



Sveriges lantbruksuniversitet  
Swedish University of Agricultural Sciences

Faculty of Veterinary Medicine and Animal Science

# Personality traits in competition dogs

– A quantitative genetic study on competition dogs



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Master's thesis • 30 credits  
Animal Science  
Uppsala 2019

# Personality traits in competition dogs – A quantitative genetic study on competition dogs

*Personlighet hos tävlingshundar – En kvantitativ genetisk studie på tävlingshundar*

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**Credits:** 30 credits

**Level:** Second cycle, A2E

**Course title:** Independent project in Animal Science

**Course code:** EX0870

**Programme/education:** Animal Science

**Course coordinating department:** Department of Animal Breeding and Genetics

**Place of publication:** Uppsala

**Year of publication:** 2019

**Online publication:** <https://stud.epsilon.slu.se>

**Cover photo:** Carla Schmeyer

**Keywords:** dog, personality, competition, heritability, dog mentality assessment, IPO, IGP, German shepherd, Belgian shepherd Malinois, Dutch Shepherd

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## Abstract

The purpose of this study was to investigate the relationship between performance and personality in three working dog breeds. The breeds that were chosen were the German Shepherd, the Belgian Shepherd Malinois and the Dutch Shepherd (Short haired). Pedigree data included pedigrees from 28536 dogs, out of those dogs 26 572 dogs also had personality test data and 1714 of those dogs had IPO results. The relationship between success in IPO and the five personality traits Playfulness, Curiosity/Fearlessness, Chase-proneness, Sociability and Aggressiveness was analysed using a linear model.

Questionnaire data from a modified C-BARQ about everyday behaviour was also collected for analysis. The relationship between fifteen personality and temperament traits from the C-BARQ and main activity and breed was also analysed using a GLM model.

The results showed a relationship between Playfulness and Curiosity/Fearlessness for success in IPO1 and between Playfulness and success in IPO 3. Heritabilities for the five personality traits were also estimated and ranged between 0.11-0.61. The results indicate that more studies are needed to find more factors that are involved and it needs to be investigated if Heritabilities of performance in competition can be estimated based on competition results.

## Preface

“Courage is probably the single most important characteristic of a Schutzhund dog.” - *Dietmar Schellenberg, Top Working Dogs*



# Table of contents

<b>List of tables</b>	<b>7</b>
<b>List of figures</b>	<b>8</b>
<b>Abbreviations</b>	<b>9</b>
<b>1 Introduction</b>	<b>10</b>
1.1 Working dogs	10
1.2 Dog behaviour	10
1.3 Competition records	11
1.3.1 Phase A - Tracking	11
1.3.2 Phase B - Obedience	12
1.3.3 Phase C – Protection	12
1.4 The Dog Mentality Assessment	13
1.4.1 The subtests	13
1.4.2 Calculations of personality trait score and boldness score	15
1.5 Questionnaire	15
1.6 Breeding for performance	16
<b>2 Material and methods</b>	<b>19</b>
2.1 Data and statistical analyses	19
2.2 Genetic analysis	20
<b>3 Results</b>	<b>22</b>
<b>4 Discussion</b>	<b>24</b>
<b>5 Conclusion</b>	<b>27</b>
<b>6 Appendix</b>	<b>28</b>
<b>7 Populärvetenskaplig artikel</b>	<b>32</b>
7.1 Beteende hos tävlingshundar	32
<b>References</b>	<b>34</b>
<b>Acknowledgements</b>	<b>37</b>







## List of tables

Table 1. Numbers of dogs in the different data sets.	19
Table 2. Heritability for the five different DMA personality traits by breed	23
Table 3. Variances estimated with DMU for the German Shepherd	30
Table 4. Variances estimated with DMU for the Belgian Malinois	30

## List of figures

Figure 1. Mean values for personality traits per breeds.	22
<i>Figure 2. Distribution of main activity for the dogs in the questionnaire</i>	23
<i>Figure 3. Distribution of dogs with results in IPO 1.</i>	28
<i>Figure 4. Boldness score for all dogs and for only dogs with IPO results</i>	29
Figure 5 Distribution of IPO 1 results by sex.	28
<i>Figure 6. Distribution of IPO 3 results by sex.</i>	<b>Error! Bookmark not defined.</b>

## Abbreviations

BLUP	Best linear unbiased prediction
C-BARQ	Canine Behaviour Assessment and Research Questionnaire
DMA	Dog Mentality Assessment
GLM	Generalized linear model
IPO	Internationale Prüfungs-Ordnung
SKC	Swedish Kennel Club
SWDA	Swedish Working Dog Association
SWB	Swedish Warmblood

# 1 Introduction

## 1.1 Working dogs

Dogs are one of the first animals to be domesticated for around 15 000 years ago (Wang et al. 2016) and has been under artificial selection for different types of dogs for at least 4000 years (Clutton-Brocks 1984). When thinking of dogs, we tend to think of them as being in the service of humans and we like to define them in breeds or breed groups that perform different tasks or jobs (Serpell et al 1995). Breeds are often used to define dogs by their common phenotype while breed groups are more often used to define a cluster of different breeds with a common purpose which they were originally bred for. Examples of different breed groups are gundogs, livestock dogs, hounds and herding dogs. Herding dogs are as the name says dogs that herds life stock (Serpell et al 1995). They do this by causing fear, flocking and flight behaviour among the livestock and using this to move the herd (Coppinger et al 1987). These dogs are also known as ‘chase and bite’ dogs and it was their ability to chase and bit that made herding dogs become popular breeds for the police and military (Serpell et al 1995). Today in Sweden working dog breeds are defined as the dog breeds that the Swedish Kennel club (SKC) has assigned the breeding responsibility for the breed to the Swedish working dog association (SWDA). Many of these breeds are originally herding dogs like the German, Belgian, and Dutch shepherd, but nowadays they are mainly used for police work, military work or for competitions in working dog trials.

## 1.2 Dog behaviour

Behaviour and especially unwanted behaviour in dogs has been of interests of owners and often even a problem for the owners. In modern time, scientists have begun

to evaluate the methods for measuring and evaluating dog behaviour. Ways of evaluating dog behaviour and performance include measures of working ability or competition records, standardized mentality assessments and owner questionnaires.

### 1.3 Competition records

One of the many sports that owners and their dogs can engage in is Internationale Prüfungs-Ordnung (IPO) trials organised by the SWDA. In the IPO trials one handler is competing with one dog. The dog's handler is to carry a leash with him for the duration of the trial. The leash can be worn around the handler or out of sight and the dog will have a collar on through the whole trial. The only collar allowed in the IPO trials is a standard choke chain, also known as a fur saver. If a fraud is in view of a spiked collar or the like, the judge will disqualify the handler from further testing due to unsportsmanlike conduct and all previous points are deleted. Before the dog is allowed to start IPO 1 they have to pass a BH test. This is a test to determine that the dog has basic obedience and are not overly aggressive or dangerous to have in the ring.

The IPO trials are done in three phases; phase A Tracking, phase B Obedience and phase C Protection. The dog and handler can earn a maximum of 300-points throughout the trial, 100-points in every phase. The dogs compete on three different difficulties where IPO 1 being the lowest and IPO 3 being the highest. The dogs have to be at least 18 months of age to start at the lowest level and 20 months of age to start at the highest level. For the dog and its handler to pass the IPO trial, they need to have at least 70% of the 100 points in each phase. Every dog gets an overall evaluation from the judge determined by their total score. There are 5 different evaluations the dog and handler can get on their performance. The different evaluations of the performance are Excellent, which is at least 96% of the total points, Very Good 95-90%, Good 89-80%, Satisfactory 79-70%, Insufficient under 70% (FCI 2012).

#### 1.3.1 Phase A - Tracking

In phase A, the dog's ability to follow a person-laid track is tested, here the dog tracks on a 10-meter-long lead or free with the owner following 10 meter behind the dog. The dog may wear a harness in addition to the choke collar or a vest. The length of the track goes from 300 paces minimum at the lowest level and up to 600 paces minimum at the highest level. The track also differs in turns and legs, it goes from minimum 2 turns and 3 legs at the lowest level and up to 4 turns and 5 legs at the highest level. In the track, the track layer will also drop objects in wood, rubber, or

leather for the dog to find. The dog's score in this phase are based on the dog's ability to track intensively with endurance, when possible at an even speed and numbers of objects found (FCI 2012)

### 1.3.2 Phase B - Obedience

In obedience, the dog's ability to react to the handler's signals willingly and accurately are tested. The Obedience phase are a sequence of subtests that are done off leash. For IPO 1 the subtests are Off-Leash heeling, Sit in motion, Down with recall, Stand while walking, Retrieve on the flat, Retrieve over the hurdle, Retrieve over the scaling wall and finally Down under distraction. For IPO 2 and IPO3 they are Off-Leash heeling, Sit in motion, Down with recall, Stand while walking, Retrieve on the flat, Retrieve over the hurdle, Retrieve over the scaling wall, Send out with down, and Down under distraction. There are always two dogs with their handlers in the ring at the same time. One dog is doing, Down under distraction while the other dog is doing the rest of the obedience program then they switch. The dogs score in each subtest is based on the dog's responsiveness to the handler's signals, as well as the dog's overall excitement, speed, and accuracy of the performance (FCI 2012).

### 1.3.3 Phase C – Protection

In phase C, the dog's ability to protect its handler is tested. The protection phase consists of a sequence of subtests in which one person, who is called the helper are being a threat to the handler. The subtests are for IPO1: Search for the helper, Bark and hold, Prevention of an attempted helper escape, Defence of an attack in the guarding phase and Attack on the dog out of motion. For IPO2: Search for the helper, Bark, and Hold, Preventing an escape by the helper, Defence of an attack in motion, Back transport, Attack on the dog out of the back transport and Attack on the dog in movement. For IPO3: Search for the helper, Bark & Hold, Prevent an escape of the helper, Defence of an attack in the guarding phase, Back transport Attack on the dog out of the back transport, Attack on the dog in motion and Defence of an attack in the guarding phase. During the protection phase, the dog is supposed to find, hold and bite the helper when needed and shall let go only on handler command. The dog's score is based on the dog's ability to effectively ward of a potential threat, the dog's responsiveness to owner's commands and the quality of the bite (FCI 2012).

## 1.4 The Dog Mentality Assessment

The dog mentality assessment (DMA) is a standardized behavioural test conducted by SWDA. All dogs from a breed SWDA has the breeding responsibility for are required to do the DMA before they are allowed to compete, be in service or breed in Sweden. No dog under the age of 12 months is allowed to do the DMA (SWDA 2018a). All the dogs in this study were between 12-18 months of age when they did the DMA. The DMA can be seen as a type of personality test for dogs and it is used by the SWDA as a breeding tool for working dogs (Fält 1997, Svartberg 2002). The behavioural scoring is made by a so called a describer. All describers have had at least 125 hours of theoretical training and years of practical experience with the DMA. The descriptor uses a score sheet to describe the dog. The dog's behaviour is scored from 1 to 5 accordingly to the intensity of the behaviour. A low score means low intensity of the dog for that behaviour. During each test one to four behavioural reactions are recorded.

The dog is accompanied by its handler and a test leader that gives strict instructions to the handler how to act and on what to do. The test leader also interacts with the dog in some of the subtests.

### 1.4.1 The subtests

#### *Social contact*

Tests the dog's approach to strangers and if the dog is allowing itself to be handled by a stranger. Here the dog is allowed to approach the test leader with the handler. First the handler greets the test leader and the dog is allowed to take contact. The test leader then takes the dogs from the handler, walks away and back and then tries to do some basic handling, feeling through the dog not unlike a basic veterinarian check. The dog is described on a scale from allowing the stranger to intense greeting and interacts with the stranger.

#### *Play*

Tests the dog's desire to engage in play with a human. The dog is introduced to a tug toy that is thrown between the handler and the test leader. The dog is then allowed to run and catch it. The dog is in the next part allowed to run, grip and play tug-of-war with the test leader. The dog's interest in the toy, play, the intensity of the grip and also interest in playing tug-of-war is described.

### *Chase*

Tests the dog's interest to follow an object in motion. The dog is introduced to an object that moves away from the dog. The dog's willingness to pursue the object, how fast it starts and what it does when the object stops are described.

### *Activity*

Tests the dog's ability to change from being active to being passive. The dog's handler becomes passive and stand still on a spot for a three minutes with the dog on the leash. The dog's activity level during this time is described

### *Distance play*

Tests the dog's curiosity in a person in the distance and for its willingness to run out and play. An unknown person first appears in the distance wearing a rain coat and moves unnaturally, after a while the person pulls out a toy and plays a little before the person runs and hides. The handler lets the dog go and find the person and the person plays with the dog, then becomes passive and then active again. The dog's curiosity for the person, threatening behaviour, its willingness to leave the handler to locate the person and to engage in play both when the person is active and passive is described.

### *Sudden appearances*

Testes the dog's reaction when a human-like dummy suddenly is pulled up in close proximity in front of the dog. The dog's startle reaction, avoidance and curiosity to investigate is described.

### *Metallic sound*

Tests the dog's reaction to metallic noise in close proximity to the dog. The noise is made by large link chains that are dragged over corrugated metal as the dog walks by. The dogs startle reaction, avoidance and curiosity to investigate is described.

### *Ghosts*

Tests the dog's reaction to two people covered in white sheets that are moving slowly towards the dog from opposite directions. The dog's avoidance reaction, control behaviour, approach behaviour and aggressiveness are described.

### *Play 2*

Tests the dog's desire to play again in the exact same way as before. The dog's interest in the toy, play, the intensity of the grip and also interest in playing tug-of-war is described.



### *Gunshot*

Tests the dog's reaction to gunshots both in passivity and in play. The dog's avoidance and anxiety are described.

#### 1.4.2 Calculations of personality trait score and boldness score

Svartberg and Forkman (2002) performed a factor analysis on 22 of the 33 items rating in the DMA results and found 5 personality traits that were labelled Playfulness, Curiosity/Fearlessness, Chase-proneness, Sociability and Aggressiveness (fig.1). The Swedish kennel club are publishing these 5 personality trait for all dogs that have completed the DMA in their dog registry that is available to everyone using SKCs breeding tool Avelsdata (<https://hundar.skk.se/avelldata/Initial.aspx>). The dogs score (1-5) on each variable was standardized and each variable with a standardized value was summed up to creating the factor scores for the personality traits. The boldness score was calculated from four of the five personality traits, Playfulness, Curiosity/Fearlessness, Chase-proneness and Sociability (Svartberg and Forkman 2002, Svartberg 2002).

## 1.5 Questionnaire

At the university of Pennsylvania, Hsu and Serpell (2003) developed and validated a questionnaire that measured behaviour and temperament traits in domestic dogs. Their hope was that this questionnaire could be used by veterinarians, behaviour specialist and scientists for describing and classifying dog behaviour (Hsu & Serpell 2003). This standardized questionnaire is called the Canine Behaviour Assessment and Research Questionnaire (C-BARQ)

The C-BARQ has been standardized and validated by Hsu and Serpell (2003). The original C-BARQ contains 118 questions that have been translated to Swedish (Svartberg 2005), it has been modified with adding questions regarding playfulness, sociability (Svartberg 2005), fearlessness, curiosity (Arvelius 2013) and respondent (Eken Ask 2015) and an additional 29 questions were added, including information about the respondent, information about the dog and information about competition and purpose of getting the dog was added for this study. In total the questionnaire contained 162 questions.

The C-BARQ results were translated into fifteen personality and temperament traits: Stranger-directed aggression, owner-directed aggression, stranger-directed fear, Non-social fear, Dog-directed fear or aggression, Separation-related behaviours, Attachment or Attention seeking behaviours, Trainability, Chasing, Excitability, Pains sensitivity (Hsu & Serpell 2003), Familiar dog aggression, Energy (Duffy and Serpell 2012), Stranger-directed interest, Human-directed play interest and Dog-directed interest (Svartberg 2005).

Using the C-BARQ, breed differences in everyday behaviour was described (Eken Asp et al. 2015). Variances within breeds and between breeds were found also for the SWDA breeds, the working dog breeds scored higher than the non-working breeds in human-directed play interested, trainability, energy and excitability (Eken Asp et al. 2015). Working dog breeds also seemed to show more dog-directed aggression but less stranger-directed fear and non-social fear (Eken Asp et al. 2015).

Svartberg (2006) also investigated the breed differences using SWDA's Dog mentality assessment (DMA) instead of the C-BARQ and based the breed groups on their original use. So instead of working and non-working dogs he divided them into herding dogs, working dogs, terriers and gundogs. No clear differences were found between the historic breed groups but there were significant differences between breeds for specific traits even though variance within the breed was also found. A positive correlation was found between Playfulness and Aggressiveness in sires that were used in working-dog trials and dog breeds for show tended to have more fears and be less playful (Svartberg 2006).

## 1.6 Breeding for performance

There has been some research on dog behaviour, but studies on how behaviour factors in on performance are scarce.

Over the last decade the dog has become more common as a pet than as a working mate. Dogs are still used for police, military, search and rescue and assistance work, but most of the dogs are today mostly pets, even though some are also working dogs or sport dogs. Most sports dogs are athletes, they and their handler are training hard for competitions in agility, obedience, lure coursing, fly ball and IPO, just to name a few sports. In dog racing sports, for example, the dog is working alone during the race so the handler is not a factor in the competition, but in most dog sports the handler and the dog works as a team. If you change the handler most dogs do not work as well and some do not work at all with the new handler (Jamieson et al 2018). The impact the handler has on performance was also a factor when looking at correlations between the dog's personality and performance in the

Swedish working dog trials (Svartberg 2002). In this study Svartberg (2002) found variation in the distribution of performance based on owner experience and also a correlation between dog personality and owner experience. Only the unexperienced owners where the distribution was even could therefore be used in the study (Svartberg 2002). Dogs with a higher boldness score in DMA were more successful at the Swedish working dog trials (Svartberg 2002). In all competitions and trials there are another factor to be accounted for if the results should be used as an evaluation for breeding and that is the judges. A good judging protocol can help minimize the difference between judges (Arvelius et al 2013). When judging on a scale where the behaviours is specified, for example with measurements on how far away is the dog is, it is easier for the judge to stay objective in their evaluation of the dog (Arvelius et al 2013). Also having more than one judge can be beneficial to get more accurate breeding values from trials (Arvelius & Klemetsdal 2013). The SKC has estimated breeding values for hip and elbow dysplasia (SKC 2014) and the Collie breeds has estimated breeding values for the DMA as well (SWDA Collie 2018) but none of the breeds within SWDA has breeding values or breeding programs for performance.

The Swedish warmblood horses (SWB) has a breeding program for multipurpose performance. The SWB is bred for competitions in both show jumping and dressage. Since 1986 a Best Linear Unbiased Prediction model (BLUP) has been used to estimate breeding values for SWB horses (Arnasson 1987). In the beginning the breeding values were only based on a Riding horse quality test (RHQT) for 4-year-old horses but later a new multi-trait animal model was introduced, which include not only data from young horse performance test (3-year-old test and RHQT) but also competition result (SWB-breeding plan 2016).

Viklund et al. (2010) found that males are more successful in dressage but also in show jumping. The heritability was higher for show jumping then for dressage, meaning that it is probably easier to breed for good performance in show jumping. A correlation between gait traits judge under rider and success in dressage competitions and for conformation and dressage performance where found. There was also a correlation between the RHQT gait trait canter and success in show jumping competition and also between conformation and show jumping performance (Viklund 2010). The higher heritability for show jumping also gives a higher accuracy, resulting in almost twice as high improvement rate as for dressage (Viklund 2011).

Another horse breed that is bred for dual purposes is the Icelandic horse. They are bred to perform well not in only three gaits like most horses but in four or five gaits in competitions as well as being a brave, weight bearing and rideable horse for the whole family (Sif 2017). The Icelandic horses also uses BLUP for breeding evaluation and for performance there is a breeding field test, where horses are judged not only on performance but also on temperament (Sifavel 2014). Spirit is

the temperament trait that has 9 % weight (Sifavel 2014) in the breeding program, the assessment of spirit is based on apparent willingness and temperament under the riding part of the ability assessment (Sigurðardottir et al. 2017). Most genetic correlations between spirit and other traits from the breeding field test were positive, although correlation with nerve strength and rein contact showed low negative values (Sigurðardottir et al. 2017). This would indicate that horses with higher spirit are more sensitive and has more flight behaviours than horses with lower spirit (Sigurðardottir et al.2017). The same trend can be seen in warmblood riding horses where horses successful in dressage tends to be to be more sensitive and have stronger fear reactions than horses used in show jumping (von Borstel et al, 2010).

The purpose of this study is to investigate the relationship between performance and personality in three working dog breeds.

## 2 Material and methods

### 2.1 Data and statistical analyses

For this study three different breeds were chosen, the German Shepherd dog (GSD), the Belgian Shepherd Malinois (Malinois) and the short haired Dutch Shepherd Dog (DSD). They were chosen since they are commonly used in international working dog trials and they have a common ancestry.

Pedigree data, IPO results and DMA data were obtained from the Swedish kennel club and analysed using Statistical Analysing Software, SAS 9.4 (SAS institute 2019). The pedigree data included pedigrees from 677 Dutch shepherds, 4122 Malinois and 223572 German Shepherds, out of these dogs 343 Dutch shepherds, 2411 Malinois and 23737 German Shepherd also had DMA data (Table 1).

Table 1. *Numbers of dogs in the different data sets.*

Breed	No. of dogs with Pedigree	No. of dogs with DMA data	No. of dogs with IPO1 data	No. of dogs with IPO3 data	No. of Questionnaire replies
German Shepherd dog	223572	23737	1204	713	54
Belgian Shepherd Malinois	4122	2411	199	310	30
Dutch Shepherd	677	343	55	52	39

A total of 59 Dutch Shepherds, 203 Malinois and 1452 German Shepherds had both pedigree data, DMA data and IPO results. The five personality traits identified in previous studies by using factor analysis of 22 of 33 DMA items (Svartberg and Forkman 2002) was used. Four of five personality traits was then used to calculate boldness score (Svartberg 2005).

A mean value per dog for the IPO results at each level was calculated, the mean value for the IPO results was used as a success variable for IPO. The higher the score the more successful is the dog. The interactions between each DMA personality traits and success in IPO 1 and success in IPO3 was tested using a linear model. Interactions between Boldness and success in IPO 3 were also tested using Proc GLM:

GLM model: Mean IPO result = sex + judge + personality trait + e

To evaluate everyday behaviour there are a few questionnaires available. In this study the C-BARQ was used because it has been validated and used in previous studies (Svartberg 2005, Arvelius et al. 2013, Eken asp et al. 2015). The dog owner questionnaire was available for only 7 months and distributed through social media and on the website of the Swedish breeding club for Dutch Shepherd. A total of 216 responses were collected. The questionnaire used was a modified C-BARQ. There were two scales used in the questionnaire, both were 5 step scales but one is on who often a dog performs a behaviour and the other is on the intensity, how much the dog performed the behaviour. The date when the questionnaire was answered was generated by the online system at Netigate ([www.netigate.se/](http://www.netigate.se/)), Netigate also stored all the answers from the online questionnaire.

The questionnaire data had to be edited since some had not identified their dog in the questionnaire so the existence of the dog and breed could not be verified. Also some dogs had more than one answer, then the answerers were the questionnaire was completed was kept. If there still was more than one questionnaire per dog the most recent answer for the dog was kept. Total 109 responses remained. The questionnaire data was analysed using Proc GLM:

personality/temperament trait = sex + main activity + breed + e

The relation between the main use for the dog, according to the owner, and the fifteen personality and temperament traits were also analysed. The significance level for this study was set to be  $\alpha=0.05$ .

## 2.2 Genetic analysis

Heritability for the personality traits from the DMA was calculated using DMUv6.

The model was chosen based on previous models (Strandberg et al. 2005 Arvelius et al 2014). Sex, age, test year and test month was put into the model as fix effects and litter, occasion, judge, the additive genetic effect of the individual and the residual was put in as random effects. Age at testing as a linear and quadratic regression was included as a random effect (Arvelius et al. 2014). Following model was used when analysing:

$$y_{ijklmnop} = \mu + \text{sex} + \text{test year} + \text{test month} + \text{test age} + \text{test age}^2 + \text{litter} + \text{judge} + \text{occasion} + a + e_{ijklmnop}$$

where  $y_{ijklmnop}$  is the score for the behaviour traits Sociability, Curiosity/Fearlessness, Playfulness, Chase-proneness, Aggressiveness.

$\mu$  is the overall average value

sex is the fixed effect of the dog's sex (male, female)

test year is the fixed effect of the year the dog was tested in (1997, ..., 2018)

test month is the fixed effect of the month the dog was tested in (jan, ..., dec)

test age and  $\text{test age}^2$  is the linear and quadratic regression of the animal age at DMA test (in days)

litter is the random effect of the litter the animal was born in,  $m \sim \text{ND}(0, \sigma^2_l)$  where  $\sigma^2_l$  is the litter variance,

judge is the random effect of test judge  $n \sim \text{ND}(0, \sigma^2_j)$  where  $\sigma^2_j$  is the judge variance, occasion is the random effect of test occasion  $o \sim \text{ND}(0, \sigma^2_o)$   $\sigma^2_o$  is the variance of occasion, a is the random effect of the animal  $p \sim \text{ND}(0, \mathbf{A}\sigma^2_A)$  in which  $\mathbf{A}$  is the additive relationship matrix and  $\sigma^2_A$  is the additive variance and  $e_{ijklmnop}$  is the random residual effect related to the observations of  $y_{ijklmnop} \sim \text{ND}(0, \sigma^2_E)$  in which  $\sigma^2_E$  is the variance of the residual. Heritability was defined  $h^2 = \sigma^2_A / (\sigma^2_A + \sigma^2_E)$ .

### 3 Results

There were significant values for interaction between Playfulness and success in IPO3 for the German Shepherd but no significant values for the Malinois or the Dutch Shepherd. For the German Shepherd there was a significant relation between IPO 1 success on the one hand and Playfulness and Curiosity/Fearlessness on the other hand.

The distribution for competition results was found to be uneven, not normal distribution (see appendix fig 3). The distribution of boldness score was also uneven since most dogs had 3 or more and almost all dogs that had any result in IPO had a boldness score over 3 (see appendix fig 4, fig 5). There was no significant effect of sex on success in either IPO 1 or IPO 3, although males tended to have higher mean result than females (see appendix fig 6, fig 7). There was no significant difference for the DMA personality traits between breeds, nor was there any difference between the mean for the breed as a whole and the mean for the dogs with IPO results.

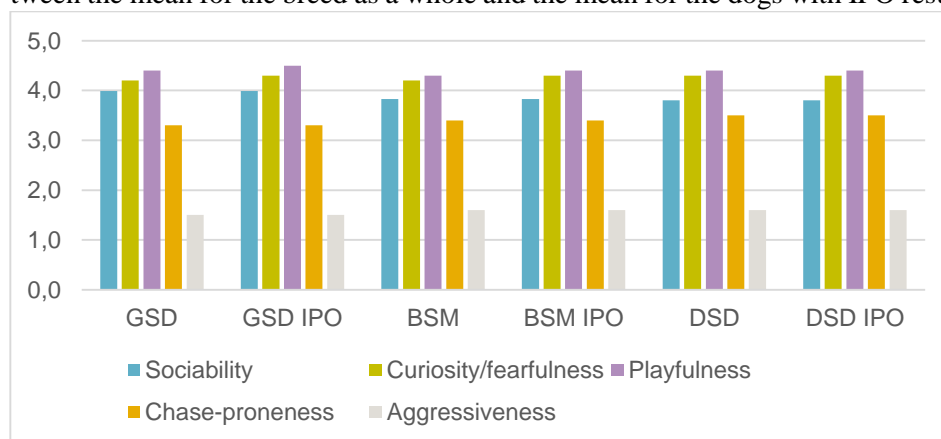


Figure 1. Mean values for personality traits per breeds. (GDS = German Shepherd GSD IPO = German Shepherd with IPO results, BSM = Belgian Shepherd Malinois, BSM IPO = Belgian Shepherd Malinois with IPO results, DSD = Dutch Shepherds, DSD IPO = Dutch Shepherds with IPO results)



For the C-BARQ questionnaire the distribution of breeds was found to be 54 German Shepherd, 30 Malinois and 39 Dutch Shepherd and the distribution of main activity was also found to be uneven (fig. 2). When analysing the questionnaire here were no significant different between the fifteen personality traits and the main activity or the breed.

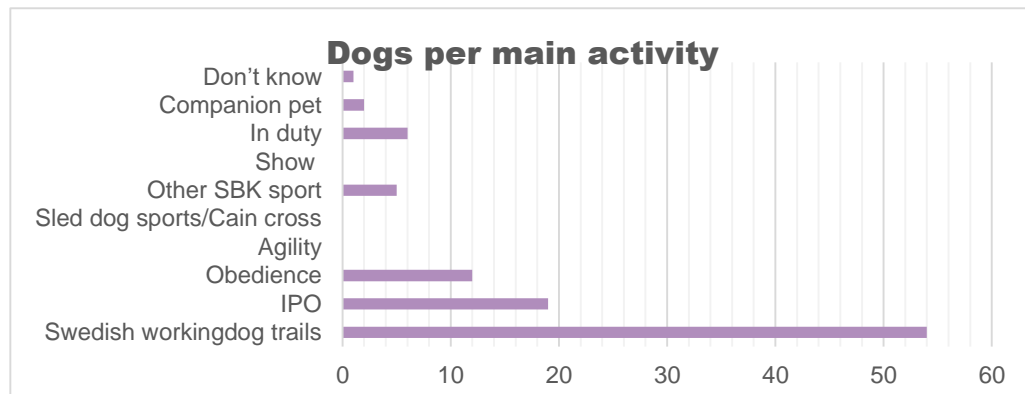


Figure 2. Distribution of main activity for the dogs in the questionnaire

The estimated variances from DMU (see appendix tab 3, tab 4) was used to estimate heritabilities for the 5 personality traits varied between 0.11-0.30 for German Shepherd and 0.13-0.61 for Malinois (tab. 3). Heritabilities for Dutch Shepherd could not be calculated because the low number of individuals.

Table 2. Heritability for the five different DMA personality traits by breed

Breed	Sociability	Curiosity /Fearlessness	Playfulness	Chase-proneness	Aggressiveness
German Shepherd	0.14	0.26	0.34	0.12	0.14
Malinois	0.22	0.14	0.63	0.13	0.17

## 4 Discussion

The results in this study showed that there is a correlation between DMA trait Playfulness and success in the IPO trials for German Shepherd. There also seem to be a correlation between success in IPO 1 and the DMA trait Curiosity/Fearlessness for the German Shepherd. It is possible that a similar correlation could be found in the other breeds if the number of dogs with IPO results would had been as high as for the German Shepherd. One explanation for why Curiosity/Fearlessness has a correlation with success in IPO1 and not in IPO 3 could be that a selection is happening on a threshold value of Curiosity/Fearlessness and all dogs that moves up to IPO 3 have a value beyond that threshold. There does not seem to be a similar relationship between IPO trial results and boldness as that found by Svartberg (2002) between the Swedish working dog trials and boldness score. This could be because in this study the owners could not be categorized by experience and therefore the data was uneven, almost all the dogs in the three breeds has a boldness score of three or higher and almost all dogs that are competing in IPO has a boldness score of four or higher. It would however be interesting if this was studied in the further.

When it comes to the everyday behaviours that were investigated with the questionnaire no significant results were found, but the variation between the different main activities for the dog was very low and therefore the majority of the dogs where sports dogs or Police/security dogs. If there were more respondents and bigger variation in main activity, for example if more owners of pets or show-dogs would have participated there would probably have been a bigger variation since previous studies (Svartberg 2006, Eken Ask 2014) found variation within breeds and maybe even a significant different between main activity. If this would be done again maybe one should include more working breeds and ask the SKC for help to distribute the questionnaire.

Investigating the relationship between personality and performance in IPO suggested some traits from the DMA might be important such as Playfulness. It might be that Playfulness plays an important part in motivating the dog in training. Dogs with a big interest for toys and play might also be easier to reward and are also more

likely to enjoy the protection training where they get to chase and bite. If, however the breeding goal is to breed for performance in dog sport, a BLUP model with multiple traits like the one in SWB horses (SWB-breeding plan 2016) would be preferred, given that performance sports have a heritability in dogs like the one in horses (Viklund 2011). Further studies to confirm heritability in performance at competition will be needed. When using a BLUP model different weights of importance can be put on the different breeding objectives and this way performance factors like competition results can be factored in as well as mentality factors and different health factors. Since IPO is an international sport, the FCI could maybe have a worldwide competition index. This could be helpful for breeders worldwide when looking to breed for IPO and also for Swedish breeders looking to import dogs. The DMA is unfortunately only available in Sweden so basing selection only on DMA traits are only possible if you only use dogs registered in the SKC for breeding. Also according to the results its only Playfulness and Curiosity/Fearlessness that seems to be important for success in this sport. There is probably some other personality or temperament factors that are important for success in IPO but these are not caught by the DMA. However, the DMA has very high heritability and is valuable breeding tool for mentality in dogs. Previous studies estimated heritabilities for 4 of 5 personality traits in the DMA for German Shepherds to be between 0.09-0.26 (Strandberg et al. 2006) and for Collies the heritability for the 5 personal trait was estimated to be between 0.13-0.25 (Arvelius et al. 2014). The heritabilities in this study was similar to the ones found in previous studies. The Malinois had a very high, almost twice as high heritability for Playfulness (0.61) as the German shepherd (0.32). One explanation is that the heritability is most likely an overestimate and the true value is more close to the ones previously estimated in other breeds.

Basing selection only on competition results might result in mentality issues like the ones with Fearlessness in dogs selected mainly on show results (Svartberg 2006, Arvelius 2014), the ones with spirit and nerve straight and rein contact in Icelandic horses (Sigurðardóttir et al.2017) or strong fear reactions in dressage horses (von Borstel et al, 2010). Because of the correlation found between Playfulness and Aggressiveness in sires that were used in workingdog trials (Svartberg 2006) selection on only competition results will probably result in higher Playfulness which might cause problem with Aggressiveness if this are not taken into consideration.

If dog sport competition results in the future is going to be a part of the breeding evaluation, studies on the judging protocols will also be needed. Trying to standardize the judging by developing good protocols with scales and having more than one judge per competition would probably result in a lower environmental effect and results in higher accuracy and a higher estimate for the heritability of performance as shown in previous studies (Arvelius 2013, Arvelius & Klemetsdal 2013). Another

factor that would be interesting to investigate in future studies is if there are any relationship between conformation and performance like the ones found for horses (Viklund 2010). A protocol for judging conformation would be developed by the FCI and used to register phenotype judging. In Sweden there is a phenotypic evaluation for all working dog breeds as a part of a breeding validation called korning (SWDA 2018b). Maybe this phenotypic evaluation could be used to study the relationship between conformation and performance.

## 5 Conclusion

The study found a relationship between Playfulness and Curiosity/Fearlessness and success in IPO1 and between Playfulness and success in IPO 3. However, more studies are needed to find more factors that are involved and it needs to be investigated if heritabilities on performance in competition can be estimated based of competition results.

## 6 Appendix

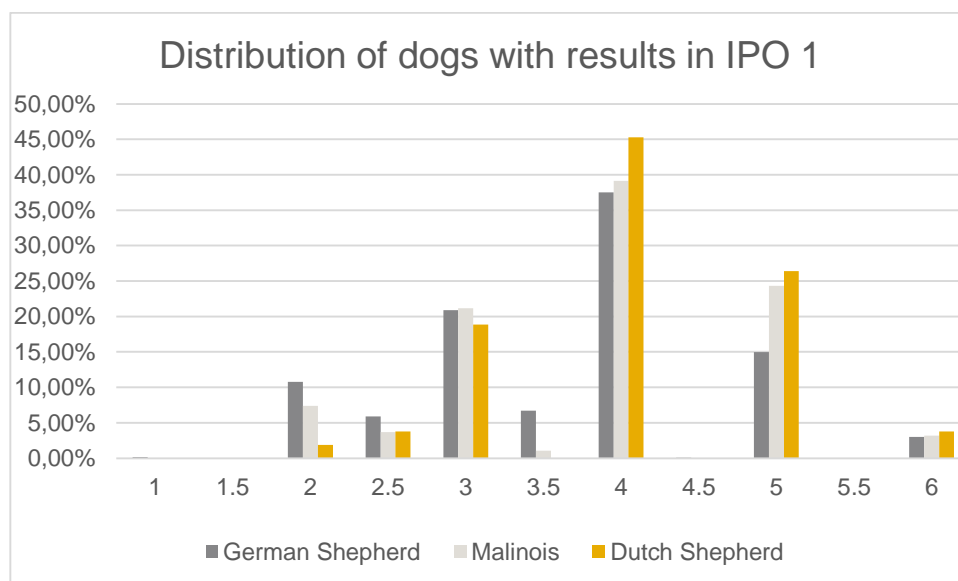


Figure 3. Distribution of dogs with results in IPO 1. Y-axis shows percent of the total population of the breed.

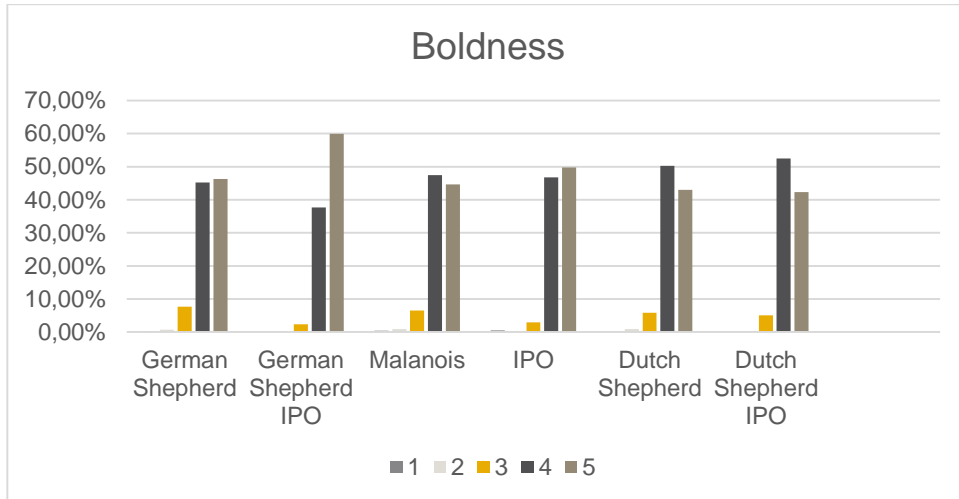


Figure 4. Boldness score for all dogs and for only dogs with IPO results.

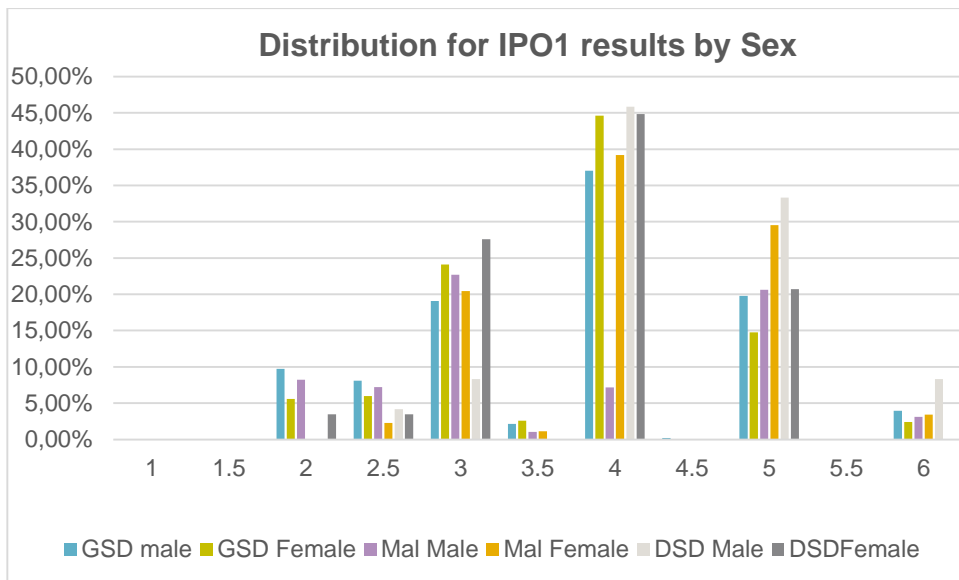


Figure 5. Distribution of IPO 1 results by sex (GSD= German Shepherd, Mal=Malinois and DSD=Dutch Shepherd).

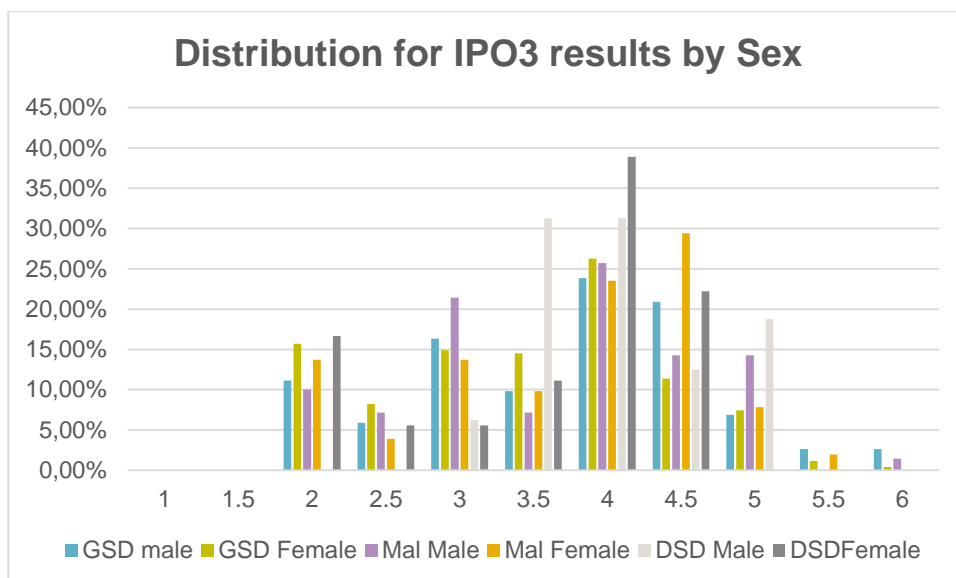


Figure 6. Distribution of IPO3 results by sex (GSD= German Shepherd, Mal=Malinois and DSD=Dutch Shepherd).

Table 3. Variances estimated with DMU for the German Shepherd

Personality trait	$\sigma^2_L$	$\sigma^2_O$	$\sigma^2_J$	$\sigma^2_A$	$\sigma^2_E$
Sociability	0.0258	0.0012	0.0468	0.0688	0.4272
Curiosity /Fearlessness	0.0150	0.0002	0.0152	0.0762	0.2216
Playfulness	0.0342	0.0007	0.0339	0.1753	0.3371
Chase prone-ness	0.0514	0.0023	0.0146	0.0741	0.5232
Aggressive-ness	0.0166	0.0009	0.0235	0.0619	0.3705

Table 4. Variances estimated with DMU for the Belgian Malinois

Personality trait	$\sigma^2_L$	$\sigma^2_O$	$\sigma^2_J$	$\sigma^2_A$	$\sigma^2_E$
Sociability	0.0037	0.0000002	0.0342	0.1254	0.4474
Curiosity /Fearlessness	0.0129	0.0040	0.0106	0.0601	0.2353
Playfulness	0.0188	0.0000002	0.0587	0.3158	0.1814
Chase prone-ness	0.0151	0.0029	0.0295	0.0833	0.5589



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Personality trait	$\sigma^2_L$	$\sigma^2_O$	$\sigma^2_J$	$\sigma^2_A$	$\sigma^2_E$
Aggressive-ness	0.0242	0.0000004	0.0226	0.0724	0.3648

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## 7 Populärvetenskaplig artikel

### 7.1 Beteende hos tävlingshundar

Det har gjorts många studier på beteende hos hund, men väldigt få studier på hur beteende hos hundar påverkar prestation på tävling. Svartberg and Forkman (2002) fann att man kan definiera fem personlighetsdrag hos hundar, baserade på beteendebeskrivningen Mentalbeskrivning hund (MH). Dessa personlighetsdrag är; Socialitet, Lekfullhet, Jaktintresse, Nyfikenhet/Orädsla och Aggressivitet. Svartberg and Forkman (2002) fann vidare att de fyra första personlighetsdragen är korrelerade med varandra och utgör ett mer övergripande personlighetsdrag som de kallade framåtanda (boldness). Svartberg (2002) fann att hundar med mer framåtanda presterade bättre på brukshundsprovet än hundar med mindre framåtanda. I den här studien ville jag undersöka om beteende på MH också har ett samband med framgång i tävlingsformen Internationale Prüfungs-Ordnung (IPO). IPO-prov (sen 2019 IGP-prov) är en sport där hundarna tävlar i tre discipliner, spår, lydnad och skydd. IPO tävlas på tre olika nivåer där IPO1 är den lägsta och IPO3 är den högsta.

För att undersöka detta användes resultat från MH och IPO för raserna tysk schäfer, belgisk vallhund, malinois och holländsk herdehund (kort hår). Dessa raser valdes då de har gemensamt ursprung och tävlas i IPO. I IPO ges hunden ett betyg på en femgradig skala, från utmärkt (5) till bristfällig (1). Ett medelbetyg för varje hund räknades ut och korrelerades med personlighetsegenskaperna från MH-beskrivningen.

Den här studien fann inte samma samband mellan tävlingsprestation och framåtanda i MH som Svartberg (2002) såg i sin studie. En av anledningarna till detta kan vara att Svartberg (2002) bara tittade på förstagångsägare. En annan anledning kan vara att de flesta hundarna i de undersökta raserna hade mycket i framåtanda, och i synnerhet de som startat i IPO (se appendix figure 4). Jag fann ett samband mellan

Nyfikenhet/Orädsla och Lekfullhet i MH och medelbetyg i IPO1, och mellan Lekfullhet i MH och framgångar i IPO 3. En av anledningarna till att Nyfikenhet/Orädsla kan vara viktigt för bra resultat i IPO1 och inte i IPO3 kan vara för att de är bara de hundarna med en viss Nyfikenhet /Orädsla som går vidare upp till IPO 3. Man kan tänka sig att lekfullhet är viktigt för att lekfulla hundar är mer lätränade.

## References

- Arvelius, Malm, Svartberg & Strandberg. 2013. Measuring herding behaviour in Border Collie – effect of protocol structure on usefulness for selection. *Journal of veterinary Behavior* 8. 9-18.
- Arvelius & Klemetsdal. 2013. How breeders can substantially increase the genetic gain for English Setter's hunting traits. *J. Anim. Breed and genet.* 130. 142-153.
- Arvelius, Eken Asp, Fiske, Strandberg & Nilsson. 2014 Genetic analysis of temperament test as a tool to select against everyday life fearlessness in Rough Collie. *Journal of Animal Science*. Vol 92, 11, 4843-4855.
- Coppinger et al. 1987. Degree of behavioural neoteny differentiates canid polymorphs. Serpell, Coppinger Schneider 1995 *The domestic Dog - its evolution, behavior and interactions with people*. Cambridge university press. 11<sup>th</sup> print. pp21-45
- Clutton- Brocks. 1984. Dog. In the evolution of domesticated animals. In Serpell, Coppinger Schneider 1995 *The domestic Dog - its evolution, behavior and interactions with people*. Cambridge university press. 11<sup>th</sup> print. pp 16-19.
- Duffy & Serpell 2012. Predictive validation of a questionnaire for measuring behavior and temperament traits in pet dogs. *J.Am.Vet.Med.Assoc.* 223,1293.
- Eken Asp, Friske, Nilsson & Strandberg. 2015. Breed differens in everyday behaviour of dogs. *Appl. Anim. Behav. Sci.* 169. 69-77.
- FCI Regulations for the International Utility Dogs trials and the international Tracking Dogs trial , 2012.
- Fält, L1997 – Anvisningar mentalbeskrivning hund, Svenska brukshundsklubben (in Swedish)
- Jamieson, Baxter & Murray. 2018. You are not my handler! Impact on dog behaviors and detection performance. *Animlas.* 8, 176. 1-11
- SAS institute 2019 - [https://www.sas.com/en\\_us/software/sas9.html](https://www.sas.com/en_us/software/sas9.html)
- Serpell, Coppinger Schneider 1995 *The domestic Dog - its evolution, behavior and interactions with people*. Cambridge university press. 11<sup>th</sup> print. pp21-32
- Sifavel 2014 – Swedish Icelandic horse studbook office (in Swedish). <http://sifavel.se/>
- Sigurðardóttir, Albersdóttir & Eriksson. 2017. Analysis of new temperament traits to better understand the trait spirit assessed in breedingfield tests for Icelandic horses. *Acta Agriculturae Scandinavica, Section A – Animal Science* 67, 1-2, 46-57.
- SKC. 2014 – Swedish Kennel club Index for HD and ED (in Swedish) <https://www.skk.se/sv/uppfodning/halsa/halsoprogram/index-for-hd-och-ed/>
- Strandberg, Jacobsson & Saetre. 2005. Direct genetic, maternal and litter effects on behaviour in Gernam Shepherd dogs in Sweden. *Livest. Prod. Sci.* 93, 33-42.

- Svartberg & Forkman. 2002. Personality traits in domestic dog (*Canis familiaris*). *Appl. Anim. Behav. Sci.* 79, 133-155.
- Svartberg, K. 2002. Shyness-boldness predicts performance in working dogs. *Appl. Anim. Behav. Sci.* 79, 155-174. *Appl. Anim. Behav. Sci.* 91, 103-128.
- Svartberg, K. 2005. A comparison of behaviour in test and everyday behaviour in dogs: evidence of three consistent boldness-related personality traits in dogs.
- Svartberg, K. 2006 Breed-typical behaviour in dogs – Historical remnants or recent constructs. *Appl. Anim. Behav. Sci.* 96, 293-313
- SWB 2016 – Swedish warmblood riding horse breeding plan (in Swedish). <https://swb.org/wp-content/uploads/2016/11/Avelsplan-fi%CC%82r-SWB.pdf>
- SWDA 2018a - Swedish working dog association Dog mentality assessment (in Swedish) <http://www.brukshundklubben.se/mentalitet/mentalbeskrivning-mh/>
- SWDA 2018b – Phenotypic Assessment of Working dogs. (in Swedish) <https://www.brukshundklubben.se/tavling-utstallning/exteriorbeskrivning/>
- SWAD Collie 2018 - Swedish working dog association breed information on Collie (in Swedish) <https://www.brukshundklubben.se/hundar/brukshundraser/collie/>
- Viklund, Braam, Näsholm & Strandberg. 2010. Genetic variation in competition traits at different ages and time periods and correlations with traits at field test of 4-year-old Swedish warmblood horses. *Animals* 4:5, 682-691.
- Viklund, Näsholm, Strandberg och Philipsson. 2011. Genetic trends for performance in Swedish warmblood horses. *Livestock Science* 141, 113-122.
- Von Borstel, Duncan, Lundin & Keeling. 2010. Fear reactions in trained and untrain horses from dressage and show-jumping breeding lines. *Appl. Anim. Behav. Sci.* 125, 124-131.
- Wang et al. 2016. Out of southern East Asia: the natural history of domestic dogs across the world. *Cell research*. Vol 26 no 1. 21-33.
- Årnason. 1987. Contribution of various factors to genetic evaluation of stallions. *Livest. Prod. Sci* 16, 407-419.



## Acknowledgements

I would like to thank Katja Nilsson for being my supervisor and helping me do this Master thesis, I could not have done it without you!

I also like to thank the Swedish Kennel Club and the Swedish working dog association for providing me with the data needed for the study and thank the breeding club for Dutch shepherds for helping me with the distribution for the questionnaire.