e.g., herding or guarding) were selected for paper I. In addition to the current behaviour status in the breeds, factors affecting everyday behaviour were analysed in paper I.

2 Aims of the thesis

The main aim of this thesis was to investigate the possibility to use information collected during dog mentality assessment to select for improved everyday behaviour in dogs. More specifically the aims were to:

- Use questionnaire information about everyday behaviour in 20 Swedish dog breeds to:
    - estimate breed differences, and
    - estimate the effect of the systematic factors age and sex.
- Use questionnaire and dog mentality assessment information about behaviour in Swedish Rough Collie to:
    - estimate genetic parameters, including heritabilities and genetic correlations between the two recording systems

3 Summary of the studies

3.1 Materials and Methods

3.1.1 Choice of breeds

The breeds included in paper I (Figure 3) were selected based on information from the Swedish Kennel Club (SKK), breed clubs and the number of new SKK registrations per year. One criterion in the selection of breeds was to include both working and non-working breeds. The distribution between working and non-working breeds in paper I was 11 vs 9 breeds. All working dog breeds originated from herding or guarding dogs.

Paper II was based on information from one working dog breed, the Rough Collie. The reason for investigating the Rough Collie was that they have the lowest average score for the personality trait Curiosity/Fearlessness out of the 75 most tested breeds in the dog mentality assessment (DMA). The Swedish Collie Club has repeatedly raised concerns regarding the temperament of the breed. There was a strong request to introduce a tool that could be used by breeders in order to reduce everyday fearfulness in the Swedish Rough Collie.

3.1.2 Everyday behaviour (papers I and II)

Information on everyday behaviour of Swedish dogs for both papers was assessed through an online questionnaire. The questionnaire was based on the validated Canine Behavioural and Research Assessment Questionnaire (C-BARQ) (Hsu and Serpell, 2003). It also included additional questions regarding the dog's sociability and play interest, as previously used by Svartberg (2005). The dog owners were asked to describe the reaction of the dog in specific situations on a five grade scale. The scale indicated how often or how severe the reaction of the dog was in the described situation. The responses regarding the behaviour of the dog were condensed into 18 behaviour subscale scores (BSS) (Table 1), 15 originating from C-BARQ (Hsu

and Serpell, 2003) and 3 originating from the questions regarding the sociability and playfulness of the dog (Svartberg, 2005). The questionnaire was open for all dog owners and was advertised through SKK as well as through the breed clubs.

Editing of questionnaire data mainly consisted of removing dogs not born within the years of interest as well as removing duplicate records. After editing, data for paper I included information on everyday behaviour of 3,591 dogs from 20 breeds born in the years 2000-2011, also including dogs that were no longer alive when the questionnaire was answered. After editing, data for paper II included information on everyday behaviour of 1,738 Rough Collies that were born in the years 1999-2009.

3.1.3 Dog Mentality Assessment (paper II)

The DMA is a standardized behavioural test, during which the dog is exposed to 10 subtests and a total of 33 behavioural reactions are recorded. The intensity of the behavioural reactions are rated by judges according to a standardized score sheet. The judges are trained and certified by the SWDA. The behavioural reactions can according to previous studies be condensed into five underlying personality traits (Table 1): Sociability, Curiosity/Fearlessness, Playfulness, Chase-proneness, and Aggressiveness (Svartberg and Forkman, 2002). In addition to the five personality traits, the score for Gunshot avoidance was also included in the analysis.

Records from the DMA were retrieved from SKK. The analysis in paper II were based on 2,953 records for Rough Collie that were tested once during the period from January 1997 to November 2010. A total of 1,003 Rough Collies had information both from the DMA and the questionnaire regarding everyday behaviour.

3.1.4 Pedigree information

Pedigree information was retrieved from the SKK. The pedigree files included information on registration number, birthdate, sex and registration number of the parents. The unique SKK registration number was used to match records from questionnaire, DMA and pedigree files.

For the questionnaire data used both in paper I and paper II, the pedigree information was used to identify the breed of the dog as well as sex and estimating age of the dog when the questionnaire was answered. For the DMA data, the pedigree information was used to identify the sex of the dog and estimating age at test. For paper II, the pedigree information was also used in the genetic analysis to create the relationship matrix. The pedigree information for paper II included a total of 8,443 records.

Table 1. *Description of selected behaviour traits from the Dog Mentality Assessment (DMA) and the dog-owner questionnaire.*

Behaviour trait	No. of questions or behavioural reactions	Summary descriptions: The personality trait or behavioural subscale score relates to/describes the…
Behavioural sucscale scores (BSS)		
Dog-directed interest[1]	5	…eagerness to greet, approach and play with unfamiliar dogs.
Stranger-directed interest[1]	5	…willingness and eagerness to greet and to approach unfamiliar persons.
Human-directed play interest[1]	5	…eagerness to play with an object (e.g., a ball, stick etc.) together with familiar and unfamiliar humans.
Trainability[2]	8	…willingness to pay attention to and obey the owner, and the dogs ability to learn new tasks and to ignore distracting stimuli.
Dog-directed aggression[3]	4	…dog's tendency to display aggressive reactions when approached by unfamiliar dogs.
Stranger-directed aggression[2]	10	…threatening or aggressive reaction towards unfamiliar persons approaching or invading the dog, the owner or the dog's or the owner's territory.
Dog-directed fear[3]	4	…tendency to display fearful reactions when approached by unfamiliar dogs.
Stranger-directed fear[2]	4	… degree of fearful reactions when approached by unfamiliar persons.
Non-social fear[2]	6	…tendency to show fearful responses to sudden or loud noise, in heavy traffic, to unfamiliar situations and objects, during thunderstorms, and to wind or wind-blown objects.
DMA personality traits		
Sociability	3	…eagerness to reject or initiate contact with, and handling by, an unknown friendly person.
Curiosity/Fearlessness	7	… intensity of flight behaviours displayed when exposed to suddenly appearing human-like objects or loud noises and the signs of remaining fearfulness.
Playfulness	5	…interest in, and intensity when, playing with an object (tug-of-war) together with a human.
Chase-proneness	4	…interest in , and intensity when, following a rag quickly moving away, and engagement in the rag if catching it.
Aggressiveness	3	… frequency and severity of aggressive behaviours displayed when confronted with a suddenly appearing, or slowly approaching, human or human resembling object.

[1] First described by Svartberg (2005); [2] First described by Hsu and Serpell (2003); [3] As described by Duffy and Serpell (2012)

3.1.5 Statistical methods

Analysis of factors affecting everyday behaviour in paper I was done using the general linear model procedure in SAS (SAS, 2011). Factors included in the analysis were breed group (working or non-working), breed, age and sex.

In paper I, the breeds were grouped in a hierarchical cluster analysis, based on LSMEANS per breed from the analysis described above, using hclust complete linkage method in the R-package (RCoreTeam, 2013). The correlation procedure in SAS (SAS, 2011) was used to estimate the phenotypic correlations between the behaviour subscale scores in paper I.

All genetic analyses of behavioural data in paper II were performed using the DMU software (Madsen and Jensen, 2012). Variance components for BSS from the questionnaire in paper II were estimated in univariate analysis using a model that adjusted for sex and age of the dog when the questionnaire was answered. Variance components for the personality traits and the behavioural reaction Gunshot avoidance from the DMA data in paper II were estimated in a univariate analysis using a model that adjusted for effects related to the dog (sex, age at test and litter) as well as effects related to the test situation (judge, occasion as well as year and month of the test). Correlations between BSS (questionnaire) and personality traits (DMA) were estimated from bivariate analysis using models as described above.

3.2 Main findings

3.2.1 Factors affecting behaviour

Breed had a significant effect for all BSS in paper I. Breed group (working or non-working) and age had a significant effect on all but three BSS. The score for social behaviour of the dog decreased with increased age while the score for aggressive behaviour increased with increased age, especially towards other dogs (Figure 1). Sex had a significant effect for more than half of the BSS. Male dogs showed more interest in, slightly more aggression towards and slightly less fear of unfamiliar dogs (Figure 2). For half the BSS all four factors had a significant effect.

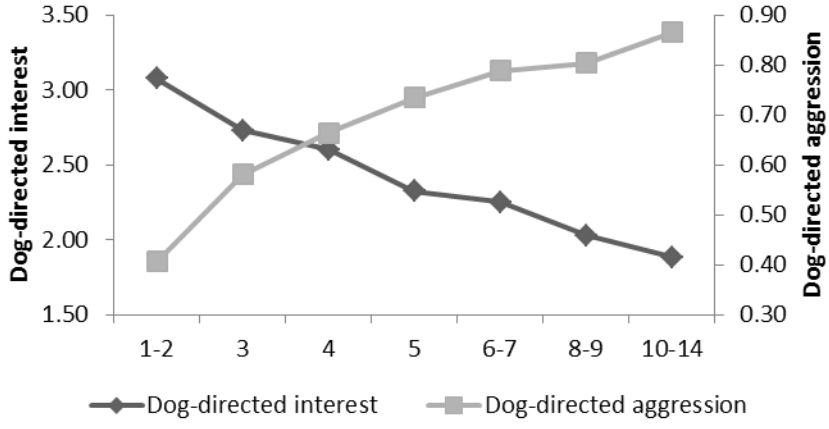

Figure 1. Average values for Dog-directed interest and Dog-directed aggression over age groups (in years) from the questionnaire data, measured on a scale 0-4.

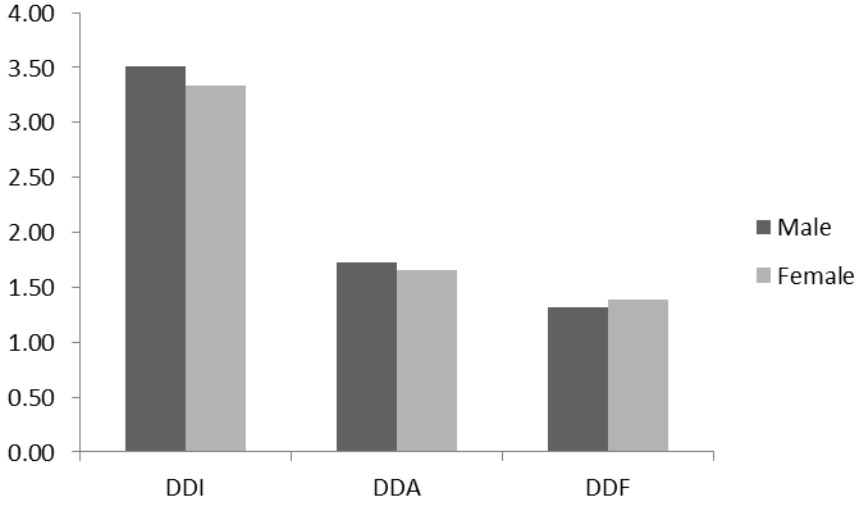

Figure 2.. Differences between male and female dogs for three everyday behaviour traits: Dog-directed interest (DDI); Dog-directed aggression (DDA) and Dog-directed fear (DDF), measured on a scale 0-4.

The cluster analysis in paper I grouped the working breeds into one cluster (Figure 3); indicating that the working breeds show similar everyday behaviour that differs from the non-working breeds. The cluster with non-working breeds was further divided into two clusters, the largest difference between the groups were found for human-directed play interest and chasing of small animals. The working breeds in paper I generally had higher average scores for Human-directed play interest, Trainability and aggression traits as well as less Non-social fear compared with non-working breeds (Figure 4). The overall levels of aggression and fear were low, however, with relatively large differences between breeds (Table 2).

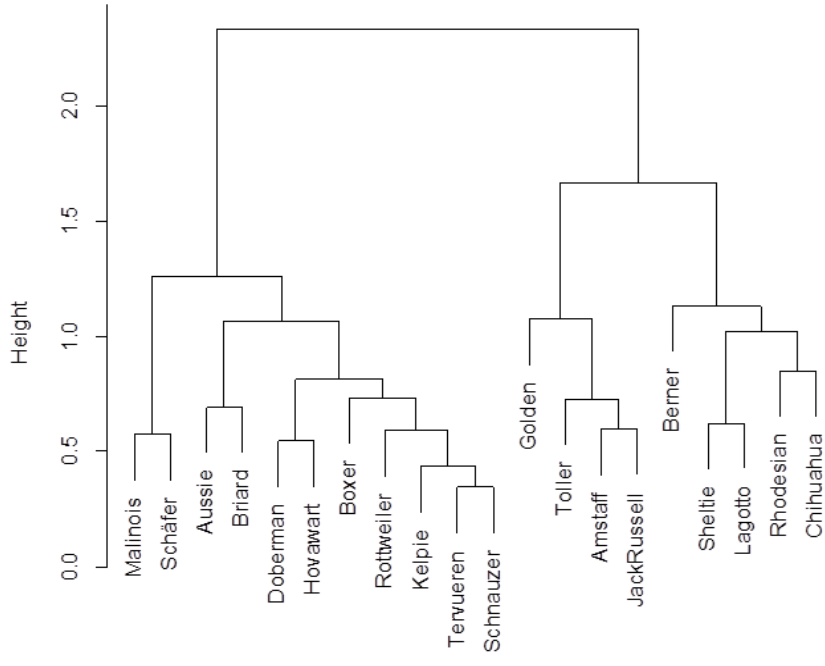

Figure 3. Dendrogram from cluster analysis in paper I based on the LSMeans for everyday behaviour traits for all breeds. Malinois: Belgian Shepherd Dog – Malinois; G. Shepherd: German Shepherd Dog; Aussie: Australian shepherd; Doberman: Doberman Pinscher; Kelpie: Australian kelpie; Tervueren: Belgian Shepherd dog – Tervueren; Schnauzer: Giant Schnauzer; Golden: Golden Retriever; Toller: Nova Scotia Duck Tolling Retriever; Amstaff: American Staffordshire Terrier; Jack Russell: Jack Russell Terrier; Berner: Bernese Mountain Dog; Lagotto: Lagotto Romagnolo; Sheltie: Shetland Sheepdog; Rhodesian: Rhodesian Ridgeback

Table 2. *Means of breed LSMeans, standard deviation of breed LSMeans, minimum and maximum values of breed LSMeans for aggression and fear traits, measured on a scale 0-4*

Trait	Mean of breed LSMeans	Standard deviation	Min	Max
Dog-directed aggression	0.7	0.2	0.4	1.0
Dog rivalry	0.4	0.1	0.2	0.6
Stranger-directed aggression	0.3	0.1	0.1	0.5
Owner-directed aggression	0.0	0.0	0.0	0.2
Dog-directed fear	0.4	0.1	0.2	0.6
Stranger-directed fear	0.3	0.1	0.1	0.6
Non-social fear	0.4	0.1	0.2	0.6

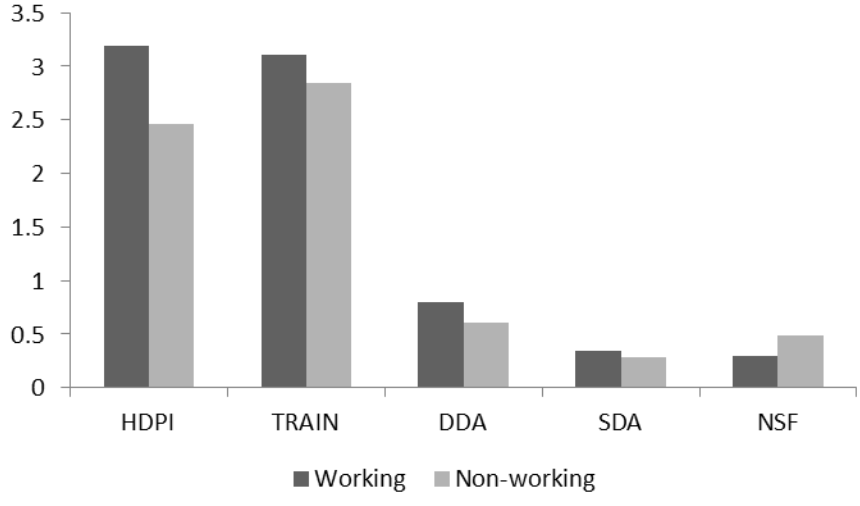

Figure 4. Average scores for working/non-working breeds for Human-directed play interest (HDPI), Trainability (TRAIN), Dog-directed aggression (DDA), Stranger-directed aggression (SDA) and Non-social fear (NSF), measured on a scale 0-4.

The random environmental effects (litter, judge and occasion) had significant effect on most of the five DMA personality traits according to genetic analysis from paper II. Both the DMA traits and the BSS for everyday behaviour , in paper II, were also influenced by systematic environmental effects (age and sex).

3.2.2 Genetic parameters of everyday life behaviour and DMA

There was a significant genetic effect on most behaviour traits in the Rough Collie, either measured by questionnaire or in the DMA, according to results from paper II. Heritabilities for questionnaire BSS ranged from 0.06 to 0.36

(Table 3). Analyses of DMA data showed that heritabilities for personality traits ranged from 0.14 to 0.25 (Table 3) and the heritability for the behavioural reaction Gunshot avoidance was 0.10. Overall the heritabilities for the individual behavioural reactions were lower than heritabilities for condensed personality traits. The estimated heritability for aggression was low, both for DMA for the questionnaire.

Table 3. *Heritability estimates for selected everyday behaviour measured by questionnaire and personality traits measured in the Dog Mentality Assessment (DMA).*

Trait	h^2 (SE)
Questionnaire behavioural subscale scores	
Stranger-directed interest	0.29 (0.05)
Dog-directed interest	0.15 (0.04)
Human-directed play interest	0.28 (0.05)
Stranger-directed fear	0.25 (0.05)
Dog-directed fear	0.11 (0.04)
Non-social fear	0.36 (0.06)
Stranger-directed aggression	0.24 (0.05)
Dog-directed aggression	0.09 (0.04)
DMA personality traits	
Sociability	0.22 (0.04)
Curiosity/fearlessness	0.20 (0.04)
Playfulness	0.25 (0.04)
Aggressiveness	0.14 (0.04)
Chase-proneness	0.16 (0.03)
Gunshot avoidance	0.10 (0.04)

3.2.3 Phenotypic correlations between everyday behaviour

Stranger-directed interest was strongly negatively correlated to both Stranger-directed fear and Stranger-directed aggression but positively correlated to Dog-directed interest (Table 4). Dog-directed interest was strongly negatively correlated to Dog-directed aggression. Human-directed play interest was strongly positively correlated to Trainability. The same was found for Stranger-directed fear on one hand and Dog-directed fear/Non-social fear/Stranger-directed aggression on the other hand, as well as between Dog-directed fear and Dog-directed aggression and between Stranger-directed aggression and Dog-directed aggression. Other correlations were weak between -0.3 and 0.3.

3.2.4 Genetic correlations between everyday behaviour and DMA

More than half of the genetic correlations between everyday behaviour and DMA personality traits as well as DMA behavioural reaction Gunshot avoidance estimated in paper II were significantly different from zero. The genetic correlations showed that the DMA results could be used to decrease everyday fearfulness in Rough Collie in Sweden (Table 5).

We expected some of the genetic correlations between questionnaire and DMA traits to be rather strong, based on similarities between the behaviours they were intended to measure (Table 5). The DMA personality trait Sociability was genetically correlated to a majority of everyday behaviour traits. The highest correlations between Sociability and everyday behaviour were related to unfamiliar dogs and humans. Sociability was negatively correlated to everyday aggression and fear. Among the correlations we expected to be strong, the strongest was found between questionnaire BSS Stranger-directed interest and DMA personality trait Sociability. There were no significant genetic correlations between DMA personality trait Aggression and aggression measured in the questionnaire.

Table 4. *Phenotypic correlations significantly different from zero between everyday behaviour traits measured by a dog owner questionnaire.*

	Dog-directed interest	Human-directed play interest	Trainability	Stranger-directed fear	Dog-directed fear	Non-social fear	Stranger-directed aggression	Dog-directed aggression
Stranger-directed interest	**0.42**	0.24	0.07	**-0.54**	0.25	0.12	**-0.44**	-0.23
Dog-directed interest		0.26	0.04	-0.16	-0.23	-0.05	-0.21	**-0.48**
Human-directed play interest			**0.37**	-0.14	-0-04	-0-14	-0.05	
Trainability				-0.10	-0.11	-0.22	-0.10	-0.11
Stranger-directed fear					**0.53**	0.30	**0.44**	0.18
Dog-directed fear						0.29	0.25	**0.35**
Non-social fear							0.11	0.10
Stranger-directed aggression								**0.38**

Bold numbers indicate values higher than 0.30 or lower than -0.3.

Table 5. *Genetic correlations[1] between selected everyday behaviour traits and behaviour traits measured in the Dog Mentality Assessment.*

Dog Mentality Assessment (DMA)	Everyday behaviour							
	Stranger-directed interest	Dog-directed interest	Human-directed play interest	Stranger-directed fear	Dog-directed fear	Non-social fear	Stranger-directed aggression	Dog-directed aggression
Sociability	**0.87**	**0.45**	0.19	**-0.80**	**-0.39**	**-0.46**	**-0.58**	**-0.49**
Curiosity/ fearlessness	0.09	-0.09	**0.30**	**-0.44**	**-0.35**	**-0.70**	0.08	-0.34
Playfulness	**0.28**	0.07	**0.63**	**-0.40**	**-0.31**	**-0.52**	**-0.23**	**-0.42**
Aggressiveness	-0.16	**-0.40**	0.18	0.07	0.16	0.05	0.20	0.28
Gunshot avoidance[2]	-0.09	**-0.47**	**-0.58**	**0.53**	**0.73**	**1.00**[3]	**0.08**	0.43

[1]Correlations significantly different from zero are indicated by bold figures.[2]Gunshot avoidance is an individual behavioural reaction not a personality trait. [3] Relaxed convergence criteria were used in the estimation

4 General discussion

4.1 Breed differences of everyday behaviour traits

Results from paper I showed significant differences between working and non-working dog breeds in the analysis of factors affecting everyday behaviour. This factor had significant effect on all but three Behavioural subscale scores (BSS). One previous study by Svartberg (2006) investigated how the number of different merits (herding, working, terrier hunting, gun dog or show merits) in the breeding stock affected the behaviour. The study showed that the type of merits in the breeding stock affected the behaviour in the dog breed. Further the study showed that the working breeds showed similar behaviour and generally had more working and hunting merits than show merits. Our results support the hypothesis by Svartberg (2006) that the current use of the breeding stock affects behaviour in the breed as a whole. This is further supported by the fact that the working breeds clustered together in the cluster analysis. The fact that the non-working breeds were divided into two clusters (Figure 3), however, could be caused by a difference in the current use of the breeding stock. The dogs in the first group showed more energy, more interest in playing with humans and more interest in chasing animals. It is likely that some dog owners appreciate a more lively dog but do not want a working dog. At the same time there are dog owners that wish to have a dog purely as companion and therefore will appreciate a calmer dog that will not for example chase after animals that come into the garden. It is possible that one of the groups of breeds is more strictly used as companion dogs, whereas the other group is more often used for competitions, e.g., agility, freestyle, rally-obedience, and that the breeding goal therefore differs between the two groups.

The DMA trait Boldness, which is a condensed trait including results from all DMA personality traits except aggressiveness, was an important factor in the success of working dogs (Svartberg, 2002). The working breeds in our study showed significantly more both Human-directed play interest and

Trainability but less Non-social fear and Stranger-directed fear (Figure 4), compared with the non-working breeds (paper I). All these behaviour traits would be expected to be correlated to higher Boldness scores. The substantial difference between working and non-working breeds indicates that further research is required before results from working breeds are applied to non-working breeds.

4.1.1 Aggression and fear

Despite the overall low levels of aggression and fear (Table 2), the relative difference between breeds was large (paper I). Duffy et al. (2008) also used C-BARQ to measure breed differences in canine aggression in a sample of American dogs and found relatively large variation in aggression between breeds. The overall level of aggression was higher in that study than in this thesis. The difference in level could be caused by differences in the breeds included or by a difference between populations. Both the previous study by Duffy et al. (2008) and the present study found higher average scores for aggression directed towards strangers (both humans and dogs) compared with aggression directed towards individuals of the same household (both humans and dogs).

The working breeds showed less fear compared with the non-working breeds. However, there was great variation within the non-working breed group. A majority of the non-working breeds showed more Non-social fear compared with the working breeds. One reason for this difference may be that the working breeds must be able to perform tasks in a great variety of situations and therefore cannot show fear of sounds or objects in the working situation. As shown in paper II, both Non-social fear and Stranger-directed fear are genetically correlated to traits measured in the DMA (Table 5). All dogs from working breeds must perform the DMA before they are used for breeding. The records from DMA are official and published on the webpage of SKK. The availability of these records makes it possible for dog breeders to, at least in theory, use information from the DMA in the selection of parents for the next generation. Although the information from DMA might not have been used in an optimal way, the availability gives the opportunity to avoid breeding from very fearful dogs thereby lowering the average level of fearfulness in the population. Fear of dogs is not measured in the DMA and our results indicate that the working breeds show more Dog-directed fear compared to Stranger-directed fear or Non-social fear. Dog-directed fear is genetically correlated to the traits measured in the DMA but the correlations are weaker compared with Non-social fear or Stranger-directed fear (Table 5).

4.1.2 Trainability and sociability

It was not unexpected that the working breeds were more trainable and showed more interest in playing with humans compared with the non-working breeds. As the name implies, the working breeds have had specific tasks to perform and to be able to perform these tasks they must be able to learn commands, which is a large part of the Behavioural subscale score (BSS) Trainability. The adult dog's play with its handler is important both for the social interaction and as a reward during training sessions (Bradshaw et al., 2015), thereby being an important factor for success in the working dog. Both Human-directed play interest and Trainability have therefore likely been important selection criterion for the working breeds. Among the non-working breeds there were also differences between breeds depending on their original working purpose. The non-working breeds originating from dogs where a close cooperation with the handler was important in their work performance were generally easier to train and more playful.

4.2 The effect of age on everyday behaviour

Age had a significant effect on most of the everyday behaviour traits and results showed that the score for social behaviour of the dog decreased with increased age while the score for aggressive behaviour increased with increased age especially towards other dogs (Figure 1). An increased presence of aggressive behaviour in older dogs have previously been found (e.g., Duffy et al. (2008) Casey et al. (2013)). Social fear increased up to 3-4 years of age and then declined, however, the overall change was small (not shown). The increase in fear may be a result of confrontation with unpleasant situations: some examples could be meeting an aggressive dog during a walk or strangers roughly greeting the dog. As the dog gets older the owner may use different strategies for handling these situations, for example by avoiding dog meetings, not letting unknown people greet the dog during walks etc.. This strategy from the owner reduces the risk for these situations and the dog may thereby appear less fearful. On the other hand the dog could also develop strategies for handling uncomfortable situations; one of them might be to act in an aggressive manner in order to avoid confrontations. This could be one of the reasons for the increased aggression in older dogs, especially towards unfamiliar dogs. The trainability increased during the first years of the dog's life and seemed to stabilize around the age of 4 years. One of the causes for this could be that the younger dog is more easily distracted as it is still very interested in things in the surroundings and could therefore be more difficult to train.

4.3 The effect of sex on everyday behaviour

There were significant differences between male and female dogs in everyday behaviour traits. Male dogs showed more interest in, slightly more aggression towards and slightly less fear of unfamiliar dogs (Figure 2). In addition male dogs had more energy and were more excitable compared with female dogs. These results are in line with previous studies (Hart and Hart, 1985; Bradshaw et al., 1996; Notari and Goodwin, 2007). Furthermore, the results showed that female dogs showed more fear overall and were more trainable compared to male dogs. Goddard and Beilharz (1985) also showed that female dogs were more fearful compared to male dogs. That female dogs are scoring higher for obedience training has previously been shown by Hart and Hart (1985), Bradshaw et al. (1996) and Notari and Goodwin (2007). Serpell and Hsu (2005) on the other hand found no significant effect of sex for trainability. Other studies based on results from behaviour tests have showed that there is a sex difference in behaviour and that males score higher (more extreme) for several traits (Svartberg, 2002; van der Waaij et al., 2008). This could be useful information for potential puppy buyers when choosing a male or female.

4.4 Genetic analysis of behaviour traits

4.4.1 Heritabilities

The estimated heritabilities for everyday behaviour were of similar size as those estimated for the DMA traits (Table 3) (paper II). The use of standardized tests and trained judges, which is the case for DMA, is regarded as one way to reduce bias in the form of measurement errors. This in turn is expected to give more reliable ratings compared with a dog owner questionnaire. One explanation for the lack of consequent difference between the estimates is that the dog owners have a greater knowledge of the behaviour of the specific individual over a longer time compared with the judge at a standardized test. Another reason could be as discussed by Jones and Gosling (2005) that the large number of independent responses give a smaller overall bias. The estimated heritabilities for everyday behaviour traits for the Rough Collie are also in concordance with estimated heritabilities for 14 breeds with records on everyday behaviour for more than 100 dogs per breed (Eken Asp, 2014).

The heritabilities for the individual behavioural reactions from the analysis of DMA data were in general lower than those for the condensed personality traits (paper II). Because the genetic correlations between behavioural reactions included in each personality traits were high, the individual

behavioural reactions could be regarded as repeated measures of the same underlying personality trait, thereby reducing the random error variance. Heritability estimates for the DMA behavioural reactions and personality traits included in this thesis are well in concordance with results from previous studies (Strandberg et al., 2005; Saetre et al., 2006). Among the DMA personality traits Aggressiveness had the lowest heritability and among everyday behaviour traits aggression traits were generally less heritable than the corresponding sociability trait. This could be due to that aggression is difficult to define. It could also be that the environmental factors play a larger part therefore reducing the heritability. Similar results were found for the social fearfulness traits among everyday behaviour traits and also this could be due to difficulties in accurately measuring the trait or a larger environmental impact. Both aggression and fearfulness traits however, showed a heritability that is large enough to improve the traits by breeding.

4.4.2 Phenotypic correlations between behaviour traits

Most phenotypic correlations between everyday behaviour traits in paper I were low (Table 4). The phenotypic correlation between everyday aggression and fear were positive both when directed towards unfamiliar humans and towards unfamiliar dogs. Similar results have previously been found by Duffy et al. (2008). The phenotypic correlation between Dog-directed fear and Stranger-directed fear was relatively high indicating that dogs that show fearful behaviour towards unfamiliar dogs also show fearful behaviour towards strangers. Dogs that are more interested in unfamiliar humans and dogs tend to show less aggression and fear in the same situation. Similar results were also found by Svartberg (2005). This phenotypic correlation could be caused by fearful individuals avoiding situations that they fear and thereby appear less interested.

The positive phenotypic correlation between Human-directed play interest and Trainability found in paper I indicates that a dog that is more interested in playing with humans is more trainable. There are likely several explanations for this correlation; one could be that play is a commonly used reward in dog training (Svartberg, 2006) and that the selection for more playful dogs have given rise to more trainable dogs.

4.4.3 Genetic correlations between behaviour traits

The genetic correlations between everyday fearfulness and the DMA personality trait Curiosity/fearlessness was not as strong as expected (paper II). Everyday fearfulness was often more strongly genetically correlated to DMA personality trait Sociability as well as DMA behavioural reaction Gunshot

avoidance (Table 5). One explanation for this could be that the fearfulness measured in the DMA is dependent on the flight reaction of the dog as well as the remaining fear. Fearfulness could be displayed in several ways that may not be captured in this type of reaction. Another reason could be that the fearfulness that dog owners experience in their dog is often related to interaction with unfamiliar dogs and humans during walks (social fearfulness) or to sudden sounds (similar to a gunshot). This indicates that information from Sociability and Gunshot avoidance could be useful in order to reduce everyday fearfulness in dogs.

The low genetic correlations between aggression measured in DMA and aggression as measured by the questionnaire indicate that aggression measured in the DMA is not an optimal measurement for reducing everyday aggression. A better way to reduce aggression towards both unfamiliar dogs and humans in everyday life could be to use the DMA personality trait Sociability, which has a relatively high heritability (0.22) and is negatively, and quite strongly, correlated to both Stranger-directed aggression and Dog-directed aggression (-0.49 and -0.58, respectively).

The DMA personality trait Playfulness was genetically correlated to a majority of the everyday behaviour traits and as expected most highly correlated to Human-directed play interest. One reason for the correlation between Playfulness and everyday fearfulness could be that the DMA personality trait measures the dog's willingness to play (chase after an object and play tug-of-war) both with the dog-owner and an unknown person. In order to leave the dog owner the dog must have a certain level of fearlessness both towards the situation and the stranger with the play object.

4.5 Breeding as a method to change everyday behaviour

Recording of the behaviour of dogs can be done either by standardised behavioural tests or by questionnaires. The standardised tests provide high quality data from a controlled environment at a specific time whereas the questionnaires have the possibility to generate larger quantities of data regarding a wider range of situations compared to the standardised tests. Behaviour assessed either through DMA (standardised test) or questionnaire was clearly influenced by genetic factors and can thus be selected for. The papers included in this thesis show that behaviour assessed through questionnaire give heritability estimates in the same range (or in some cases even higher) as the DMA. Why then, not use the questionnaire directly for breeding purposes? The questionnaire could be more vulnerable to external pressure than the standardised test. The external pressure applied to the dog

owners can affect their responses to the questions, which in turn will reduce the credibility and accuracy of the questionnaire as a tool for breeding. In order to alter the results in the DMA the handler would either have to train the dog before the test to bring about the desired behaviour in the test situation or in some way affect the judges, which seems less likely to occur on a large scale.

In addition to the genetic influence several environmental factors, both systematic and random effects, had a significant effect on the behaviour. Today most dog breeders use phenotypic selection in their breeding. When selection is based on the individual's phenotype alone, little consideration can be given to environmental effects and as a result genetic progress is often low. One way to increase the genetic progress is to include environmental effects as well as information from relatives in the selection by using Best Linear Unbiased Prediction (BLUP) to estimate breeding values. BLUP is most effective for low heritable traits were the environment plays a larger part, as for behaviour traits. For this reason shifting from selection based on phenotype to selection based on estimated breeding values using BLUP has high potential to give a larger genetic progress compared with today.

The most important factor for success in a breeding program is that it is adopted by the breeders. If the breeders will not use the suggested breeding program there will not be any systematic genetic progress. If BLUP is introduced for conformation traits and behavioural traits simultaneously the genetic progress will probably increase also for conformation traits compared with the phenotypic selection today. There is a plethora of dog breeds today and most breeds have a small population size. This results in few animals to select among when finding parents for the next generation. In addition to the small breeding population there is often a large focus on conformation traits that could give the dog and breeder show merits. In order to create a change in everyday behaviour for the dog and their owner breeders must shift some of their focus from conformation traits to mental health. There are great possibilities to reduce aggressive and fearful behaviour in dogs if all breeders of a breed shift focus more towards the mentality of the dog instead of the conformation. The recommendation based on results from this thesis is to use DMA personality trait scores to estimate BLUP breeding values as a way to change everyday behaviour in dogs.

5 Conclusions

Based on the results of the studies in this thesis it can be concluded that:

- Everyday behaviour was affected by the age, sex and breed of the dog.
- The levels of aggressive and fearful behaviour in the investigated breeds were overall low but with large differences between breeds.
- The everyday behaviour differed between working and non-working dog breeds.
- Working dog breeds were more interested in playing with humans, more trainable and less fearful compared with non-working breeds.
- Heritability estimates for behaviour traits were low to medium both for everyday behaviour and behaviour measured at the Dog Mentality Assessment (DMA).
- The estimated genetic correlations between everyday behaviour and DMA were medium to high between similar behaviours.
- The estimated heritabilities for aggression were generally low but everyday aggressiveness towards humans and dogs was significantly genetically correlated to the DMA personality trait Sociability.
- The temperament description DMA could be an effective tool for selection of breeding animals with the goal to decrease everyday life fearfulness in the Swedish Rough Collie population.

6 Future challenges

This thesis has brought about several questions that would be interesting to investigate further, both from a genetic point of view but also from an ethological point of view. From a genetic point of view, there is a great need for more effective breeding programs in dog breeding in general and especially for temperament traits. Much of the focus in dog breeding today is on exterior traits, which are often more easily measured and selected for on the phenotypic level. Before including temperament traits on a routine basis in the breeding of other breeds than Rough Collie, more research is needed on the genetic contribution to behaviour in these breeds. There are differences between working and non-working breeds as well as between breeds and more information is therefore needed both regarding heritabilities and genetic correlations between traits in the two breed groups and the breed in question. More research is also needed on the differences we found between non-working breeds. In this thesis the non-working breeds divided into two clusters indicating that there are systematic differences also within the group of non-working breeds.

It would also be interesting to further investigate the effect of age on everyday behaviour. Because aggressive and fearful behaviour showed low heritabilities and had a strong effect of age, environment is likely to play an important role. More knowledge on why behaviour changes with age could be important in the rehabilitation of aggressive or fearful dogs.

During the work with this thesis a new dog mentality assessment, called the Behaviour and Personality Assessment in Dogs (BPH) has been introduced in Sweden. The BPH was designed to contribute to better knowledge about the mentality of all dogs. One important difference between the DMA and BPH is that DMA was originally designed for the working dogs whereas BPH was designed to assess behaviour more related to everyday situations and to be suitable for all breeds. As the number of dogs assessed by the BPH increases it is important to analyse the correlations between BPH personality traits and

everyday behaviour. For the non-working breeds the BPH could play an important part to increase the number of assessed dogs as the test is marketed and run by SKK not SWDA. For the working dogs DMA will probably continue to play an important part as the test is well known among the working dog breeders.

7 Vardagsbeteende hos hund – rasskillnader och genetiska analyser

Hundens och människans historia sträcker sig långt tillbaka i tiden då hunden var det första djuret som domesticerades. Tidigare fyllde hunden en viktig roll som arbetshund vid jakt eller vallning eller som vakthund på gården. Idag är rollen som sällskapshund den vanligaste i stora delar av världen. Som sällskapshund utsätts hunden för andra situationer än arbetshunden och det är andra saker i vardagen som kan vara stressande för hunden, t.ex. möten med okända människor och hundar på promenader, plötsliga ljud eller att vara ensamma hemma under stora delar av dagen när familjen är på jobbet eller i skolan. Hur hunden hanterar dessa situationer är viktigt för både hundens och hundägarens välbefinnande men också för samhället. Rädsla hos hunden är dels ett välfärdsproblem för hunden men också för hundägaren som kan bli begränsad i sina aktiviteter. I värsta fall kan hundens rädsla uttryckas som ett aggressivt beteende vilket kan innebära en risk för djur och människor. Det är därför viktigt att hundar i dagens samhälle har de bästa förutsättningarna för att klara av dessa situationer. Ett alternativ för att öka välbefinnandet hos hundar och hundägare kan vara att genom ett aktivt avelsarbete minska rädsla och aggressivitet hos hundar.

För att kunna förändra en egenskap genom avel krävs att egenskapen går att mäta. Beteende kan exempelvis mätas genom att använda ägarenkäter där hundägaren beskriver hundens beteende. Fördelen med ägarenkäter är dels att det går att få information om situationer som man av etiska och praktiska skäl inte kan testa i verkligheten t.ex. aggressivitet gentemot andra hundar och/eller barn. Det är också möjligt att få in information från många individer eftersom antalet testplatser inte är begränsat.

Ett annat alternativ för att mäta beteende är att använda standardiserade beteendebeskrivningar där hundens reaktion i ett antal, för hunden nya, situationer beskrivs av en utbildad domare. Mentalbeskrivning hund (MH) är ett exempel på standardiserad beteendebeskrivning där hunden går en bana

med 10 stationer, en domare beskriver hundens reaktion vid varje station. Totalt görs 33 beteendebeskrivningar, dessa kan sedan kombineras till fem personlighetsegenskaper. Resultaten från MH redovisas på Svenska Kennelklubbens hemsida.

Många tidigare studier kring hundars beteende har främst fokuserat på den arbetande hundens förmåga att utföra en specifik uppgift eller en mer generell lämplighet som arbetshund. Ett fåtal studier fokuserar på beteendet hos sällskapshundar och om det skiljer sig från de arbetande hundarnas beteende. I Sverige finns indelningen bruksraser och icke-bruksraser, där bruksraserna generellt har fler arbetande hundar. Innan en hund som tillhör någon av bruksraserna används i avel ska den ha genomfört MH.

Syftet med denna avhandling var att undersöka om det går att använda MH-resultat när man väljer ut avelsdjur för att förändra vardagsbeteendet. För att bedöma om det är möjligt har vi undersökt vilka faktorer som påverkar vardagsbeteendet hos 20 svenska hundraser. Vidare har vi också undersökt hur den genetiska bakgrunden för vardagsbeteende och beteende mätt vid MH ser ut samt kopplingen mellan dessa genom att skatta genetiska parametrar och korrelationer för beteendeegenskaperna för långhårig collie.

7.1 Sammanfattning av studierna

Den första studien i avhandlingen undersökte vilka faktorer som påverkar vardagsbeteende och analyserna baserades på information om vardagsbeteendet hos 3,591 hundar från 20 olika raser. Av de 20 raserna var 11 bruksraser. Den andra studien som undersökte den genetiska bakgrunden till och kopplingen mellan vardagsbeteende och beteende vid MH hos långhårig collie baserades dels på information om vardagsbeteende för 1,738 hundar och dels på resultat från MH för 2,953 hundar beskrivna under åren 1997 till 2010.

7.1.1 Ålder och kön påverkar vardagsbeteende

Ålder och kön hade en signifikant effekt på de flesta vardagsbeteenden. Den tydligaste effekten kunde ses för intresse för okända hundar och aggressivitet mot okända hundar. Intresset för okända hundar minskade med stigande ålder medan aggressiviteten gentemot okända hundar ökade. En ökad aggressivitet med ökad ålder skulle exempelvis kunna bero på att hundens tidigare erfarenheter gör att den uppvisar ett aggressivt beteende för att undvika obehagliga situationer i mötet med okända hundar eller människor.

Det fanns en signifikant skillnad mellan hanar och tikar för flera vardagsbeteenden. Hanhundar visade ett större intresse av och mindre rädsla för okända hundar men samtidigt mer aggressivt beteende gentemot okända

hundar. Studien visade också att tikarna generellt sett var lättare att träna än hanhundarna.

7.1.2 Skillnader i vardagsbeteende mellan raser och rasgrupper

Resultaten visade på stora skillnader i vardagsbeteende mellan olika raser men också mellan olika rasgrupper. Bruksraserna var generellt sett mer intresserade av lek och lättare att träna jämfört med övriga raser. Skillnaden kan bero på att det för att brukshundarna ska kunna lära sig sin arbetsuppgift krävs att de är lättränade och att lek är en viktig del av belöningen i samband med träning. Bruksraserna visade också mindre rädsla jämfört med övriga raser vilket kan bero på att en arbetande hund måste kunna genomföra sin uppgift i en mängd olika miljöer utan att uppvisa rädsla. De övriga raserna kunde delas upp ytterligare i två grupper baserat på deras beteende. Den ena gruppen visade då beteenden som till stor del liknade bruksraserna men de visade mer icke-social rädsla, t.ex. rädsla för plötsliga ljud eller föremål.

Överlag var rasmedelvärdena för rädsla och aggressivitet låga i studierna men det fanns förhållandevis stora skillnader mellan raser. Även om det är positivt att nivåerna för dessa egenskaper överlag är låga är det viktigt att undersöka skillnaderna vidare eftersom både rädsla och aggressivitet har stor betydelse för hundens och hundägarens välbefinnande. Att det finns relativt stora skillnader mellan raser tyder på att det är egenskaper som går att påverka genom ett aktivt avelsarbete.

7.1.3 Genernas påverkan på beteende

Arvbarheterna för beteenden baserade på enkätsvaren var låga till medelhöga (0,06-0,36) och liknande för personlighetsegenskaperna från MH (0,14-0,25). Skattningarna för MH egenskaperna stämmer väl överens med tidigare studier. Att skattningarna baserade på ägarenkäten delvis ger högre arvbarheter jämfört med MH beror troligen på att de tränade domarna vid MH trots allt bara ser hunden under 45 minuter medan hundägaren baserar sin bedömning på en längre tids observation, samt att det stora antalet svar som kommit in från hundägare till viss del minskar effekten av varje enskilt svar.

Det fanns starka genetiska korrelationer mellan vissa vardagsbeteenden och beteenden mätta vid MH. De starkaste kopplingarna fanns som väntat mellan beteenden som påminner om varandra t.ex. MH egenskapen Socialitet och vardagsbeteendet Intresse för okända människor. Däremot var den genetiska kopplingen mellan aggressivitet mätt vid MH och aggressivitet i vardagen liten vilket tyder på att det inte är samma typ av aggressivitet som mäts. Både aggressivitet gentemot okända människor och okända hundar var dock negativt genetiskt kopplat till MH egenskapen Socialitet vilket innebär att hundar som

visade mycket aggressivitet mot okända människor och hundar hade låga värden för MH egenskapen Socialitet och tvärtom. Det fanns också en tydlig genetisk koppling mellan vardagsegenskapen Icke-social rädsla och MH egenskapen Nyfikenhet/orädsla samt MH momentet skotträdsla.

7.1.4 Möjligheten att avla för mindre rädsla

Resultaten från studierna som ingår i den här avhandlingen visar att det finns goda möjligheter att avla för minskad rädsla och även generellt för ett ändrat vardagsbeteende hos våra hundar. Minskad rädsla hos våra hundar skulle både öka välfärden för våra hundar och välbefinnandet hos många hundägare som idag måste anpassa sin vardag efter hunden. De genetiska kopplingarna mellan MH egenskaper och vardagsbeteende visar att det finns goda möjligheter att använda MH som ett verktyg i avelsarbetet för ett förändrat vardagsbeteende. För att nå framsteg i avelsarbetet krävs dock att uppfödarna använder de verktyg som finns i sin avel. I arbetet mot ett förändrat vardagsbeteende spelar både rasklubbar och enskilda uppfödare en viktig roll.

Strukturen inom hundaveln där det finns många uppfödare och varje uppfödare har ett fåtal avelsdjur innebär en ökad risk för ett avelsurval där uppfödaren främst tittar på hundens egna prestationer. Egenskaper som är lätta att påverka genom att titta på individens egna prestationer är främst egenskaper med hög arvbarhet till exempel exteriöra egenskaper. Exteriöra egenskaper kan också ge hunden och kenneln viktiga utställningsmeriter. Med de förutsättningarna är riskerna för att exteriöra egenskaper får för stort fokus i avelsarbetet stor. Uppfödare måste aktivt lägga ett större fokus på mentalitet vilket innebär att en del av det genetiska framsteget för exteriöra egenskaper kommer att minska.

För beteendeegenskaper som till stor del påverkas av miljön är det svårt att genomföra en förändring genom att enbart titta på individens resultat. För att kunna nå framgång i avelsarbetet för minskad rädsla eller mer generellt förändrat vardagsbeteende behöver man ta med information om miljön och släktingars resultat när man skattar avelsvärden. BLUP (Best Linear Unbiased Prediction) är en metod för att skatta avelsvärden där den informationen tas med i skattningen. Metoden har använts framgångsrikt främst inom avel av lantbruksdjur men även hos hund. Rekommendationen från arbetet med den här avhandlingen är att använda BLUP och information från MH för att skatta avelsvärden för vardagsbeteenden för hundar. Framgången med arbetet beror sedan på hur rasklubbar och uppfödare hanterar informationen från en avelsvärdering.

7.2 Slutsatser i korthet

- Vardagsbeteendet påverkades av hundens ålder, kön och ras.
- Det var överlag låga nivåer av rädsla och aggressivitet i de aktuella raserna men det fanns stora skillnader mellan raser.
- Vardagsbeteendet hos en ras påverkades av om det var en bruksras eller inte.
- Bruksraserna var överlag mer intresserade av att leka med människor, lättare att träna och mindre rädda jämfört med övriga raser.
- De skattade arvbarheterna var låga till medelhöga för både vardagsbeteende och beteende mätt vid Mentalbeskrivning hund (MH).
- Den skattade genetiska korrelationen mellan vardagsbeteende och beteende vid MH var medel till hög för liknande beteenden.
- De skattade arvbarheterna för aggressivitet var överlag låga men aggressivitet mot okända människor och hundar i vardagen var genetiskt kopplat till MH egenskapen Socialitet som hade medelhög arvbarhet.
- Mentalbeskrivning hund skulle kunna vara ett effektivt verktyg för urval av avelsdjur med målet att minska rädslan hos långhårig collie.

References

Bennett, P.C., Cooper, N., Rohlf, V.I., Mornement, K., 2007. Factors influencing owner satisfaction with companion-dog-training facilities. Journal of Applied Animal Welfare Science 10, 217-241.

Bradshaw, J.W.S., Goodwin, D., Lea, A.M., Whitehead, S.L., 1996. A survey of the behavioural characteristics of pure-bred dogs in the United Kingdom. Veterinary Record 138, 465-468.

Bradshaw, J.W.S., Pullen, A.J., Rooney, N.J., 2015. Why do adult dogs 'play'? Behavioural processes 110, 82-87.

Casey, R., Loftus, B., Bolster, C., Richards, G., Blackwell, E., 2013. Inter-dog aggression in a UK owner survey: prevalence, co-occurrence in different contexts and risk factors. Veterinary Record: Journal of the British Veterinary Association 172.

Duffy, D.L., Hsu, Y.Y., Serpell, J.A., 2008. Breed differences in canine aggression. Applied Animal Behaviour Science 114, 441-460.

Eken Asp, H., Arvelius, P., Fikse, W.F., Nilsson, K. and Strandberg, E., 2014. Genetics of Aggression, Fear and Sociability in Everyday Life of Swedish Dogs, 10th World Congress of Genetics Applied to Livestock Production, American Society of Animal Science, Vancouver, Canada.

Goddard, M.E., Beilharz, R.G., 1985. A multivariate-analysis of the genetics of fearfulness in potential guide dogs. Behavior Genetics 15, 69-89.

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

Hedhammar, A., A. Egenvall, P. Olson, M. Sallander, U. Uddman, and B. Bonnett., 1999. Hund i Sverige. Svensk Veterinärtidning, 355-362.

Hsu, Y.Y., Serpell, J.A., 2003. Development and validation of a questionnaire for measuring behavior and temperament traits in pet dogs. Journal of the American Veterinary Medical Association 223, 1293-+.

Jones, A.C., Gosling, S.D., 2005. Temperament and personality in dogs (Canis familiaris): A review and evaluation of past research. Applied Animal Behaviour Science 95, 1-53.

Khoshnegah, J., Azizzadeh, M., Gharaie, A.M., 2011. Risk factors for the development of behavior problems in a population of Iranian domestic dogs: Results of a pilot survey. Applied Animal Behaviour Science 131, 123-130.

King, T., Marston, L.C., Bennett, P.C., 2012. Breeding dogs for beauty and behaviour: Why scientists need to do more to develop valid and reliable behaviour assessments for dogs kept as companions. Applied Animal Behaviour Science 137, 1-12.

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. Applied Animal Behaviour Science 82, 137-148.

Madsen, P., Jensen, J., 2012. A Package for Analysing Multivariate Mixed Models. Version 6 release 5.1 ed., Danish Institute of Agriculture and Science, Tjele, Denmark.

Norling, A.-Y., Keeling, L., 2010. Owning a Dog and Working: A Telephone Survey of Dog Owners and Employers in Sweden. Anthrozoos: A Multidisciplinary Journal of The Interactions of People & Animals 23, 157-171.

Notari, L., Goodwin, D., 2007. A survey of behavioural characteristics of pure-bred dogs in Italy. Applied Animal Behaviour Science 103, 118-130.

PAW, 2013. PDSA Animal Wellbeing (PAW) Report, The State of our Pet Nation.

RCoreTeam, 2013. R: A language and environment for statistical computing. , R Foundation for Statistical Computing, Vienna, Austria.

Saetre, P., Strandberg, E., Sundgren, P.E., Pettersson, U., Jazin, E., Bergstrom, T.F., 2006. The genetic contribution to canine personality. Genes Brain and Behavior 5, 240-248.

SAS, 2011. Statistical Analysis Systems Release 9.3 ed., SAS Institute Inc., Cary, NC, USA.

Serpell, J.A., Hsu, Y.Y., 2005. Effects of breed, sex, and neuter status on trainability in dogs. Anthrozoos 18, 196-207.

Sherman, B.L., Mills, D.S., 2008. Canine Anxieties and Phobias: An Update on Separation Anxiety and Noise Aversions. Veterinary Clinics of North America: Small Animal Practice 38, 1081-1106.

Strandberg, E., Jacobsson, J., Saetre, P., 2005. Livestock Production Science 93, 33-42.

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

Svartberg, K., 2005. A comparison of behaviour in test and in everyday life: evidence of three consistent boldness-related personality traits in dogs. Applied Animal Behaviour Science 91, 103-128.

Svartberg, K., 2006. Breed-typical behaviour in dogs - Historical remnants or recent constructs? Applied Animal Behaviour Science 96, 293-313.

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

van der Waaij, E.H., Wilsson, E., Strandberg, E., 2008. Genetic analysis of results of a Swedish behavior test on German Shepherd Dogs and Labrador Retrievers. Journal of Animal Science 86, 2853-2861.

Wells, D.L., Hepper, P.G., 2000. Prevalence of behaviour problems reported by owners of dogs purchased from an animal rescue shelter. Applied Animal Behaviour Science 69, 55-65.

Weng, H.-Y., Kass, P.H., Hart, L.A., Chomel, B.B., 2006. Risk factors for unsuccessful dog ownership: An epidemiologic study in Taiwan. Preventive Veterinary Medicine 77, 82-95.

Acknowledgements

The work in this thesis was performed at the Department of Animal Breeding and Genetics at the Swedish University of Agricultural Sciences. I gratefully acknowledge the financial support from the Swedish Kennel Club. I am also grateful to the Swedish Kennel Club for providing data. Thank you to all the dog owners that took the time to respond to the questionnaire.

There are many people who have supported me during the time I have been working with this thesis, and I would especially like to thank:

Erling Strandberg for having faith in me and giving me the opportunity to work with something I really loved! For all your valuable input in analysis, writing and all other aspects of the project. *Katja Nilsson* for providing an excellent introduction to the project and for all your support. *Freddy Fikse* for always taking time to look at errors in the analysis and for explaining the world of programing to someone that spent a large part of her life avoiding it ☺. I have really enjoyed working with all of you!

To all my colleagues at the department thank you for making this a stimulating place to work at. I have learnt a lot from many of you. Jörgen Sahlin for your way of always finding a solution to all of life's problems both small and large, I wish you all the best. Monica Jansson, Harriet Staffans, Helena Pettersson and Anniqua Melin for all your help with various administrative issues.

The *PhD student group* both the present and the ones that have already finished. I am grateful for all our discussions regarding both research and life. I wish you the best of luck in work and life! A special thank you to those of you that have supported me during some of the rough times: *Jennie, Lina, Sofia,*

Anne, Emelie, Tessan and Helena. *Per* for sharing your knowledge on dog training and always keeping your door open.

Till familj och vänner för stöttning, god mat, många diskussioner och härliga skratt. Rasmus och Kasper för att ni så tydligt visat hur både arv och miljö påverkar beteendet. Micke för att du alltid finns där för mig och stöttar mig i det jag gör – du är min klippa. Sebastian min lilla skatt!