Genetics of Aggression, Fear and Sociability in Everyday Life of Swedish Dogs

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ABSTRACT: Most potential dog owners are looking for a non-aggressive, non-fearful, social and easily trained dog that functions well in everyday life. Despite this, most studies of genetic components for behavior traits have mainly focused on analyzing results from behavior tests and not everyday behavior data. The aim of this study was to estimate genetic parameters for aggression, fear, sociability and trainability in everyday life by using a questionnaire to assess information of the dog's everyday behavior. The genetic analysis included 3128 records distributed over 14 breeds. The effect of breed, sex and age were adjusted for in the estimations of genetic parameters. The estimated heritabilities ranged between 0.08 and 0.38, with the highest heritability found for human-directed play interest. Positive genetic correlations were found between aggression and fear traits. Sociability traits showed a negative genetic correlation with both aggression and fear traits.
Keywords: Everyday behavior, Genetic parameters, Dog

Introduction

Most of the dogs today are not used for their original purpose but are mainly used as companion dogs (King et al. (2012)). Traits like aggression, fear, sociability and trainability in the dog are all important for the dog owner (King et al. (2009)). Fearfulness and aggression problems are common reasons for relinquishing a dog to a dog shelter (Wells and Hepper (2000); Diesel et al. (2008)). Previous studies based on questionnaire data have found significant breed differences for aggression, fear and trainability (Serpell and Hsu (2005); Duffy et al. (2008)).

The genetic component of dog behavior has previously been studied mainly by analyzing results from behavior tests, working trials etc. These studies have shown low to medium high heritabilities (Strandberg et al. (2005); Saetre et al. (2006); Meyer et al. (2012)). Svartberg (2005) showed that there are low but significant phenotypic associations between results in behavior tests and the owners perception of the dogs' everyday behavior. An acceptable everyday behavior is of great importance for many companion dog owners. Even though we may have some selection based on results of behavior tests and working trials, we believe that the everyday behavior is the breeding goal trait. In order to create well-functioning breeding programs for everyday behavior traits it is important to know the genetic parameters for these traits. The aim of this study was to estimate genetic parameters for aggression, fear, social and trainability traits using an online questionnaire for collection of data on everyday behavior traits.

Materials and Methods

Animals and pedigree information. Data from 14 dog breeds were included in the study (Table 1). The pedigree information received from the Swedish Kennel Club (SKC) included pedigree records, date of birth and sex of the dog. The dogs included in the study were born in the years 2000-2011 and were registered within SKC. Also dead dogs were included in the analysis, in total 132 dogs corresponding to 4% of the total records. The median age of the dogs included in the study was 4.6 years. There was an even distribution between sexes in the sample.

Table 1 Breeds included in the study and number of questionnaire answers (N) from each breed

Breed	N
American Staffordshire Terrier	156
Australian kelpie	183
Australian shepherd	293
Bernese Mountain dog	189
Boxer	121
Chihuahua	137
German Shepherd	353
Golden Retriever	361
Jack Russell Terrier	108
Lagotto Romagnolo	253
Nova Scotia Duck Tolling Retriever	257
Shetland Sheepdog	242
Rhodesian ridgeback	239
Rottweiler	236
Total	3128

DDAF: dog-directed aggression or fear; DDA: dog-directed aggression; DR: dog rivalry; SDA: stranger-directed aggression; ODA: owner-directed aggression; DDF: dog-directed fear; SDF: stranger-directed fear; NSF: non-social fear; DDI: dog-directed interest; SDI: stranger-directed interest; HDPI: human-directed play interest; TRAIN: trainability. All heritabilities estimated had SE that ranged between 0.04 and 0.06.

Questionnaire. The questionnaire used was based on a questionnaire previously used by Svartberg (2005). That questionnaire was based on the Canine Behavioral Assessment and Research Questionnaire (C-BARQ), described and validated by Hsu and Serpell (2003). An online version of the questionnaire was open for all dog owners. Information regarding the questionnaire was posted on the websites of SKC and the breed clubs. The respondent was asked to describe the dog's recent behavior in specific situations (118 questions). Each question had a 5 grade scale (0-4), indicating how often or how much the

dog shows a specific type of behavior. Responses to the questions were combined into behavior subscale scores (BSS) based on the average of 4 to 10 questions.

In total the questions combine into 17 BSS; for this study we focus on the 12 BSS related to the dogs' aggression, fear and sociability in different situations. The aggression BSS used were dog-directed aggression or fear (DDAF), dog-directed aggression (DDA), dog rivalry (DR), stranger-directed aggression (SDA) and owner-directed aggression (ODA). The fear BSS used were dog-directed fear (DDF), stranger-directed fear (SDF) and non-social fear (NSF). The sociability BSS used were dog-directed interest (DDI), stranger-directed interest (SDI), human-directed play interest (HDPI) and trainability (TRAIN). The BSS DDI, SDI and HDPI have previously been described by Svartberg (2005), DR has previously been described by Duffy et al. (2008), and the remaining 8 BSS were first described by Hsu and Serpell (2003).

Data editing and statistical analysis. The dataset included a total of 5841 records. After removing dogs from other breeds, with unknown registration numbers, duplicate responses and dogs born before 2000 or after 2011, 3128 records remained. The identification of individual dogs was done by matching the unique SKC registration number to the registration number given by the respondent.

Estimation of heritabilities and correlations between BSS was done using the DMU software (Madsen and Jensen (2010)). A preliminary study had shown that breed, sex and age had a significant effect on the BSS; therefore the following model was used:

$$Y = brd + sex + age(brd) + age(brd)^2 + a + e$$

Y is the BSS value for each individual, brd is the fixed effect of breed, sex is the fixed effect of sex (male/female), age(brd) and age(brd)^2 are the linear and quadratic regressions on age (months) within breed, a is the random genetic effect of individual (a~N(0,G⊗A) where G is the genetic variance-covariance matrix and A the numerator relationship matrix) and e is the random residual effect (e~N(0,R⊗I) where R is the residual variance-covariance matrix). The genetic correlations were estimated by pairwise analysis of all the BSS. The heritability of a BSS was calculated as the average of the 11 bivariate analyses where the BSS was included.

Results and Discussion

Heritabilities. The heritabilities ranged between 0.08 and 0.38 (Figure 1); SE for all estimates ranged between 0.04 and 0.06. These heritabilities are in line with previous studies for behavior traits based on behavior test data (Strandberg et al. (2005); Saetre et al. (2006); Meyer et al. (2012)), indicating that a questionnaire is a possible way to assess everyday behavior for genetic analysis. The highest heritability was found for human-directed play interest (0.38). This BSS consists of questions regarding how eagerly the dog plays with both familiar and unfamiliar people as well as the dog's interest in playing with objects. One of the reasons for the high heritability could be that these questions are straightforward and easy for the respondent to answer therefore limiting the measurement error in the data. The scale for the answer was from never to always which may give a more correct description of the behavior compared to other questions where the respondent was asked to describe how much of a behavior the dog is showing. The other sociability BSS also showed rather high heritabilities (0.20 and 0.26 respectively) and also consisted of questions regarding eagerness in different situations. Trainability had amongst the highest heritabilities (0.25) and had the same type of scoring as for the sociability BSS.

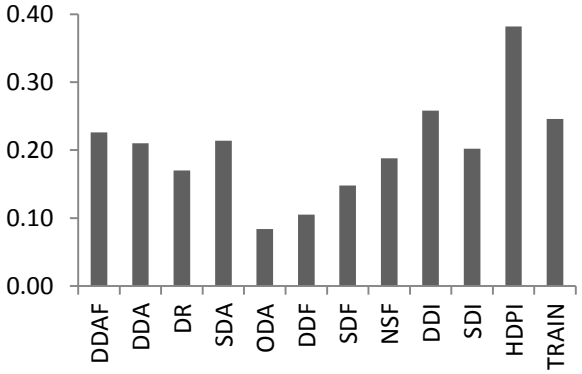

Figure 1. Heritability estimates for 12 behavior subscale scores for the 14 breeds.

The aggression and fear BSS generally had lower heritabilities (Figure 1). The lowest heritability was found for the BSS owner-directed aggression. One reason for this could be that aggression towards the owner or other family members is rarely expressed, as previously also found by Duffy et al. (2008). Another reason could be that the aggression traits are difficult to describe correctly. The questions included in the aggression BSS in this study are regarding how much aggression the dog shows in certain situations. Aggression traits measured at behavior tests have previously been found to have low heritabilities in the range 0.05-0.20 (Strandberg et al. (2005); Saetre et al. (2006); Meyer et al. (2012)), which could indicate a problem correctly describing the aggression trait. Another reason for the low heritability for owner-directed aggression may be as Duffy et al. (2008) mentioned that there has, most likely, been a selection against aggression towards family members for a long time.

Genetic correlations. The genetic correlations among aggression and fear BSS directed towards unfamiliar dogs and humans ranged from 0.22 to 0.96 (Table 2). As expected, a strong positive genetic correlation was found between DDAF and the sub BSS DDA and DDF. The behavior subscale scores DR, ODA, NSF, HDPI and TRAIN all had high SE in relation to the estimated genetic correlations and are therefore not included in Table 2.

The genetic correlation was much stronger between the two fear BSS across triggers (i.e., DDF vs SDF, 0.79) than between the two aggression BSS (DDA vs SDA, 0.43). The genetic correlations between aggression on one hand and fear on the other were stronger if relating to the same trigger (i.e., SDA vs SDF and DDA vs DDF). All these results indicate that there is a common genetic

component for aggression and fear but that also the trigger has some influence.

The sociability BSS were negatively correlated to both fear and aggression BSS (Table 2). The strongest negative genetic correlations were found between fear and sociability BSS. In a previous study by Svartberg (2005) stranger-directed interest and stranger-directed fear were both phenotypically associated to the two traits sociability and boldness measured in the Dog Mentality Assessment (DMA), a Swedish temperament test – stranger-directed interest was phenotypically positively associated whereas stranger-directed fear was negatively associated. Stranger-directed aggression was also negatively phenotypically associated to sociability as measured in the DMA (Svartberg (2005)), indicating a reversed relationship between fear/aggression and sociability traits, similar to what was found in our study.

Conclusion

Our study showed that there is a genetic component for aggression, fear and sociability traits seen in everyday life of dogs that can be captured by means of a questionnaire. The largest genetic components were found for the sociability behavior subscale scores (BSS) and especially for the BSS human-directed play interest. The aggression BSS were positively correlated to fear BSS whereas the sociability BSS were negatively correlated to both aggression and fear BSS.

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Table 2 Genetic correlations for 7 behavior subscale scores

	DDA	SDA	DDF	SDF	DDI	SDI
DDAF	0.96	0.38	0.87	0.57	-0.78	-0.50
DDA		0.43	0.68	0.44	-0.65	-0.45
SDA			0.22	0.53	-0.36	-0.65
DDF				0.79	-0.98	-0.61
SDF					-0.50	-0.93
DDI						0.51

DDAF: Dog-directed aggression or fear; DDA: dog-directed aggression; SDA: stranger-directed aggression; DDF: dog-directed fear; SDF: stranger-directed fear; DDI: dog-directed interest; SDI: stranger-directed interest.