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Linear profiling of Swedish Warmblood foals

– and the relationship to linear traits described at Young Horse Test

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- och relationen till linjära egenskaper beskrivna vid unghästtest

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Linear assessment in Swedish Warmblood foals – and the relationship to linear traits described at Young Horse Test

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Abstract

Of all Swedish Warmblood (SWB) foals born between 2014 and 2018 approximately 24% attended foal inspection. At the foal inspections trained judges assess conformation and gait traits by evaluating/subjective scoring five traits and making a linear profiling/description of 15 traits. The linear assessment of foals was implemented in the SWB population in 2014, and this was the first study based on the linear foal data. Similar data from horses attending Young Horse Test (YHT) are used to estimate breeding values.

The aim was to estimate genetic parameters for both linear profiling and evaluating traits and to analyse genetic and phenotypic correlations between the different traits. Another aim was to study the correlations between results of linear profiled traits at foal inspections and later results from Young Horse Test (YHT). The data consisted of data from 2881 foals assessed at foal inspections between 2014 and 2018[1] and data from 4673 three-year-old horses assessed at YHT between 2013 and 2018.

An BLUP animal model with the fixed effects of age in days, event and sex were used to analyse the foal data. For the YHT data the animal model included the fixed effects of event and sex. The event was in both models a combination of location and date of the test.

Heritabilities estimated for linear traits assessed at foal inspection were found to be generally low for conformation traits, ranging from 0.03 to 0.28, and medium high for the gait traits, ranging from 0.27 to 0.51. Estimated genetic correlations were strong between evaluating conformation and gait traits and their corresponding linear traits, ranging between -0.93 and -1.00. The evaluating trait total score had medium to strong genetic correlations with almost all linear traits, ranging from -0.35 to -0.95.

This study showed strong genetic correlations between linear traits assessed at foal inspection and corresponding traits at YHT. For the conformation traits the genetic correlations ranged from 0.59 to 0.93, and for the gait traits from 0.71 to 0.92.

Results from this study showed that data from foal inspections has potential to be used in future estimation of linear breeding values, due to its moderately high heritabilities and strong genetic correlations to YHT.

Keywords: foal, horse, warmblood, sport horse, animal model, linear profiling, linear traits, conformation, gaits, foal inspection, young horse test, SWB, heritability, genetic correlation, breeding.

[1] Data from the time period 2014-2018 for evaluated traits and 2014-2017 for linear profiled traits.

Sammanfattning

Andelen Svenska Varmblodsföl (SWB) som deltog vid fölbedömning under tidsperioden 2014 - 2018 var cirka 24%. Vid fölbedömning inspekteras fölet av en tränad exteriördomare som bedömer fölet genom att sätta poäng på fem egenskaper samt genom att beskriva 15 egenskaper på en linjär skala. Den linjära bedömningen av föl infördes år 2014 och detta var den första studien gjord på materialet från SWB:s linjära földata. Liknande data från hästar som deltagit vid unghästtest används för att skatta avelsvärden. Syftet med studien var att skatta genetiska parametrar för både de linjära och poängbedömda egenskaperna, analysera genetiska och fenotypiska korrelationer mellan egenskaperna och slutligen undersöka relationen mellan resultatet från de linjära egenskaperna vid fölbedömning och egenskaper vid unghästtest.

Data bestod utav resultat från fölbedömningar mellan 2014 och 2018[2] (2881 föl) och resultat från unghästtest mellan 2013 och 2018 (4673 hästar). För data från fölbedömningar användes en djurmodell med de fixa effekterna ålder i dagar, bedömningstillfälle och kön. För data från unghästtesterna användes en djurmodell med de fixa effekterna plats och kön. Den fixa effekten bedömningstillfälle var i båda modellerna en kombination av både plats och datum. De skattade arvbarheterna för linjära egenskaper bedömda hos föl var generellt låga för exteriöregenskaperna (0.03 – 0.28) och medelhöga för gångartsegenskaperna (0,27 – 0,51).

De skattade genetiska korrelationerna var starka mellan poängbedömda och linjärbeskrivna gångartsegenskaper (-0.93 - -1.00). Den poängbedömda egenskapen totalpoäng hade medelstark till stark genetisk korrelation till nästan alla linjära egenskaper (-0,35 - -0,95).

Den här studien visade även på hög genetisk korrelation mellan linjära egenskaper bedömda hos föl och de motsvarande linjära egenskaperna bedömda hos unghästar. För exteriöregenskaperna var den genetiska korrelationen mellan 0,59 till 0,93 och för gångartsegenskaperna mellan 0,71 och 0,92.

Resultatet från denna studie visar att fölbedömningsdata har potential att användas i skattningen av avelsvärden för linjära egenskaper i framtiden, då den genetiska korrelationen med resultat vid unghästtest är stark.

Nyckelord: föl, häst, djurmodell, linjärbeskrivning, fölbedömning, unghästtest, SWB, arvbarhet, genetisk korrelation

[2] Data från tidsperioden 2014–2018 för poängbedömda egenskaper och 2014–2017 för linjärbeskrivna egenskaper.

Table of contents

1 Introduction

The use of linear profiling as a complement to the traditional evaluating scoring system is becoming more common in Warmblood sport horse breeding. It divides the evaluating traits into smaller, multiple, more objective traits assessed on a scale which describes the trait from one biological extreme to the other. When collecting data from phenotypic traits it is desirable to have clear and nonevaluative definitions, high reproducibility and an ability of early assessment, something that linear profiling can provide (Duensing, Stock & Krieter 2014). The linear profiling data provides horse owners with valuable information regarding their horses, and studbooks gets larger amounts of data to evaluate. Studbooks strive for development of their breeding work and higher accuracy of their breeding values, which the use and development of more objective recording of traits can contribute to (Duensing, Stock & Krieter 2014).

The Swedish Warmblood Association (SWB) implemented the use of linear profiling for 3-year-old horses in 2013, and in 2014 it was adapted for all assessments, including for foals. The purpose of foal inspections, at present, is to encourage breeders to handle the foals at an early age as well as an opportunity for marketing. The foal data is not used in estimation of breeding values but reported back to, and archived by, the breeding organisation for future use (ASVH 2018). The first breeding values for linear profiling traits were published in 2017, both for stallions with a minimum of ten linearly profiled offspring at Young Horse Test (YHT) and for mares linearly profiled at YHT. The estimated heritabilities for linear profiled traits were low to moderate for conformation (0.10 - 0.52) and movement (0.08 - 0.54) and the genetic correlations between linear profiled and evaluating traits were strong (-0.37 - -0.90) (Viklund & Eriksson 2018). High genetic correlations (0.86 - 1.00) have been estimated between evaluating traits assessed in SWB foals and 3-year-old horses (Edlén 2008). This might indicate that there is potential to use data records from foals in future estimations of breeding values for linear profiled traits. This would require that the data is found to be of good quality and correlated to future results from YHT. Preisinger, Wilkens & Kalm (1991) stated already in 1991

that the potential use of foal data could shorten the generation interval and thereby give an increased genetic progress, which is in agreement with one of the goals in the breeding of SWB horses (SWB 2015).

The aim of this study was to estimate genetic parameters for both linear profiled and evaluating traits at foal inspections between 2014 and 2018[3], and to estimate genetic correlations between linear profiled traits at foal inspections and YHT.

3. Data from 2014-2018 for evaluated traits and from 2014-2017 for linearly described traits.

2 The Swedish Warmblood

The SWB Association was established in 1928 and has the responsibility of SWB breeding. The official breeding goal for SWB is "A noble, correct and sound warmblood horse, that through its rideability, performance-oriented temperament, excellent gaits and/or jumping ability is internationally competitive" (SWB 2015). The conformation is stated to aim for "A Warmblood sport horse naturally built for correct carriage under rider that with easily accomplish the tasks demanded. The horse should be refined, well proportioned, long legged, long lined, have an expressive and beautiful head, well set neck, well developed withers, straight positioned shoulders, somewhat sloping croup, strong back with good saddle position and correct limbs with hooves of good quality" (SWB 2015). A SWB dressage horse should be moving uphill, with ease, elasticity and pace, and with good energy and carriage in all gaits. It should have capacity for collection as well as lengthening. The SWB show-jumping horse should have good fore- and hind leg technique, have a balanced and easy adjustable canter, elasticity, power and quick response (SWB 2015).

One of the first milestones in SWB breeding was the introduction of the Riding Horse Quality Test (RHQT) for 4-year-old horses in 1973 to provide local mare-owners with better information of conformation, health and performance traits for the stallions used in breeding (SWB 2015). In 1977, developing of a Stallion Performance Test (SPT) begun with the aim to improve selection of stallions for sport horse breeding. The Young Horse Test (YHT) for 3-year-old horses was introduced in 1999 to enable even earlier progeny evaluation of stallions and to select young broodmares. Foal inspections became official the same year. Earlier the foal inspections often consisted of farm-to-farm inspections were judges toured around Sweden and assessed foals to give the owners a professional opinion.

In year 1986 genetic evaluation with a multi-trait Best Linear Unbiased Prediction (BLUP) animal model based on data from RHQT was implemented (Árnason 1987). Also, since 1986 data and statistics of the covering and fertility results for stallion has been officially reported (SWB 2015). The number of covered mares has ranged between 8000 in year 1990 to 3000 between 2007 and 2013 (SWB 2015). In

2019 a total of 4106 coverings were registered according to preliminary results (SWBc 2019). The use of artificial insemination with fresh semen, frozen semen, and transported chilled semen began its broad application in the early 1980s (SWB 2015). The open studbook gives opportunity for the breeders to choose genetic material from other Warmblood sport horse populations and the use of foreign stallions are common. Before 1980 approximately 80% of the foals were sired by SWB stallions, in 2006 80% were sired by foreign stallions (Thorén Hellsten et al. 2009). In year 2006 the genetic evaluation was revised and since then, the estimated breeding values (EBV) for SWB stallions and now also for mares, are estimated with a multiple-trait animal model with data from competitions, RHQT and YHT (Viklund et al. 2011).

In a study by Viklund et al. (2011) the genetic trends of SWB horses were analyzed. The results showed that the selection intensity for breeding stallions had increased from almost non-existing in year 1984 to selection of the best 5% showjumping and 28% dressage stallions in year 2009. The implementation of higher selection intensity of sires due to revision of the SPT, import of foreign sires and use of BLUP in estimation of EBV had led to a genetic progress in the SWB population (Viklund et al. 2011).

The breeding plan is revised every fifth year with a goal of good efficiency, with a genetic progress as great as possible (SWB 2015). The most recent revision in the breeding program of SWB horses was done in 2014 and includes the implementation of linear profiling (SWB 2015).

2.1.1 Foal Inspection

The SWB Association have protocols from foal inspections back from year 1999, when foal inspections became official (Edlén 2008). Reporting of protocols increased during 2001, and since 2004 common regulations for the inspection are used by all regional associations. The events usually take place during the summer, between May to September, and are arranged by regional SWB associations. At the inspection trained judges evaluate both conformation and gaits of the foals. All foals registered, or to-be registered, in the SWB studbook are allowed to attend, with the demands of membership in SWB for the breeder/owner and a minimum age of 21 days for the foal (ASVH 2018). It is only allowed to attend foal inspection at one occasion. There are different classes depending on if the foal is bred for show-jumping or dressage. If a foal is found to be lame, show signs of sickness or bad general condition, the judges are entitled to stop the inspection and note the cause in the protocol (Appendix 1).

During the inspection of conformation, the foal should be haltered and presented for the judges, then shown by hand in walk and trot before removal of the halter and being showed in free movement. If possible, the mare and foal are both shown in free movement during the assessment of canter. Afterwards the horses are haltered and shown in walk before formation and oral judgement.

The judgement consists, since 2014, of one linear profiling part and one evaluating part. The linear profiling part consists of 15 traits (Table 1) described on a scale from A to E, where C is seen as average and A as well as E are considered biological extremes of the trait (Appendix 1). The linear description is not official, only presented for the breeder/owner. The evaluating part is official and consists of five traits scored from one (very poor) to ten (excellent); 'Conformation', 'Walk', 'Trot', 'Canter' and 'General impression'. The final 'Total' score is based on a 30-point scale and is the sum of 'Conformation', average point for gaits and 'General impression'. Results for total and sub scores for all attending foals are presented officially.

Highly ranked foals have the possibility to attend regional foal championships. The owner decides which category, dressage or jumping, the foal belongs to. To be qualified, dressage foals must have at least 24 points and show-jumping foals 23 points. At the regional foal championships, the foals are re-assessed. The event has no connection to the results from foal inspection except for the requirement for attending, and the best foal for each class i.e. show-jumping or dressage are presented. Often the regional foal championships are held as a final class at the foal inspections.

Previously the foals attending foal inspection got divided into different quality classes depending on their given score/points. The quality classes were removed in 2014 due to the fact that over 70% of the foals achieved the highest classification (Edlén 2008).

In the breeding plan of SWB, there are several goals set regarding the development of SWB foal inspections. The work is focusing on being easily available for breeders to attend, reaching at least 50% participation. In order to use foal assessments for evaluation of sires, it is recommended to have at least 15 evaluated offspring per sire (SWB 2015).

2.1.2 Young Horse Test

In year 1999 the YHT for 3-year-old horses was introduced (SWB 2015). The objective of YHT is to be a goal for the training of the young horse, as well as a first assessment of its suitability for a future sport or breeding career (ASVH 2018). Most important, this test contributes with the earliest offspring recordings used in estimation of EBV for both evaluating scores and linear profiling traits. The event is arranged by regional SWB Associations from spring to mid-summer, and about

35-45% of the SWB population of 3-year-olds are assessed every year (Viklund et al. 2008). Since 2018 the YHT are divided in two classes depending on the age of the horse. All 3- and 4-year-old SWB horses, who have not attended the YHT earlier, are allowed to attend (ASVH 2018).

The test includes measuring of height at withers, ID control, assessment of conformation, assessment of gaits both by hand and in free movement, assessment of jumping skills by free jumping and a voluntary test under rider (ASVH 2018). Eight traits (‘Type’, ‘Head-Neck-Body’, ‘Correctness of legs’, ‘Walk’, ‘Trot’, ‘Canter’, ‘Jumping Technique & Ability’, ‘Jumping Temperament & Overall impression’) are scored between one (very poor) to ten (excellent). In 2013, the test was complemented with a linear profiling protocol. The linear profiling protocol consists of 21 conformation traits, 15 movement traits and 14 jumping traits described on a scale from A to I, where D to F is seen as average and A as well as I are considered biological extremes of the trait (Appendix 2). Twelve of the conformation and movement traits are assessed almost in the same way as at foal inspections, using the same extremes (Table 1). For the YHT the scale has nine steps (A-I) and for the foal inspection a five-step scale is used (A-E).

Table 1. Linear profiled traits assessed at Foal Inspection and corresponding traits assessed at Young Horse Test

Trait	Description	Described between	
		Foal inspection	Young Horse Test
Development	*Not well – Well*	A – E[1]	
Type	*Refined – Heavy*	A – E	A – I
Length of neck	*Long – Short*	A – E	A – I
Position of shoulder	*Straight – Sloping*	A – E	A – I
Shape of croup	*Sloping – Straight*	A – E	A – I
Foreleg	*Toed in – Toed out*	A – E	A – I
Hind leg	*Sickle – Straight*	A – E	A – I
Pastern	*Long – Short*	A – E	
Walk, stride length	*Long – Short*	A – E	A – I
Walk, suppleness	*Supple – Stiff*	A – E	A – I
Trot, stride length	*Long – Short*	A – E	A – I
Trot, elasticity	*Elastic – Inelastic*	A – E	A – I
Canter, stride length	*Long – Short*	A – E	A – I
Canter, elasticity	*Elastic – Inelastic*	A – E	A – I
Gait, balance	*Balanced – Unbalanced*	A – E	

[1]Development can only be defined as A, C or E.

Two different total scores are calculated based on the evaluating traits; promising dressage horse and promising show-jumping horse. The total scores are calculated as follows:

'Total' score as promising dressage horse (max 60 points):
'Type' + 'Head-Neck-Body' + 'Conformation' + 'Walk' + 'Trot' + 'Canter'.

'Total' score as promising show-jumping horse (max 60 points):
'Type' + 'Head-Neck-Body' + 'Conformation' + 'Canter' + 'Free jumping technique & ability' + 'Free jumping-temperament & general impression'.

Based on the 'Total' score the best horses can achieve rewards, either Diploma or Class I. In order to achieve the rewards, they need to fulfil certain requirements (SWBb 2018). The horses can also, by attending YHT with good results, qualify to both Rikssto and Breeders Trophy, where the best horses for each class i.e. show-jumping and dressage are stated.

In the breeding plan, there are several goals set regarding the development of YHT. Briefly, the work is focusing on being adapted for what is appropriate to assess for 3-year-olds in springtime, reaching at least 60% participation and thereby give good amounts of data for genetic evaluation. It also stimulates early handling/breaking of young horses as well as selection of good mares for breeding (SWBb 2019).

2.2 Linear profiling in other studbooks

The first warmblood studbook to implement linear profiling was the association of The Royal Dutch Warmblood (KWPN) in year 1989 (Koenen, van Veldhuizen, & Brascamp 1995). In a study by Duensing, Stock & Krieter (2014) the implementation of linear profiling in Warmblood horse breeding was investigated. The summary showed that out of the 15 investigated studbooks, 11 used numerical scales, for example 1 to 9 or -20 to 20. Others, such as the SWB, used alphabetical scales often ranging from A to I. The definition of traits, number of traits and scale differed between the studbooks.

The World Breeding Federation for Sport Horses (WBFSH) aims for an improved transparency between the work made in different breeding organisations (Koenen et al. 2004). There is also an international working group for this cause; Interstallion (Interstallion 2020). The working group is linked to the Horse Commission of the European Federation of Animal Sciences and each year an International Workshop on Linear Profiling in the Warmblood Horse (IWSLP) is arranged,

where studbooks are invited to discuss recent changes, experiences, research results and further development (WBFSH 2019).

Already in 2016 at the annual meeting of EAAP Sperrle et al. (2016) showed preliminary results from an across studbook study regarding linear traits in Oldenburg and SWB. EBV could be compared despite the differences in linear profiling systems. The results showed correlation patterns both within and across studbooks and showed the possibility for future collaboration aiming towards using linear traits as targets in genomic applications (Sperrle et al. 2016).

2.2.1 Foal inspections

Studbooks with linear profiling included at foal inspections are the SWB, KWPN, Holstein, Oldenburg, BWP and Danish Warmblood (DWB) (Duensing, Stock & Krieter 2014). The studbook with the most developed use of linear profiling is Oldenburg, where the judges since 2012 use a tablet PC for their digital protocol to describe all traits (Workel 2019) (Appendix 3). The linear foal data is used in estimation of Oldenburg genetic profiles, where 46 linear traits, with heritabilities above 0.10, are presented. The foals are assessed according to the same sheet as the adult horses, which are describe up to 186 different traits, but only for the categories for free movement i.e. 'Walk' (6 traits), 'Trot' (11 traits), 'Canter' (10 traits) and for the conformation traits 'Format' (13 traits), 'Front' (19 traits), 'Topline' (8 traits), 'Limbs' (27 traits), 'Correctness of gaits/coordination' (13 traits) (Workel 2019) (Appendix 3).

The BWP studbook introduced linear profiling of foals in 2016. The protocol is a manual paper protocol and consists of nine conformation traits, five leg traits and five movement traits (De Smet, Meurrens & Janssens 2019). The annual proportion of attending foals is 10 – 20% of all live born foals. The foal data is not used in the estimation of breeding values but are predicted to be used for that in the future. According to the BWP, their main challenges of developing the use of data from linear profiling of foals are the lack of knowledge and interest from the breeders, limited time at foal shows and the possible large effect of age (De Smet, Meurrens & Janssens 2019).

The British Breeding (BB) has a project named Futurity, to develop the use of linear profiling and breeding of all British bred horses and ponies (Broomer 2019). They also have a linked program called the Equine Bridge, were the top scored foals are supported to get a future successful sports career. The support consists of a program designed to bring together breeders, trainers and riders to cooperate. Increasing the number of British riders competing on British horses. The development of both evaluating and linear scoring system is said to be based on "a balancing act between our need for data and the breeders' need for feedback and recognition".

2.3 Earlier studies of foal data

2.3.1 Evaluating traits

Bösch et al. (2000) investigated genetic parameters for traits in 34 359 Holstein foals, assessed between 1984 and 1998. The scale used for evaluation was numeric from 1 to 10 and the foals were assessed for two traits: 'Type' and 'Gaits'. The descriptive results showed that during the 15 years of assessment none had got a score of 10 in neither of the traits. The model used for genetic analysis were corrected for the effect of year/season, breeder, sex and age. The estimated heritabilities were 0.42 for 'Type' and 0.40 for 'Gaits', the genetic correlation between the traits was 0.77 and the phenotypic correlation was 0.59. The study also consisted of data from studbook registration and performance traits of mares. The relationship between the foal assessment results and later results at studbook registration showed strong genetic correlations ranging from 0.51 to 0.87, whereas the genetic correlation to performance traits of mares were medium to strong ranging from 0.20 to 0.52.

In a study by Bhatnagar et al. (2011) the genetic parameters of foal inspection traits for two North American sport horse populations were estimated; International Sport horse Registry (ISR) and Oldenburg Registry North America (OLNA). The material consisted of foal inspection data for 5505 foals obtained between 1999 and 2009. Traits were assessed on a numeric scale from 1.0 to 10.0. The foals were evaluated on four traits; 'Type & conformation', 'Athletic ability of movement', 'Overall development as related to age' and 'Total score'[4]. The model used for estimation of genetic parameters of traits at foal inspections were corrected for the effects of sex, period, year/period and dam-breed. The results showed that the use of scale was limited, only ranging from 6.4 to 9.5. Heritabilities of the traits were found to be between 0.45 and 0.55, with high genetic correlations to each other.

In a genetic evaluation of the German Sport Horse (GSH) data from 17 881 horses attending foal inspections, broodmare inspections and mare performance tests between 1990 and 2006 was analysed (Schöpke et al. 2013). All traits used in the study were scored on a scale between 1 and 10. The foals were evaluated for three traits; 'Type', 'Conformation' and 'Gait'. The results showed that the use of scale was limited, ranging from 4.0 to 10.0, with a population mean between 7.42 ('Conformation') and 8.20 ('Type'). The model used for estimation of genetic parameters of traits at foal inspections were corrected for the effects of age, sex and place/year. In this study age at test were divided in to four age-groups. The results

4. The total score was a weighted mean value calculated as; 0.4 * type and conformation + 0.4 * athletic ability of movement + 0.2 * overall development as related to age = Total score.

showed that estimated heritabilities varied between 0.24 and 0.50, and high genetic correlation (0.84) was found between 'Type' and 'Conformation'. The results from foal inspection data were also compared to later results at broodmare inspection and mare performance tests (Schöpke et al. 2013). The estimates of the genetic correlation between assessments ranged from moderate to high, with exception for the relationship between 'Gait' at foal inspection and 'Free jumping' at mare performance test (Schöpke et al. 2013).

For the evaluated traits in both SWB foals and 3-year-old horses the heritabilities and correlations have been estimated with data from foal inspections between year 2002 and 2006 and YHT between year 1999 and 2007 (Edlén 2008). In total there were observations from 4861 foals and 8284 horses. For traits at foal inspection the heritabilities ranged between 0.02 ('Correctness of legs') and 0.77 ('Total' score). For traits assessed for 3-year-old horses heritabilities ranged between 0.08 ('Correctness of legs') and 0.60 ('Trot'). The genetic correlation between the different assessments ranged from 0.86 to 1.00 (Table 2).

Table 2. Evaluated traits assessed both at SWB Foal Inspection and Young Horse Test (YHT) and their heritability (h^2), additive genetic variance (σ_a^2) and correlations, both genetic (r_g) and phenotypic (r_p), between traits assessed at Foal Inspection and YHT. In total the observations were from 4861 foals and 8284 horses (Edlén 2008)

Trait	**h^2**		**r_g**	**r_p**
	Foal inspection	YHT		
Type	0.38	0.42	0.94 $_{0.03}$	0.27
Head-neck-body	0.35	0.32	0.86 $_{0.05}$	0.23
Correctness of legs	0.02	0.08	1.00 $_{0.42}$	0.15
Walk	0.27	0.39	0.93 $_{0.04}$	0.21
Trot	0.53	0.60	0.90 $_{0.03}$	0.31
Canter	0.42	0.38	0.90 $_{0.04}$	0.25
Total	0.77			

2.3.2 Linear traits

Not many studies have been made on data from linear profiling of foals in warmblood populations. The first estimations of heritability of traits described on a linear scale was made from data of Dutch Shetland ponies assessed between 1989 and 1990 (Van Bergen & Van Arendonk 1993). The protocol used at the time consisted of 28 traits, all scored on a scale from 0 to 40. Heritability of the traits varied between 0.07 and 0.39, but most were considered intermediate, with values of approximately 0.2. Overall, movement traits had higher estimations of heritability than conformation traits. The trait with highest heritability was 'Trot stride length' and lowest heritabilities were estimated for traits of leg conformation (Van Bergen & Van Arendonk 1993).

The Oldenburg studbook publishes linear genetic profiles (breeding values) for young stallions with more than eight linearly described offspring and older stallions with more than 30 linearly described offspring, or 20 if at least 10 records are for older offspring. The estimations are based on data from 20 000 horses, where 13 000 are foals. In the analysis the fixed effects used in the model was judge, society (OL for dressage horses and OS for show jumping horses), age and sex (Workel 2019). When investigating the relationship between corresponding traits in young and adult Oldenburg horses, the genetic correlation was found to be favourable and for most traits above 0.5 (Stock et al. 2013). The genetic profile of a young stallion serves as a valuable first prediction and can be used in decision making for breeders (Stock et al. 2019). In the Oldenburg population the heritabilities for walk, canter and behaviour has been found low (0.06 – 0.10) whereas heritabilities for conformation, trot and jumping were above 0.2 (Stock et al. 2019).

Out of the 15 linear profiled traits assessed at SWB foal inspections 13 are also assessed at YHT and 14 at RHQT, but with so far unknown heritability for foals and horses attending RHQT. In a study by Viklund & Eriksson (2018) the linear profiling data for 3-year-old SWB horses were found suitable for genetic evaluation, with heritability of conformation traits ranging between 0.10 and 0.52, movement traits between 0.08 and 0.54 and jumping traits between 0.05 and 0.57.

2.3.2.1 Correlation between evaluating and linear traits

Duensing, Stock & Krieter (2014) overviewed linear data from the different studbooks in Europe and found that the traits of limb conformation would benefit most by replacing evaluated scores to linear profiled, since the heritability's of the linear limb traits were larger than the evaluating limb traits. Further it was found that heritability estimates for the other linear traits were in the same range as corresponding evaluated trait, with values ranging between 0.02 and 0.77 for conformation traits and 0.12 to 0.52 for gait traits.

The correlation between evaluated and linear profiled traits have been estimated for 3-year-old SWB horses assessed at YHT between year 2013 and 2016 (Viklund & Eriksson 2018). The genetic correlations ranged from 0.04 to -0.97 and the phenotypic correlation between 0.05 and -0.76 (Table 3).

Table 3. Heritabilities (h^2) and correlations, both genetic (r_g) and phenotypic (r_p), between evaluated traits and corresponding linear profiled traits in assessed SWB horses at Young Horse Test (YHT) (Viklund & Eriksson 2018)

Evaluating trait	h^2	Linear trait	h^2	r_g	r_p
Type	0.44 $_{0.06}$	Type	0.25 $_{0.05}$	-0.39 $_{0.11}$	-0.23
Head-neck-body	0.47 $_{0.06}$	Length of neck	0.21 $_{0.04}$	-0.52 $_{0.11}$	-0.20
		Position of shoulder	0.27 $_{0.05}$	-0.81 $_{0.12}$	-0.36
		Shape of croup	0.20 $_{0.04}$	0.04 $_{0.13}$	0.05
Correctness of legs	0.09 $_{0.03}$	Foreleg	0.27 $_{0.05}$	-0.52 $_{0.17}$	0.08
		Hind leg	0.21 $_{0.04}$	-0.03 $_{0.20}$	0.06
		Pastern	0.16 $_{0.08}$	-0.20 $_{0.35}$	-0.10
Walk	0.45 $_{0.06}$	Stride length	0.32 $_{0.05}$	-0.91 $_{0.03}$	-0.73
		Suppleness	0.33 $_{0.05}$	-0.97 $_{0.02}$	-0.75
Trot	0.81 $_{0.06}$	Stride length	0.49 $_{0.06}$	-0.94 $_{0.02}$	-0.66
		Elasticity	0.54 $_{0.06}$	-0.96 $_{0.01}$	-0.76
Canter	0.46 $_{0.06}$	Stride length	0.34 $_{0.05}$	-0.87 $_{0.04}$	-0.52
		Elasticity	0.27 $_{0.05}$	-0.97 $_{0.02}$	-0.72

3 Material and methods

3.1 Data

3.1.1 Foal inspection

During the five-year time period between 2014 and 2018 a total of 12 161 foals were live born and registered in the SWB studbook (SWBa 2019). Of these foals 2 881 attended foal inspection and were assessed according to the standardised protocol used by SWB. The distributions of live born and assessed foals over the time period are presented in Table 4. In total the proportion of foals participating in linear profiling has been on the same annual level, of approximately 24%, during the time period. The attending foals were equally distributed over the sexes, 50.68% colts and 49.32% fillies. The events were distributed over 25 regional SWB associations, at 172 different times/locations, given at dates from end of May to September. The reported protocols were delivered by SWB as Excel files. Some protocol information were not complete, thereby the variation in missing number of observations and available linear profiles (Table 4). The given data from foal inspections during 2018 only consisted of the evaluating traits at the time for this study, due to delays in reporting of the linear results.

Table 4. *Distribution over the number of live born foals, foals assessed at foal inspection, percent attending foals and foals with official linear profile during the time period 2014 – 2018*

Year	Live born foals	Foals assessed	Percent	Foals with available linear profile
2014	1941	468	24%	468
2015	2212	522	24%	505
2016	2501	625	25%	563
2017	2735	601	22%	533
2018	2772	665	24%	0
Total	12161	2881	24%	2069

The protocol used at foal inspections consists of two parts: one with linear traits and one with evaluating traits (Appendix I). The 15 linear traits are divided in two parts: Conformation and Gaits. In the protocol the linear traits are assessed on a scale from A to E. When the data is manually translated from paper protocols to digital excel files the scale is translated into numbers from 1 (A) to 5 (E) to enable statistical analyses, where 1 (A) and 5 (E) are the biological extreme of the traits. Some of the linearly described traits also have optional sub-traits in the protocol, with an underlying trait scored as present (1) or non-present (0). One conformation trait, development, can only be assessed as 1 (A), 3 (C) or 5 (E) in the protocol. In the evaluating/point scoring part of the protocol four traits (‘Conformation’, ‘Walk’, ‘Trot’, ‘Canter’ and ‘General impression’) are scored in relation to the breeding goal, from 1 (very poor) to 10 (excellent). ‘Average of gaits’, ‘Total’ score and ‘Percent’ are calculated from the five separate traits.

3.1.2 Young Horse Test

During the six-year time period between 2013 and 2018 a total of 4 673 horses attended YHT and were assessed according to the standardised protocol used by SWB. The number of assessed young horses, foals and horses that attended both (foal inspection and YHT three years later) are presented in Table 5. The events were distributed over 25 regional SWB associations, at 147 different times/locations, given at dates from middle of April to start of July. The reported protocols were delivered by SWB as Excel files. Of the 4673 attending SWB horses 17 were 4-year-old and 4656 were 3-year-old horses. The distribution of sexes in total were 52.4% mares, 16.6% stallions and 31.0% geldings. The protocol was revised during 2014, hence some of the traits were deleted. In this study the results will only include the traits of the revised protocol.

Table 5. *Number of horses linearly described at Young Horse Test (YHT) during the time period 2013 – 2018. Also, number of horses linearly described both YHT and foal inspection three years earlier*

Year	N	Foal inspection three years earlier
2013	986	0
2014	903	0
2015	795	0
2016	726	0
2017	603	192
2018	660	208
Total	4673	400

3.2 Methods

Editing of the material and descriptive statistical analyses were performed using Statistical Analysing System (SAS) (SAS Institute Inc. 2012). Estimations of genetic parameters were performed in DMU, version 6 (Madsen & Jensen 2013). All traits in the linear profiling protocol were analysed in univariate analyses, the genetic and phenotypic correlations were estimated with a selection of traits in bivariate analyses. Correlations were estimated both within and between linear and evaluating scored traits for foals. Estimations of correlations were also performed between linear traits from foal inspection and YHT. A genetic correlation was considered significant if the estimated value was two times larger than the standard error. The pedigree of each horse with an observation was traced back seven generations resulting in a pedigree file including 27079 horses. The fixed effects of event (combination of location and date), age (in days, as a fixed regression) and sex were significant for the majority of traits. Inclusion of location in the model takes into account the variation among judges and environmental testing conditions.

The following linear animal model was used to analyse the foal inspection data:

$$Y_{ijkl} = \mu + age_i + event_j + sex_k + animal_l + e_{ijkl}$$

Where

Y_{ijkl} = observed trait value for foal l
μ = the population mean value for the trait
age_i = fixed effect of age. I = 18, 21…236
$event_j$ = fixed effect of a combination of location and date. J = 1,2 …172
sex_k = fixed effect of sex. K = 1,2 were 1 = filly and 2 = colt
$animal_l$ = additive genetic effect of foal l ~ND (0, A σ_a^2)
e_{ijkl} = random residual effect ~IND (0, σ_e^2)

The following linear animal model was used to analyse the YHT data:

$Y_{ijk} = \mu + event_i + sex_j + animal_k + e_{ijk}$

Where

Y_{ijk} = observed trait value for horse k
μ = the population mean value for the trait
$event_i$ = fixed effect of a combination of location and date. I = 1,2 …147
sex_j = fixed effect of sex. J = 1,2 were 1=mare and 2=stallion/gelding
$animal_k$ = additive genetic effect of horse k ~ND (0, A σ_a^2)
e_{ijk} = random residual effect ~IND (0, σ_e^2)

4 Results

4.1 Foal inspection

4.1.1 Descriptive statistics

The age for foals where measured in days from birth to foal inspection. Number of observations were 2149 with a mean value of 93.53 days and standard deviation of 27.39. The age ranged from 18 to 236 days (Figure 1).

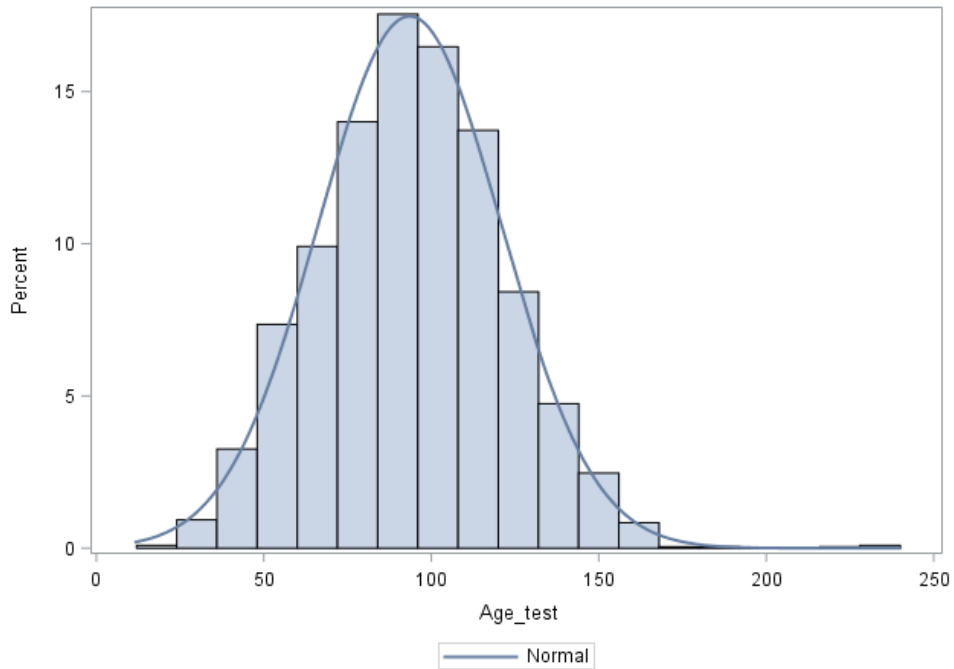

Figure 1. The range of age at test in Swedish Warmblood foals attending foal inspection 2014 – 2018. With age measured in days from birth to date of foal inspection

4.1.1.1 Linear traits

For the conformation traits described A (1) to E (5) the mean values varied between 2.61 (‘Type’) and 3.73 (‘Development’) (Table 6). The linear profiling scale was used fully for all traits except ‘Neck length’ and ‘Pasterns’, with no extreme value of 5 (E). The conformation trait with the largest variation (standard deviation) was ‘Development’ (1.12) while the trait ‘Pastern’ had lowest variation (0.42).

For the gait traits described A (1) to E (5) the mean value varied between 2.58 (‘Canter stride length’) and 2.88 (‘Trot stride length’) (Table 6). The linear profiling scale where fully used for all traits except ‘Gait balance’. The gait trait with the highest standard deviation were ‘Trot elasticity’ (0.77), while the trait ‘Gait balance’ had the lowest standard deviation (0.63).

Table 6. *Number of observations (N), mean values (mean), standard deviation (SD), minimum (min) and maximum (max) values for linearly described traits assessed at Swedish Warmblood foal inspections 2014-2017*

Trait	Description 1 - 5	N	Mean	SD	Min	Max
Conformation						
Development	*Not well – Well*	2067	3.73	1.12	1	5
Type	*Refined – Heavy*	2026	2.61	0.57	1	5
Length of neck	*Long – Short*	2045	2.76	0.56	1	4
Position of shoulder	*Straight – Sloping*	2032	2.95	0.61	1	5
Shape of croup	*Sloping – Straight*	2054	2.81	0.48	1	5
Foreleg	*Toed in – Toed out*	2004	3.09	0.58	1	5
Hind leg	*Sickle – Straight*	1989	2.97	0.44	1	5
Pastern	*Long – Short*	1967	2.79	0.42	1	4
Gaits						
Walk, stride length	*Long – Short*	1936	2.77	0.68	1	5
Walk, suppleness	*Supple – Stiff*	1931	2.84	0.67	1	5
Trot, stride length	*Long – Short*	1967	2.88	0.72	1	5
Trot, elasticity	*Elastic – Inelastic*	1960	2.80	0.77	1	5
Canter, stride length	*Long – Short*	1985	2.58	0.66	1	5
Canter, elasticity	*Elastic – Inelastic*	1978	2.66	0.69	1	5
Gait, balance	*Balanced – Unbalanced*	1903	2.63	0.63	1	4

Table 7 shows the frequency of all sub-scores/checkboxes connected to some of the linearly described traits. These traits are assessed as either not present (0) or present (1). The sub-score with the highest frequency was ‘Type; well proportioned’ (26.1%). The sub-score with the lowest frequency was ‘Completed; called off’ (0.4%).

Table 7. *Number of observations (N), description of presence and percent for sub-scores (scored 1 if present or 0 if not present) of linear assessed traits for Swedish Warmblood foals in 2014-2017*

Trait	Sub-score	N	Presence (1)	Percent
Type	*Well proportioned*	2074	541	26.1%
Neck	*Low set*	2075	187	9.0%
Position of shoulder	*Deep chest*	2075	125	6.0%
Forelegs	*Parallel displacement of cannon bone*	2075	59	2.8%
	Outward rotated cannon bone	2075	94	4.5%
Pastern	*Weak pastern*	2075	78	3.8%
Trot elasticity	*Movement tight to the ground*	2075	99	4.8%
Completed	*Called off*	2272	10	0.4%

4.1.1.2 Evaluating traits

For the conformation and gait traits scored 1 to 10 the mean values varied between 7.46 (‘Walk’) and 8.01 (‘Conformation’) (Table 8). The scale was not used fully for any trait; no trait had a score below 5 (Table 8). The highest score (10) was used for all traits except ‘Walk’ and ‘General impression’. The evaluating trait with the highest standard deviation was ‘Trot’ (0.76), while ‘General impression’ had the lowest standard deviation (0.50).

The traits ‘Average of gaits’, ‘Total’ score and ‘Percent’ were calculated from the five scored traits.

Tabell 8. *Scoring traits. Means for traits scored categorical with points, 1 (very poor) – 10 (excellent).*

Trait	N	Mean	Std	Min	Max
Conformation	2867	8.01	0.57	6	10
Walk	2867	7.46	0.60	5.5	9.5
Trot	2866	7.52	0.76	5	10
Canter	2867	7.83	0.66	5	10
General impression	2867	7.90	0.50	6	9.5
Average of gaits[1]	2810	7.61	0.50	5.5	9.7
Total score[2]	2859	23.50	1.31	18.5	28.3
Percent[3]	2392	78.49	4.39	61.7	94.3

1.Average of gaits = (‘Walk’ + ‘Trot’ + ‘Canter’)/3
2.Total = ‘Conformation’ + ‘Average of gaits’ + ‘General impression’
3.Percent = ‘Total’/30

4.1.2 Genetic parameters

4.1.2.1 Linear traits

The estimated heritabilities for the linearly described traits varied between 0.03 (‘Pastern’) and 0.28 (‘Forelegs’) for the conformation traits and between 0.27 (‘Canter elasticity’) to 0.51 (‘Trot elasticity’) for the gait traits (Table 9). The conformation traits generally had lower heritabilities than the gait traits. The trait with the lowest heritability was ‘Pastern’, which also had the lowest additive genetic variance among all traits. The additive genetic variances was generally lower for the conformation traits compared with the gait traits. The residual variance varied between 0.14 (‘Hind legs’) to 0.30 (‘Canter elasticity’), except for the trait ‘Development’ which had a residual variance of 0.97.

Table 9. *Heritabilities (h^2), additive genetic (σ_a^2) and residual variances (σ^2_e) with corresponding standard errors (subscripts) for linear assessed traits for Swedish Warmblood foals in 2014-2017*

Trait	σ_a^2	σ^2_e	h^2
Conformation			
Development	0.14 $_{0.06}$	0.97 $_{0.06}$	0.13 $_{0.06}$
Type	0.06 $_{0.02}$	0.24 $_{0.02}$	0.21 $_{0.06}$
Length of neck	0.05 $_{0.02}$	0.22 $_{0.02}$	0.20 $_{0.06}$
Position of shoulder	0.04 $_{0.02}$	0.27 $_{0.02}$	0.13 $_{0.05}$
Shape of croup	0.02 $_{0.01}$	0.19 $_{0.01}$	0.08 $_{0.04}$
Forelegs	0.09 $_{0.02}$	0.23 $_{0.02}$	0.28 $_{0.07}$
Hind legs	0.04 $_{0.01}$	0.14 $_{0.01}$	0.23 $_{0.07}$
Pastern	0.004 $_{0.01}$	0.16 $_{0.01}$	0.03 $_{0.03}$
Gaits			
Walk stride length	0.13 $_{0.03}$	0.28 $_{0.03}$	0.31 $_{0.07}$
Walk suppleness	0.10 $_{0.02}$	0.25 $_{0.02}$	0.30 $_{0.06}$
Trot stride length	0.17 $_{0.03}$	0.25 $_{0.03}$	0.40 $_{0.07}$
Trot elasticity	0.24 $_{0.04}$	0.24 $_{0.03}$	0.51 $_{0.08}$
Canter stride length	0.11 $_{0.03}$	0.26 $_{0.02}$	0.29 $_{0.07}$
Canter elasticity	0.11 $_{0.03}$	0.30 $_{0.03}$	0.27 $_{0.07}$
Gaits balance	0.10 $_{0.03}$	0.26 $_{0.02}$	0.28 $_{0.07}$

4.1.2.2 Evaluating traits

The heritabilities for the evaluated traits varied between 0.36 (‘Walk’) and 0.70 (‘Total’ score) (Table 10). The traits with highest heritabilities were the summarized traits, ‘Total’ score and ‘Average of gaits’. The additive genetic variances were generally low, except for ‘Total’ score (1.06), ‘Trot’ (0.26) and ‘Canter’ (0.20). The residual variance varied between 0.07 (‘Average of gaits’) to 0.22 (‘Trot’), except for the trait ‘Total’ which had a residual variance of 0.46.

Table 10. *Heritabilities (h^2), additive genetic (σ_a^2) and residual variances (σ^2_e) with corresponding standard errors (subscripts) for evaluating traits for Swedish Warmblood foals in 2014-2018*

Trait	σ_a^2	σ^2_e	h^2
Conformation	0.12 $_{0.02}$	0.18 $_{0.02}$	0.40 $_{0.07}$
Walk	0.11 $_{0.02}$	0.20 $_{0.02}$	0.36 $_{0.06}$
Trot	0.26 $_{0.04}$	0.22 $_{0.03}$	0.55 $_{0.06}$
Canter	0.20 $_{0.03}$	0.20 $_{0.03}$	0.51 $_{0.07}$
General impression	0.13 $_{0.02}$	0.10 $_{0.01}$	0.57 $_{0.07}$
Average of gaits [1]	0.13 $_{0.02}$	0.07 $_{0.01}$	0.63 $_{0.07}$
Total [2]	1.06 $_{0.13}$	0.46 $_{0.10}$	0.70 $_{0.07}$

1. Average of gaits = ('Walk' + 'Trot' + 'Canter')/3

2. Total = 'Conformation' + 'Average of gaits' + 'General impression'

4.1.3 Correlations between linear traits

Correlations between the linear conformation and gait traits are shown in Table 11. For the conformation traits the results showed few significant genetic correlations. For the trait 'Development' significant genetic correlations were found with 'Hind-legs' (0.51), 'Trot elasticity' (-0.39) and 'Canter elasticity' (-0.56). That means that a higher mark for 'Development' (well developed) was correlated to straighter hind legs and higher elasticity in both trot and canter.

The trait 'Type' showed significant genetic correlations with 'Length of neck' (0.66), 'Trot stride length' (0.42), 'Trot elasticity' (0.48), 'Canter stride length' (0.40) and 'Gait balance' (0.66). That means that a higher mark for 'Type' (heavy) was correlated to shorter neck, shorter stride length in both trot and canter, less elastic trot and more unbalanced gaits.

For the trait 'Length of neck' significant genetic correlations were found with 'Trot stride length' (0.44) and 'Trot elasticity' (0.38). That means that a higher mark for 'Length of neck' (shorter) was correlated with shorter stride length in trot and less elastic trot.

The trait 'Position of shoulder' showed significant genetic correlations with 'Trot stride length' (0.50), 'Trot elasticity' (0.41), 'Canter stride length' (0.55) and 'Gait balance' (0.52). That means that a higher mark for 'Position of shoulder' (sloping) were correlated to shorter stride length in both trot and canter, less elastic trot and more unbalanced gaits.

The phenotypic correlations between conformation traits were all generally low, ranging from -0.15 to 0.23.

All gait traits showed significant genetic correlation with each other, ranging from 0.47 ('Walk suppleness' and 'Canter elasticity') and 0.94 ('Walk stride length' and 'Walk suppleness').

The phenotypic correlations between gait traits were all generally low to medium, ranging from 0.12 to 0.59.

Table 11. *Correlations of linear profiled traits in Swedish Warmblood foals assessed 2014-2017, genetic (r_g) above diagonal, with standard error as subscripts, and phenotypic (r_p) below diagonal*

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1		.29 .22	.22 .25	.06 .29	.16 .33	-.10 .23	**.51 .23**	-.68 .62	-.18 .22	-.24 .21	-.25 .18	**-.39.17**	-.43.22	**-.56 .22**	-.25 .23
2	.23		**.66 .17**	.11 .25	.36 .24	.03 .19	.17 .20	.85 .51	.21 .18	.28 .18	**.42 .16**	**.48 .15**	**.40 .18**	.36 .19	**.66 .16**
3	-.06	.10		.28 .26	-.26 .28	.20 .19	.31 .19	.68 .56	.26 .18	.36 .18	**.44 .16**	**.38 .15**	.31 .18	.14 .19	.30 .19
4	-.14	.03	.03		-.35 .34	-.22 .21	.08 .25	1.0 .84	.37 .21	.17 .22	**.50 .20**	**.41 .19**	**.55 .20**	.30 .21	**.52 .21**
5	.10	.04	-.02	-.03		.10 .25	.07 .29	-.16 .63	-.02 .23	-.18 .24	.05 .21	.19 .19	.39 .23	.41 .25	.38 .24
6	-.07	-.07	.02	-.04	-.005		-.05 .19	.37 .52	**.55 .14**	**.50 .14**	.21 .15	.21 .14	.16 .17	-.09 .18	-.03 .17
7	.01	.01	.05	.004	.03	-.07		.12 .45	.00 .18	.09 .18	.21 .15	.16 .15	-.04 .19	-.04 .20	.15 .19
8	.03	.05	.09	.04	.01	.03	-.03		1.00 1.49	.50 .46	.48 .66	.43 .52	-.10 .17	.69 .48	.94 .88
9	-.03	.02	.04	.09	.02	.10	.01	.07		**.94 .07**	**.72 .10**	**.64 .11**	**.54 .14**	**.52 .14**	**.59 .15**
10	-.05	.06	.06	.09	-.02	.09	.01	.04	.50		**.65 .12**	**.75 .10**	**.48 .15**	**.47 .16**	**.51 .16**
11	-.08	.03	.08	.11	-.03	.05	.05	.09	.30	.27		**.91 .04**	**.52 .12**	**.57 .12**	**.67 .11**
12	-.10	.07	.07	.11	.01	.04	.06	.06	.24	.29	.59		**.60 .11**	**.72 .09**	**.86 .08**
13	-.04	.11	.12	.08	.01	.02	.07	.08	.22	.16	.30	.19		**.92 .06**	**.79 .11**
14	-.06	.10	.08	.12	.04	.01	.03	.10	.16	.21	.25	.35	.51		**.85 .08**
15	-.15	.10	.08	.14	.01	.03	.04	-.01	.12	.20	.28	.36	.31	.47	

1. Development (Not Well – Well)
2. Type (Refined – Heavy)
3. Length of neck (Long – Short)
4. Position of shoulder (Straight – Sloping)
5. Shape of croup (Sloping – Straight)
6. Forelegs (Toed in – Toed out)
7. Hindlegs (Sickle – Straight)
8. Pastern (Long – Short)
9. Walk, stride length (Long – Short)
10. Walk, suppleness (Supple – Stiff)
11. Trot, stride length (Long – Short)
12. Trot, elasticity (Elastic – Inelastic)
13. Canter, stride length (Long – Short)
14. Canter, elasticity (Elastic – Inelastic)
15. Gait, balance (Balanced – Unbalanced)

4.1.4 Correlations between evaluating traits

Correlations between evaluating conformation and gait traits are shown in Table 12. The results showed significant positive correlations between the different traits. The correlations ranged between 0.33 and 0.93. The highest correlations were found between 'Conformation' and 'General impression' (0.93) and between 'Average of gaits' and 'Trot' (0.93). The trait 'Total', i.e. the total amount of points, had the highest genetic correlation with 'General impression' (0.98) and lowest with 'Walk' (0.59).

Table 112. *Correlations of evaluating traits in Swedish Warmblood foals assessed 2014-2018, genetic (r_g) above diagonal, with standard error as subscripts, and phenotypic (r_p) below diagonal*

	Conformation	**Average of gaits**	**General imp.**	**Walk**	**Trot**	**Canter**	**Total**
Conformation		**0.66 0.07**	**0.93 0.03**	**0.33 0.11**	**0.57 0.08**	**0.79 0.06**	**0.91 0.02**
Average of gaits	0.33		**0.84 0.03**	**0.83 0.04**	**0.93 0.02**	**0.79 0.04**	**0.90 0.02**
General imp.	0.62	0.71		**0.50 0.09**	**0.70 0.05**	**0.92 0.03**	**0.98 0.01**
Walk	0.12	0.65	0.35		**0.77 0.07**	**0.40 0.10**	**0.59 0.07**
Trot	0.27	0.79	0.55	0.29		**0.56 0.08**	**0.79 0.04**
Canter	0.32	0.71	0.62	0.18	0.33		**0.88 0.03**
Total	0.80	0.79	0.92	0.42	0.62	0.64	

4.1.5 Correlations between evaluating and linear traits

Correlations between evaluating and linear traits are shown in Table 13. The results showed few significant correlations. For the evaluating trait ‘Conformation’, significant genetic correlations were found with the linear traits ‘Development’ (0.84) and ‘Length of neck’ (-0.58). That means that higher points for ‘Conformation’ were connected to better development and longer neck.

The evaluating trait ‘Walk’ had significant genetic correlations with the linear traits ‘Walk stride length’ (-0.94), ‘Walk suppleness’ (-1.00), ‘Gait balance’ (-0.56) and ‘Forelegs’ (-0.40). This means that a foal with higher points for ‘Walk’ were connected to a longer stride length and a supple walk with better balanced gaits and more toed in forelegs. The results for correlations with ‘Pastern’ never converged.

For the evaluating trait ‘Trot’ significant genetic correlations was found with the linear traits ‘Trot stride length’, ‘Trot elasticity’, ‘Gait balance’, ‘Type’, ‘Length of neck’ and ‘Position of shoulder’, ranging between -0.40 to -0.95 (Table 13).That means that higher points for ‘Trot’ were correlated to longer stride length and better elasticity in trot, more balanced gaits, a refined type with longer neck and a straighter position of shoulder.

The evaluating trait ‘Canter’ showed significant genetic correlation with the linear traits ‘Canter stride length’ (-0.97), ‘Canter elasticity’ (-0.97), ‘Gait balance’ (-0.87), ‘Development’ (0.66) and ‘Shape of croup’ (-0.45). That means that higher points for ‘Canter’ was correlated to longer stride length and better elasticity in canter, more balanced gaits, better development and a sloping shape of croup.

For the evaluating trait ‘General impression’ significant genetic correlation was found with the linear traits ‘Development’ (0.79), ‘Length of neck’ (-0.40), ‘Position of shoulder’ (-0.36), ‘Walk stride length’ (-0.50), ‘Walk suppleness’ (-0.42), ‘Trot stride length’ (-0.64), ‘Trot elasticity’ (-0.77), ‘Canter stride length’ (-0.92), ‘Canter elasticity’ (-0.90) and ‘Gait balance’ (-0.96). That means that higher points for ‘General impression’ was correlated to a better development, longer neck, straighter shoulder, longer stride length and better suppleness/elasticity in all gaits and more balanced gaits.

The final evaluating trait ‘Total’, i.e. the total amount of points, showed significant genetic correlation with the linear traits ‘Development’ (0.69), ‘Type’ (-0.35), ‘Length of neck’ (-0.48), ‘Position of shoulder’ (-0.36), ‘Walk stride length’ (-0.56), ‘Walk suppleness’ (-0.52), ‘Trot stride length’ (-0.75), ‘Trot elasticity’ (-0.86), ‘Canter stride length’ (-0.85), ‘Canter elasticity’ (-0.84) and ‘Gait balance’ (-0.95). That means that higher ‘Total’, i.e. total amount of points was correlated to better development, more refined type with longer neck, straighter position of shoulder, longer stride length and better suppleness/elasticity for all gaits and more balanced gaits.

The phenotypic correlations were high between the evaluating traits and their corresponding linear traits, ranging from -0.75 to 0.40.

Table 123. *Correlations between evaluating traits and linear traits in Swedish Warmblood foals assessed 2014-2017, genetic (r_g) with standard error as subscripts and phenotypic (r_p)*

Evaluating trait	**Linear trait**	**r_g**	**r_p**
Conformation	Development *(Not well – well)*	**0.84** $_{\mathbf{0.09}}$	0.40
	Type *(Refined – Heavy)*	-0.30 $_{0.17}$	-0.15
	Length of neck *(Long – Short)*	**-0.58** $_{\mathbf{0.14}}$	-0.25
	Position of shoulder *(Straight – Sloping)*	-0.12 $_{0.20}$	-0.19
	Shape of croup *(Sloping – Straight)*	-0.15 $_{0.27}$	0.01
	Forelegs *(Toed in – Toed out)*	-0.07 $_{0.15}$	-0.03
	Hind legs *(Sickle – Straight)*	0.13 $_{0.17}$	-0.01
	Pastern *(Long – Short)*	-0.62 $_{0.56}$	0.03
Walk	Walk length *(Long – Short)*	**-0.94** $_{\mathbf{0.05}}$	-0.65
	Walk suppleness *(Supple – Stiff)*	**-1.00** $_{\mathbf{0.05}}$	-0.67
	Gaits balance *(Balanced – Unbalanced)*	**-0.56** $_{\mathbf{0.13}}$	-0.20
	Development *(Not well – well)*	0.19 $_{0.18}$	0.07
	Type *(Refined – Heavy)*	-0.29 $_{0.15}$	-0.05
	Length of neck *(Long – Short)*	-0.29 $_{0.15}$	-0.07
	Position of shoulder *(Straight – Sloping)*	-0.31 $_{0.19}$	-0.10
	Shape of croup *(Sloping – Straight)*	0.03 $_{0.20}$	0.02
	Forelegs *(Toed in – Toed out)*	**-0.40** $_{\mathbf{0.13}}$	-0.08
	Hind legs *(Sickle – Straight)*	-0.13 $_{0.15}$	-0.01
	Pastern *(Long – Short)*	-	-
Trot	Trot, stride length *(Long – Short)*	**-0.95** $_{\mathbf{0.03}}$	-0.67
	Trot, elasticity *(Elastic – Inelastic)*	**-0.93** $_{\mathbf{0.03}}$	-0.75
	Gaits balance *(Balanced – Unbalanced)*	**-0.73** $_{\mathbf{0.09}}$	-0.38
	Development *(Not well – well)*	0.24 $_{0.16}$	0.14
	Type *(Refined – Heavy)*	**-0.46** $_{\mathbf{0.13}}$	-0.05
	Length of neck *(Long – Short)*	**-0.40** $_{\mathbf{0.14}}$	-0.08
	Position of shoulder *(Straight – Sloping)*	**-0.51** $_{\mathbf{0.17}}$	-0.12
	Shape of croup *(Sloping – Straight)*	-0.05 $_{0.18}$	-0.01
	Forelegs *(Toed in – Toed out)*	-0.12 $_{0.13}$	-0.05
	Hind legs *(Sickle – Straight)*	-0.09 $_{0.14}$	-0.05
	Pastern *(Long – Short)*	-0.25 $_{0.41}$	-0.06
Canter	Canter, stride length *(Long – Short)*	**-0.97** $_{\mathbf{0.03}}$	-0.63
	Canter, elasticity *(Elastic – Inelastic)*	**-0.97** $_{\mathbf{0.03}}$	-0.72
	Gaits balance *(Balanced – Unbalanced)*	**-0.87** $_{\mathbf{0.06}}$	-0.56
	Development *(Not well – Well)*	**0.66** $_{\mathbf{0.18}}$	0.10

	Type *(Refined – Heavy)*	-0.27 $_{0.15}$	-0.12
	Length of neck *(Long – Short)*	-0.25 $_{0.15}$	-0.10
	Position of shoulder *(Straight – Sloping)*	-0.30 $_{0.18}$	-0.11
	Shape of croup *(Sloping – Straight)*	**-0.45** $_{\mathbf{0.20}}$	-0.06
	Forelegs *(Toed in – Toed out)*	-0.03 $_{0.14}$	-0.03
	Hind legs *(Sickle – Straight)*	0.06 $_{0.16}$	-0.05
	Pastern *(Long – Short)*	-0.82 $_{0.46}$	-0.08
General impression	Development *(Not well – Well)*	**0.79** $_{\mathbf{0.11}}$	0.29
	Type *(Refined – Heavy)*	-0.29 $_{0.16}$	-0.15
	Length of neck *(Long – Short)*	**-0.40** $_{\mathbf{0.14}}$	-0.17
	Position of shoulder *(Straight – Sloping)*	**-0.36** $_{\mathbf{0.18}}$	-0.17
	Shape of croup *(Sloping – Straight)*	-0.11 $_{0.21}$	-0.002
	Forelegs *(Toed in – Toed out)*	-0.01 $_{0.14}$	-0.04
	Hind legs *(Sickle – Straight)*	0.04 $_{0.15}$	-0.06
	Pastern *(Long – Short)*	-0.66 $_{0.55}$	-0.01
	Walk, stride length *(Long – Short)*	**-0.50** $_{\mathbf{0.11}}$	-0.25
	Walk, suppleness *(Supple – Stiff)*	**-0.42** $_{\mathbf{0.12}}$	-0.29
	Trot, stride length *(Long – Short)*	**-0.64** $_{\mathbf{0.08}}$	-0.40
	Trot, elasticity *(Elastic – Inelastic)*	**-0.77** $_{\mathbf{0.06}}$	-0.48
	Canter, stride length *(Long – Short)*	**-0.92** $_{\mathbf{0.06}}$	-0.40
	Canter, elasticity *(Elastic – Inelastic)*	**-0.90** $_{\mathbf{0.06}}$	-0.48
	Gaits, balance *(Balanced – Unbalanced)*	**-0.96** $_{\mathbf{0.05}}$	-0.53
Total	Development *(Not well – Well)*	**0.69** $_{\mathbf{0.11}}$	0.34
	Type *(Refined – Heavy)*	**-0.35** $_{\mathbf{0.15}}$	-0.17
	Length of neck *(Long – Short)*	**-0.48** $_{\mathbf{0.13}}$	-0.22
	Position of shoulder *(Straight – Sloping)*	**-0.36** $_{\mathbf{0.17}}$	-0.21
	Shape of croup *(Sloping – Straight)*	-0.15 $_{0.19}$	-0.003
	Forelegs *(Toed in – Toed out)*	-0.10 $_{0.13}$	-0.06
	Hind legs *(Sickle – Straight)*	0.03 $_{0.14}$	-0.05
	Pastern *(Long – Short)*	-0.73 $_{0.81}$	-0.02
	Walk, stride length *(Long – Short)*	**-0.56** $_{\mathbf{0.10}}$	-0.30
	Walk, suppleness *(Supple – Stiff)*	**-0.52** $_{\mathbf{0.11}}$	-0.35
	Trot, stride length *(Long – Short)*	**-0.75** $_{\mathbf{0.07}}$	-0.45
	Trot, elasticity *(Elastic – Inelastic)*	**-0.86** $_{\mathbf{0.05}}$	-0.53
	Canter, stride length *(Long – Short)*	**-0.85** $_{\mathbf{0.07}}$	-0.41
	Canter, elasticity *(Elastic – Inelastic)*	**-0.84** $_{\mathbf{0.06}}$	-0.47
	Gaits, balance *(Balanced – Unbalanced)*	**-0.95** $_{\mathbf{0.06}}$	-0.54

4.2 Young Horse Test

4.2.1 Descriptive statistics

4.2.1.1 Linear traits

For the conformation traits described A (1) to I (9) the mean values varied between 4.66 (‘Shape of croup’) to 5.23 (‘Position of shoulder’) (Table 14). The linear profiling scale was not used fully for any traits. Of the 21 linear conformation traits four had observations with the extreme value 1 and two the extreme value 9. The conformation trait with the largest variation (standard deviation) was ‘Shape of neck’ (0.88) while the trait ‘Foreleg’ (toed in – toed out) had the lowest variation (0.36).

For the gait traits described A (1) to I (9) the mean values varied between 4.71 (‘Canter balance’) and 5.12 (‘Trot stride length’) (Table 14). The linear profiling scale was used fully for one trait (‘Gait direction’). Of the 15 gait traits seven had the extreme value 1 and two had the extreme value 9. The gait trait with the highest standard deviation was ‘Walk stride length’ (0.84) and ‘Trot elasticity’ (0.84) while the trait ‘Walk pace’ had the lowest variation (0.51).

For the free jumping traits described A (1) to I (9) the mean values varied between 4.62 (‘Carefulness’) and 5.09 (both ‘Technique, back’ and ‘Scope’) (Table 14). The linear profiling scale was used fully for eight traits. Of the 13 free jumping traits eight had the extreme value of 1 and all used the extreme value 9. The free jumping trait with the highest standard deviation was ‘Approach to assignment’ (0.99), while the trait ‘Balance’ had the lowest variation (0.62).

The only behaviour trait ‘Behaviour’ had the mean value 5.14. The linear scale was not used fully, the extreme value 1 was not used. The standard deviation was high (1.01).

Table 14. *Number of observations (N), mean, standard deviation (Std), minimum (min) and maximum (max) values for linear scored conformation, gait, free jumping and behavioural traits assessed at Young Horse Tests 2014-2018*

Trait	Description 1 – 9	N	Mean	SD	Min	Max
Conformation						
Type	*Refined – Heavy*	4643	4.76	0.74	1	8
Length of body	*Long – Short*	4661	4.71	0.74	2	7
Formation of body	*Long legged – Short legged*	4658	4.76	0.75	1	8
Body direction	*Uphill – Downhill*	4592	5.10	0.59	1	8
Length of neck	*Long – Short*	4652	4.80	0.69	2	8
Position of neck	*Vertical – Horizontal*	4651	4.71	0.75	2	7

Shape of neck	*Arched - Straight*	4655	4.90	0.88	2	8
Withers	*High – Low*	4660	4.89	0.67	3	7
Position of shoulder	*Straight - Sloping*	4614	5.23	0.72	3	8
Back	*Straight – Swayback*	4649	5.14	0.60	2	9
Lumbar area	*Long – Short*	4639	4.79	0.63	2	7
Shape of croup	*Sloping – Straight*	4649	4.66	0.64	2	8
Length of croup	*Long – Short*	4645	4.93	0.61	3	7
Foreleg	*Over at knee – Back at knee*	4606	5.10	0.36	4	7
Foreleg	*Toed in – Toed out*	4578	5.01	0.76	2	9
Foreleg; pastern	*Upright – Weak*	3646	5.09	0.43	2	7
Hind leg	*Sickle – Straight*	4614	4.96	0.63	1	7
Hind leg	*Cow hocked - Bowlegged*	4440	4.98	0.49	3	8
Hind leg, pastern	*Upright – Weak*	3652	5.13	0.46	2	8
Correctness of gaits	*Winging - paddling*	4506	5.10	0.54	3	8
Hooves	*Big - Small*	4549	5.01	0.40	3	7
Gaits						
Walk, pace	*Even – Uneven*	4647	4.94	0.51	3	9
Walk, stride length	*Long – Short*	4653	4.98	0.84	2	7
Walk, activity	*Hurried – Slow*	4650	5.01	0.56	2	8
Walk, suppleness	*Supple – Stiff*	4643	4.89	0.81	2	8
Trot, stride length	*Long – Short*	4654	5.12	0.75	3	8
Trot, elasticity	*Elastic – Inelastic*	3663	5.05	0.84	2	8
Trot, foreleg activity	*Shoulder free – Short*	3668	4.96	0.76	2	8
Trot, hind leg position	*Under the body – Behind the body*	4648	4.99	0.74	2	7
Trot, hind leg activity	*Active – Inactive*	4642	4.90	0.81	1	8
Canter, pace	*Even - Uneven*	4663	4.76	0.65	1	7
Canter, stride length	*Long – Short*	4655	4.75	0.77	1	8
Canter, action	*Round – Flat*	3676	4.94	0.74	1	8
Canter, elasticity	*Elastic – Inelastic*	4643	4.97	0.79	1	8
Canter, balance	*Well balanced – Unbalanced*	4651	4.71	0.77	1	7
Gaits, direction	*Uphill – Downhill*	4534	4.95	0.72	1	9
Free jumping						
Take-off	*Powerful – Weak*	4657	5.01	0.89	1	9
Take-off	*Quick – Slow*	4654	4.72	0.87	1	9
Take-off, direction	*Upwards – Forwards*	4645	4.91	0.98	1	9
Technique, forelegs	*Bent – Hanging*	4654	4.71	0.93	1	9
Technique, back	*Rounded – Hollow*	4658	5.09	0.92	2	9
Technique, hind legs	*Open – Tight*	4659	4.74	0.89	1	9
Scope	*Much - Little*	4657	5.09	0.96	2	9
Elasticity	*Elastic - Stiff*	4653	4.94	0.88	1	9
Carefulness	*Too careful – Not careful*	4657	4.62	0.96	1	9

Distance estimation	*Secure – Insecure*	4657	4.99	0.84	2	9
Balance	*Balanced – Unbalanced*	3672	4.89	0.62	1	9
Reaction	*Quick – Slow*	3674	4.83	0.77	2	9
Approach to assignment	*Focused – Unfocused*	3669	4.79	0.99	2	9
Behaviour						
Behaviour	*Relaxed – Tense*	3673	5.14	1.01	2	9

Table 15 shows the frequency of all sub-scores/checkboxes connected to some of the linearly described traits. These traits are assessed as either not present (0) or present (1). The sub-score with highest frequency was 'Type; well proportioned' (27.93%). The sub-score with lowest frequency was 'Trot, irregular rhythm' (0.3%).

Table 135. *Number of observations (N), description of presence and percentage for sub scores (scored 1 or 0) of linear assessed traits for Swedish Warmblood horses attending Young Horse Test 2014 - 2018*

Trait	Sub-score	N	Present (1)	Percent
Type	*Well proportioned*	3684	1029	27.9%
Neck	*Wide set*	3684	601	16.3%
	Low set	3685	547	14.8%
	Heavy transition	4671	167	3.6%
Position of shoulder	*Deep chest*	4671	999	21.4%
Lumbar area	*Roach back*	4671	41	0.9%
Forelegs	*Tied in*	4670	656	14.1%
	Parallel displacement of cannon bone	4671	125	2.7%
	Misplaced cannon bone	4671	581	12.4%
	Thin legs in proportion to body	3685	927	25.2%
	Outward rotated cannon bone	4671	230	4.9%
Foreleg, pastern	*Long*	3685	341	9.3%
	Short	3685	160	4.3%
Hind leg	*Tied in*	4671	213	4.6%
Hind leg, pastern	*Long*	3685	252	6.8%
	Short	3685	150	4.1%
Hooves	*Uneven*	4670	50	1.1%
	Low heels	4670	430	9.2%
Trot	*Irregular rhythm*	4670	12	0.3%
Trot, elasticity	*Movement tight to the ground*	4671	387	8.3%
Technique, forelegs	*Under body*	4670	159	3.4%
	Extended/stretched	4669	51	1.1%

4.3 Correlation between Foal inspection and Young Horse Test

4.3.1 Conformation and gaits

The genetic correlations between linear traits assessed at foal inspection and later on at YHT were generally high, presented in Table 16. For the linear conformation traits, the genetic correlation to corresponding trait at YHT varied between 0.59 (‘Position of shoulder’) to 0.93 (‘Type’). The phenotypic correlation ranged between 0.05 (‘Position of shoulder’) to 0.29 (‘Hind legs’). For the linear gait traits, the genetic correlation to corresponding trait at YHT varied between 0.71 (‘Canter elasticity’) to 0.92 (‘Canter stride length’). The phenotypic correlation ranged between 0.15 (‘Walk suppleness’) to 0.27 (‘Trot elasticity’).

Table 16. *Correlations between linear traits assessed at foal inspection and corresponding trait assessed at Young Horse Test in Swedish Warmblood horses between 2014 and 2017, genetic (r_g) with standard error as subscripts and phenotypic (r_p)*

Trait assessed at Foal Inspection and YHT	$\mathbf{r_g}$	$\mathbf{r_p}$
Conformation		
Type (*Refined – Heavy)*	**0.93** $_{0.13}$	0.19
Neck length (*Long – Short)*	**0.84** $_{0.15}$	0.18
Position of shoulder *(Straight – Sloping)*	**0.59** $_{0.24}$	0.05
Shape of croup *(Sloping – Straight)*	**0.76** $_{0.18}$	0.16
Forelegs *(Toed in – Toed out)*	**0.74** $_{0.11}$	0.25
Hind legs *(Sickle – Straight)*	**0.73** $_{0.12}$	0.29
Gaits		
Walk, stride length *(Long – Short)*	**0.79** $_{0.10}$	0.20
Walk, suppleness *(Supple – Stiff)*	**0.75** $_{0.12}$	0.15
Trot, stride length *(Long – Short)*	**0.91** $_{0.07}$	0.23
Trot, elasticity *(Elastic – Inelastic)*	**0.79** $_{0.08}$	0.27
Canter, stride length *(Long – Short)*	**0.92** $_{0.09}$	0.23
Canter, elasticity *(Elastic – Inelastic)*	**0.71** $_{0.13}$	0.22

4.3.2 Canter and Jumping technique

At foal inspection no traits for jumping are described. In an earlier study the trait ‘Canter’ seemed to have the strongest correlation to jumping traits (Edlén 2008). Therefor the linearly described traits for canter at foal inspection were analysed to see if they had any correlations to the linear jumping traits described at YHT (Table 17). The results showed few significant correlations.

For the trait ʻCanter stride lengthʼ (described at foal inspection) significant genetic correlation was found with ʻTake-offʼ (-0.35), ʻForeleg techniqueʼ (-0.31) and ʻReactionʼ (-0.38). That means that higher marks for ʻCanter stride lengthʼ (short) was connected to being quicker in take-off, have a more bent foreleg technique and quick reactions at YHT free jumping.

For the trait ʻCanter elasticityʼ (described at foal inspections) significant genetic correlation was found with ʻBalanceʼ (0.49) and ʻTake off speedʼ (-0.39). That means that higher marks for ʻCanter elasticityʼ (inelastic) was connected to being more unbalanced and quicker in take off at YHT free jumping.

For the trait ʻGait balanceʼ (described at foal inspections) significant genetic correlation was found with ʻBalanceʼ (0.51), ʻReactionʼ (-0.64), ʻForeleg techniqueʼ (-0.49) and ʻTake off speedʼ (-0.39). That means that higher marks for ʻGait balanceʼ (unbalanced) was connected to being more unbalanced, have quicker reactions, more bent foreleg technique and quicker take off speed at YHT free jumping.

Tabell 17. *Correlations between linear canter traits and the trait gait balance assessed at foal inspection and jumping traits assessed at Young Horse Test in Swedish Warmblood horses. Genetic (r_g) with standard error as subscripts and phenotypic (r_p)*

Foal inspection	**YHT**	**r_g**	**r_p**
Canter, stride length	Take-off *(Powerful – Weak)*	-0.08 $_{0.13}$	-0.06
(Long – Short)	Take-off *(Quick – Slow)*	**-0.35 $_{0.15}$**	-0.09
	Take-off, direction *(Upwards – Forwards)*	-0.08 $_{0.14}$	0.05
	Technique, forelegs *(Bent – Hanging)*	**-0.31 $_{0.15}$**	0.04
	Technique, back *(Rounded – Hollow)*	0.07 $_{0.14}$	0.09
	Technique, hind legs *(Open – Tight)*	-0.17 $_{0.15}$	-0.02
	Scope *(Much – Little)*	-0.08 $_{0.11}$	-0.01
	Elasticity *(Elastic – Stiff)*	0.23 $_{0.16}$	-0.06
	Carefulness *(Too careful – Not careful)*	-0.22 $_{0.18}$	-0.06
	Distance estimation *(Secure – Insecure)*	-0.25 $_{0.19}$	-0.05
	Balance *(Balanced – Unbalanced)*	0.23 $_{0.22}$	0.06
	Reaction *(Quick – Slow)*	**-0.38 $_{0.17}$**	-0.03
	Approach to assignment *(Focused – Unfocused)*	-0.41 $_{0.22}$	-0.05
Canter, elasticity	Take-off *(Powerful – Weak)*	0.02 $_{0.13}$	0.09
(Elastic – Inelastic)	Take-off *(Quick – Slow)*	**-0.39 $_{0.15}$**	-0.01
	Take-off, direction *(Upwards – Forwards)*	0.09 $_{0.13}$	0.05
	Technique, forelegs *(Bent – Hanging)*	-0.28 $_{0.15}$	0.09
	Technique, back *(Rounded – Hollow)*	0.10 $_{0.14}$	0.08
	Technique, hind legs *(Open – Tight)*	-0.11 $_{0.15}$	0.02
	Scope *(Much – Little)*	0.02 $_{0.11}$	0.09
	Elasticity *(Elastic – Stiff)*	0.29 $_{0.16}$	0.03

	Carefulness *(Too careful – Not careful)*	-0.05 $_{0.18}$	-0.02
	Distance estimation *(Secure – Insecure)*	-0.07 $_{0.19}$	0.01
	Balance *(Balanced – Unbalanced)*	**0.49** $_{\mathbf{0.21}}$	0.06
	Reaction *(Quick – Slow)*	-0.31 $_{0.17}$	0.05
	Approach to assignment *(Focused – Unfocused)*	-0.36 $_{0.22}$	0.08
Gait, balance	Take-off *(Powerful – Weak)*	-0.25 $_{0.14}$	-0.03
(Balanced – Unbalanced)	Take-off *(Quick – Slow)*	**-0.39** $_{\mathbf{0.15}}$	-0.01
	Take-off, direction *(Upwards – Forwards)*	-0.08 $_{0.14}$	0.06
	Technique, forelegs *(Bent – Hanging)*	**-0.49** $_{\mathbf{0.15}}$	0.04
	Technique, back *(Rounded – Hollow)*	-0.05 $_{0.14}$	0.01
	Technique, hind legs *(Open – Tight)*	**-0.39** $_{\mathbf{0.15}}$	-0.01
	Scope *(Much – Little)*	-0.21 $_{0.12}$	-0.05
	Elasticity *(Elastic – Stiff)*	0.08 $_{0.17}$	0.03
	Carefulness *(Too careful – Not careful)*	-0.14 $_{0.18}$	-0.03
	Distance estimation *(Secure – Insecure)*	-0.31 $_{0.17}$	-0.01
	Balance *(Balanced – Unbalanced)*	**0.51** $_{\mathbf{0.18}}$	0.05
	Reaction *(Quick – Slow)*	**-0.64** $_{\mathbf{0.14}}$	-0.05
	Approach to assignment *(Focused – Unfocused)*	**-0.63** $_{\mathbf{0.20}}$	-0.03

5 Discussion

5.1 Foal inspection

In the earlier study by Edlén (2008) the number of annually attending foals at foal inspections between 2003-2006 was approximately 1000 foals, corresponding to approximately 30% of the SWB foal population. In this study the numbers of annually attending foals between 2014-2018 were about 500, or 24% of live born foals. The number of attending foals has followed the downward trend of covered mares and there has been a slight decrease in proportion assessed foals out of the foals born. Work on increasing the number of covered mares and also the number of attending foals are of high importance in order to get valid results from the data.

The removal of quality classes in SWB foals 2014, due to the fact that over 70% of the attending foals achieved the highest classification, might have been seen negative from the breeders' point of view, hence making the attendance less important. As mentioned by the British Breeding (BB), the breeders need feedback and recognition to keep the interest of participation and in order to deliver large amount of data (Broomer, 2019). The foals that score above 77-80% at foal inspection qualifies to the regional foal championships, earlier all foals with a score above 75% got ranked as Class 1 (Edlén, 2008). One suggestion would be to incorporate a quality class to the top-scored foals showed during the year, for example the 25% best, and the above average (25-50%) scored foals, with an opportunity to send some type of certificate to the breeders and/or horse owners and market the results afterwards. It would be a delayed process, since the foal inspection results must be reported back and looked through, but it would result in quality classes with higher impact for the breeders and work as a marketing tool for breeders, which might enhance the level of attendance at foal inspections. If the foals would be divided into different classes in that way, the system would not be affected or in need of renewal if the scoring system for the foal inspection changed or switched scale, there would always be the

top 25% of every year shown foals. The foals are not prepared for attending events during the next coming spring, such as the older 3-year-old horses are, so the results would not affect any training possibilities.

Since cooperation between studbooks regarding linear data is encouraged and indicates to generate more accurate estimations of breeding values the work on development of equal assessment in some of the traits and transparency between studbooks regarding the linear data are of interest for further development (Sperrle et al. 2016). SWB and Oldenburg have started a joint project on the subject and Oldenburg already use their foal inspection data in estimations of breeding values (Sperrle et al. 2016). Hopefully SWB will follow that trend in a near future.

The reported data from foal inspections were of shifting quality and in some cases completely missing from some SWB regional associations. This might be due to time limitation and use of paper protocols that needs to be sent back from the regional SWB associations before being manually converted into digital excel-files. The conversion of paper protocols into excel-files also seem to lack standard formats, which has led to data being reported in various ways over the years. The development of a standardised converting format would ease the later editing of the data and minimize human made errors associated to the digital conversion, if the transition to digital protocols on tablet PC will delay further.

In this study there were no reported data of which judge that assessed at the different foal inspections. This information might be of interest for future studies, since some of the earlier studies of foal data have shown significant effect of judge (Preisinger, Wilkens & Kalm 1991). Effect of event (location and year) has been used to take into account the situation at each inspection, considering the effect of judge and environmental effects. The same judge can work at multiple events both in a year and over the years. A possible way of including the effect of judge could be by giving each judge a personal number, that could be noted in the digital files in order to not use the real names in the digital version, making it easier to analyse. There is also a risk of human made error, when at present, each name are spelled in the reported digital version. Results from that could be seen in this study as the regional SWB association was named differently both within and between each year and therefore had the need to be coded in this study.

When viewing foal inspections and YHT you can see a difference in how the horses are shown depending on how the handler of the horses have prepared the horses for the task and also how they act during the events. At present there are no score for how well the horse is shown for the day, which might have an effect on the results. It would be of great interest to analyse data and see whether or not a professional trainer of young horses has a significant effect on the results or not. In reality it would also benefit the trainers since their work would be recognised in a more practical way. Today most judges give the oral judgement of "well shown" at

the events but an implementation of a score describing how well the horse is shown could lead to horse owners taking the events more seriously, by preparing both themselves and the horses more. The Oldenburg have a presentation trait under the category movement in hand were the ‘Influence of the handler’ are described between the extremes negative and positive (Appendix 3).

It was also found in this study that age at inspection had a significant effect on the traits at inspection, which is in line with Bösch et al. (2000) but not with the study by Preisinger, Wilkens & Kalm (1991). Further, event, year and sex had significant effect which was also shown by Bösch et al. (2000), which means that these traits are of importance to include in the model when analysing or estimating breeding values.

The use of linear profiling generates large amount of valuable data for use in both research and for the breeders and horse owner’s choice of selection. Since the aim of the linear assessment is to be as objective as possible it should not be thought as replacement for the traditional evaluating assessment. The evaluating assessment works as method for reaching the breeding goal and the linear assessment as an objective magnifier of all the smaller traits within. Instead work should be done on establishing how to include the foal data in the estimation of breeding values, spread common knowledge about both the foal data and the linear assessment and how to interpret/use the results from it for horse owners.

5.1.1 Evaluating traits

In this study the evaluating traits at foal inspections had high heritabilities, 0.36-0.70, which is equal or above the results in earlier studies for Holstein, OLNA and GSH (Bösch et al. 2000; Bhatnagar et al. 2011; Schöpke et al. 2013) as well as in line with earlier results for the SWB population (Edlén, 2008).

The evaluating trait ‘General impression’ had low variation, with a standard deviation of 0.50 (Table 8), and a high heritability of 0.57 (Table 10), but also seems to be some sort of overall score, since the trait is defined as a score for development, general condition, harmony and charisma. In addition to high genetic correlation to the ‘Total’ score (-0.98), the trait ‘General impression’ also had high genetic correlation to stride length and elasticity in canter as well as gait balance and development (Table 13). In my opinion I would have separated the trait general impression into subtraits to be used in the linear description as ‘Development’ (which already exists), ‘General condition’, ‘Harmony’ and ‘Charisma’. This would give a better description/view of how the traits actually appears.

For the sub-traits related to some of the linear traits, assessed as present or not present, the frequencies were similar between the assessments at foal inspection and YHT for ‘Well-proportioned type’, ‘Parallel displacement of cannon bone’ and

‘Outward rotated cannon bone’ (Table 7 and 15). For the sub-traits ‘Low set neck’, ‘Deep chest’ and ‘Movement tight to the ground in trot’ the frequencies were higher in the YHT assessment. This could indicate that these traits are harder to judge in young foals, or that these traits are the ones that change the most during the growth period.

5.1.2 Linear traits

Duensing, Stock & Krieter (2014) stated in their summary of studies that linear traits had similar estimated heritabilities as the corresponding evaluating traits. Similar results are not found in this study or in the study by Viklund & Eriksson (2018). In this study the linear gait traits had lower heritabilities than the corresponding evaluating traits. Especially the canter traits where the heritability of the evaluating score ‘Canter’ was 0.51 and heritabilities for linear traits were 0.29 for ‘Canter stride length’ and 0.27 for ‘Canter elasticity’. The results are similar to the earlier study on SWB 3-year-olds, with the difference that in this study the linear trot traits described at foal inspection had especially lower heritabilities compared to the results for YHT in Viklund & Eriksson (2018).

Since there are few studies on evaluating data and only one regarding linear profiling on foals in warmblood sport horse populations there is not much to compare the results with. The estimated heritabilities for conformation and gaits are in line with or higher than the heritabilities Stock et al. (2019) estimated for similar traits assessed in Oldenburg foals.

In the earlier study by Edlén (2008) ‘Correctness of legs’ had the lowest heritability (0.02). In this study heritabilities of traits connected to the legs were equal or well above, ranging from 0.03 to 0.28. This indicates that the use of linear profiling could benefit the traits connected to correctness of legs the most, which also is in accordance to the conclusion of the review by Duensing, Stock & Krieter (2014).

The linear trait ‘Development’ is the only linear trait described on a smaller scale: A, C or E. In this study the trait shows a heritability of 0.13 (Table 9) and has a high genetic correlation to ‘Total’ score, ‘Canter’ and ‘Conformation’. It would be of interest to expand the description to the same scale as the other traits are described on: A, B, C, D or E.

According to the descriptive results the extreme version of the trait ‘Pastern’ (short pastern), does not exist in the population and ‘Weak pasterns’ are available to note as a sub-trait. Overall the results for ‘Pastern’ were hard to analyse, do to very few significant results. This might indicate that the trait is hard to describe. In the future it would be of interest to either develop the definition of the described trait, refine the approach of examination in order to hopefully get more useful data/information or even skip the trait.

5.1.3 Correlations between evaluating and linear trait

The conformation of foals is scored as one trait in the evaluating part of the assessment. In this study that trait was compared to the eight linear conformation traits. The results showed that a higher score for ‘Conformation’ had high genetic correlation to being more developed and having a longer neck, which is right in line with the breeding goal of the SWB horse (SWB 2015). For the evaluating gait traits, the corresponding linear traits had strong genetic correlation, ranging between -0.93 and -1.00. The phenotypic correlations between them were also high, ranging between -0.63 and -0.75. The results are similar to the earlier study made on evaluating and linear traits in 3-year-old SWB horses (Viklund & Eriksson 2018).

The evaluating ‘Total’ score generally had moderate to strong genetic correlations to all linear traits, ranging from -0.35 to -0.95. The evaluating ‘Total’ score is a measure of “how good” a foal is, or of how well they fulfil the breeding goal. According to this study high ranked foals have balanced gaits, elasticity and long stride length in all three gaits, well developed body, long neck, straighter shoulders and a more refined type.

5.2 Correlations between traits assessed at foal inspection and YHT

The results from this study show high genetic correlations between linear traits assessed at foal inspection and corresponding trait at YHT. For the conformation traits the genetic correlation ranged from 0.59 to 0.93, and for the gait traits between 0.71 to 0.92. This is in accordance to the earlier study of Oldenburg horses, where most linear traits were correlated above 0.5 (Wobbe et al 2019).

The linear trait ‘Type’ had a genetic correlation of 0.93 between foal inspection and YHT. The relationship between the evaluating trait ‘Type’ showed similar results regarding genetic correlation in the study made by Edlén (2008), which were slightly higher than in the earlier studies by Bösch et al. (2000) and Schöpke et al. (2013) were the genetic correlation between the evaluating trait ‘Type’ were 0.88 and 0.85.

A comparison between the results in this study and the study by Edlén (2008), who investigated evaluating traits, shows similar or slightly weaker correlations for the linear traits, except for the phenotypic correlation of leg traits, where the linear traits have stronger correlations than the evaluating trait ‘Correctness of legs’. The phenotypic correlation of ‘Position of shoulder’ showed the absolute weakest results (0.05). The much lower phenotypic correlation between the assessments could be due to traits being harder to assess in foals. The results also show that the separate assessment of all three gaits results in similar or slightly higher genetic correlation

to corresponding trait in older horses than in the earlier studies were foal gaits only are assessed as one trait (Schöpke et al. 2013; Bösch et al. 2000).

Since linear traits are more objective, although being subjectively assessed, than evaluating traits they are not connected to the breeding goal but can rather describe the trends of conformation and gaits in the population. The large amount of data and available linear profiles of mares and stallions works as a valuable tool for selection when breeding horses. Since the foal data has high genetic correlation to the YHT data it could be possible to add the data in the estimation of linear profiles, hence leading to larger amount of offspring data and faster development of the data results, giving an earlier prediction. SWB says that at least 15 offspring are required to get a somewhat true offspring data (SWB 2015), yet breeding values currently are presented at the number of ten offspring. This is due to the low number of offspring per stallion and it is motivated to get somewhat more unsecure breeding values rather than no breeding values at all.

5.2.1 Jumping traits

The results for the genetic correlation between linear foal traits and jumping traits at YHT were difficult to analyse. There seems to be a connection between stride length and elasticity in canter as well as the overall gait balance with some of the YHT jumping traits. These results serves only as indications because of their weak significance level, due to the yet small amount of data. The conclusion of it would be that at present jumping traits are suitable to be measured in older horses, attending YHT. The data from foal inspection traits did not work as indicators for traits that would be beneficial for jumping horses, but the subject would be of great interest to investigate further in the future since good jumping skills is in the SWB breeding goal.

5.3 Conclusion

Results from this study shows that:

- **Foal data has potential to be used in the future estimation of linear breeding values/indexes**. The traits had low to medium heritability and all conformation and gait traits described at foal inspection and their corresponding trait at YHT had strong genetic correlations. Few linear traits had significant genetic correlations with other linear traits.
- The evaluating conformation and gait traits had medium/high heritability and few traits had significant genetic correlations with linear traits
- The amount of data was not large enough to find any certain correlations between linearly described traits at foal inspection and free jumping traits at YHT.

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Appendix 1 Protocol SWB foal Inspection 2018

Fölbedömning

Arrangör/Datum……

Nr. Hästnamn: Kön: Reg nr:

Uppfödare: Ägare:

e. u. Färg

☒ Hoppstammat föl ☒ Dressyrstammat föl

Linjärbeskrivning Född:_____

	EXTERIÖR	**Extremvariant**						**Extremvariant**	**Kommentar**
			A	B	C	D	E		
1	Utvecklingsfas	outvecklad	☒		☐		☒	välutvecklad	
2	Typ	ädel	☒	☒	☐	☒	☒	grov	☒ väl proportionerlig
3	Halsens längd	lång	☒	☒	☐	☒	☒	kort	☒ lågt ansatt
4	Bogens position	liggande	☒	☒	☐	☒	☒	brant	☒ djup bål
5	Korsets lutning	stupande	☒	☒	☐	☒	☒	rakt	
6	Framben	intåad	☒	☒	☐	☒	☒	uttåad	☒ avvikande inskening ☒ fransysk
7	Bakben	krokhasig	☒	☒	☐	☒	☒	rakhasig	
8	Kotor	långa	☒	☒	☐	☒	☒	korta	☒ veka kotor
	GÅNGARTER	**Extremvariant**						**Extremvariant**	**Kommentar**
			A	B	C	D	E		
9	Skritt: steglängd	lång	☒	☒	☐	☒	☒	kort	
10	Skritt: rörlighet	rörlig	☒	☒	☐	☒	☒	låst	
11	Trav: steglängd	lång	☒	☒	☐	☒	☒	kort	
12	Trav: elasticitet	elastisk	☒	☒	☐	☒	☒	oelastisk	☒ markbunden
13	Galopp: språnglängd	lång	☒	☒	☐	☒	☒	kort	
14	Galopp: elasticitet	elastisk	☒	☒	☐	☒	☒	oelastisk	
15	Gångarter: balans	balanserad	☒	☒	☐	☒	☒	obalanserad	

Poängbedömning

BEDÖMNING	**Kommentar**	**Poäng**	
Exteriör:			
Skritt			Genomsnitt gångarter
Trav			
Galopp			
Allmänt intryck:			
		TOTALPOÄNG:	
		PROCENT (%):	

ÖVRIGT**:**

Domarunderskrift	Domarunderskrift

Poängbedömningen innefattar: Exteriör; Typ, huvud-hals-bål och extremiteter. Gångarter; genomsnitt av skritt, trav och galopp. Allmänt intryck; utvecklingsfas, allmäntillstånd, harmoni och utstrålning.
Poängförklaring: 10=utmärkt, 9=mycket bra, 8=bra, 7=ganska bra, 6=godkänd, 5=med tvekan godkänd, 4= ej fullt godkänd, 3=ganska dålig, 2=dålig, 1=mycket dålig/ej visningsbar. Halva poäng kan ges.

Appendix 2 Protocol SWB YHT 2019

Unghästtest

Arrangör/Datum……..

Nr. **Hästnamn:** Kön: Reg nr:
Uppfödare: Ägare: Visas av
e. u. Färg:

Linjärbeskrivning Mankhöjd_____cm

	EXTERIÖR	**Extremvariant**	A B C	D E F	G H I	**Extremvariant**	**Kommentar**
1	Typ	ädel	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	grov	☐ väl proportionerlig
2	Kroppsform a	lång	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	kort	
3	Kroppsform b	högställd	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	lågställd	
4	Kroppens riktning	uppförsbacke	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	framvikt	
5	Halsens längd	lång	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	kort	☐ brett ansatt
6	Halsens position	vertikal	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	horisontell	☐ lågt ansatt
7	Halsens form	välvd	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	rak	☐ grov övergång huvud-hals
8	Manke	hög	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	låg	
9	Bogens position	liggande	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	brant	☐ djup bål
10	Rygg	rak	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	svank	
11	Ländrygg	lång	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	kort	☐ karp
12	Korsets lutning	stupande	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	rakt	
13	Korsets längd	långt	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	kort	
14	Framben	bockbent	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	sabelbent	☐ knipt ☐ parallellförskj. ☐ felaktigt inskenad
15	Framben	intåad	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	uttåad	☐ gracil ☐ fransysk
16	Framkotor	upprätade	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	veka	☐ långa ☐ korta
17	Bakben	krokhasig	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	rakhasig	☐ knipt under has
18	Bakben	hasträng	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	hjulig	
19	Bakkotor	upprätade	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	veka	☐ långa ☐ korta
20	Rörelsernas korrekthet	nystar	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	biljarderar	
21	Hovar	stora	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	små	☐ ojämn storlek ☐ understuckna trakter
	GÅNGARTER	**Extremvariant**	A B C	D E F	G H I	**Extremvariant**	**Kommentar**
22	Skritt takt	taktmässig	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	oregelbunden	
23	Skritt steglängd	lång	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	kort	
24	Skritt energi	överilad	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	oengagerad	
25	Skritt rörlighet	rörlig	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	låst	
26	Trav steglängd	lång	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	kort	☐ otaktmässig
27	Trav elasticitet	elastisk	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	oelastisk	☐ markbunden
28	Trav framb. aktivitet	bogfri	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	kort/låst	
29	Trav bakb. position	väl undersatt	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	bakom sig	
30	Trav bakb. aktivitet	aktiv	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	inaktiv	
31	Galopp takt/rytm	taktmässig	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	oregelbunden	
32	Galopp språnglängd	lång	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	kort	
33	Galopp aktion	rund	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	flack	
34	Galopp elasticitet	elastisk	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	oelastisk	
35	Galopp balans	balanserad	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	obalanserad	
36	Gångart: rörelseriktn.	uppförsbacke	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	framvikt	

Domarsignatur

_____

Unghästtest

Arrangör/Datum……..

Hästnamn: Reg nr:

	HOPPNING	Extremvariant	A B C	D E F	G H I	Extremvariant	Kommentar
37	Avstamp	kraftfullt	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	svagt	
38	Avsprång: snabbhet	snabbt	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	långsamt	
39	Avsprång: riktning	uppåt	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	framåt	
40	Teknik: framben	böjda	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	hängande	☐ under kroppen ☐ utsträckta
41	Teknik: rygg	rundad	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	sänkt	
42	Teknik: bakben	öppnar upp	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	kniper	
43	Scope	stort	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	litet	
44	Elasticitet	mjuk, elastisk	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	stel	
45	Försiktighet	överförsiktig	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	oförsiktig	
46	Taxeringsförmåga	säker	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	osäker	
47	Balans	balanserad	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	obalanserad	
48	Reaktionsförmåga	snabb	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	långsam	
49	Inställning till uppg.	fokuserad	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	ofokuserad	
50	Beteende	avspänd	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	spänd	

Poängbedömning

BEDÖMNING		Kommentar	Gångarter	Hoppning
Exteriör	Typ			
	Huvud hals bål			
	Extremiteter			
Gångarter	Skritt			
	Trav			
	Galopp			
Hopp	Teknik o förmåga:			
	Temperament:			
TOTALPOÄNG:				

KLASS GÅNGARTER	**Diplom** ☐	**Klass 1** ☐	**KLASS HOPPNING**	**Diplom** ☐	**Klass 1** ☐

ÖVRIGT:

RIDPROV (se särskilt protokoll)	**Godkänt** ☐	**Ej godkänt** ☐	**Ej utfört** ☐

Domarunderskrift	Domarunderskrift

50

För kvalitetsgradering av stoet skall ansökan skickas till ASVH. Protokoll och verifierade meriter skall bifogas.

Poängförklaring: 10=utmärkt, 9=mycket bra, 8=bra, 7=ganska bra, 6=godkänd, 5=med tvekan godkänd, 4= ej fullt godkänd, 3=ganska dålig, 2=dålig, 1=mycket dålig/ej visningsbar, halvpoäng får användas.

Appendix 3 Protocol Oldenburg 2017

Catalogue no.: _____ Place: _____ Date: ____ . ____ . _____

UELN: _____ born on ____ . ____ . _____ Sex: ☐ female ☐ male

Event: ☐ FR ☐ SBI ☐ MPT ☐ SI ☐ SA Assessor: _____ Assistance: _____

CONFORMATION		☐ presented	3	2	1	0	1	2	3	
Format	Breed type	plain								true to type
	Gender expression	weak								strong
	Frame	small-framed								large-framed
	Caliber	light								heavy
	Chest width	narrow								wide
	Barrel	shallow (tucked-up)								deep
	Umbilical thickening									marked umbilical thickening
	Condition	skinny								fat
	Development	poor								much
	Length of legs	short-legged								long-legged
	Harmony of proportions	unharmonious								harmonious
	Body shape	square								(long-)rectangular
	Body direction	downhill								uphill
Front	Head shape	coarse								fine
	Head length	short								long
	Eye size	small								large
	Eye colour	white in the eye								much white in the eye
			☐unilateral				☐bilateral			
		blue eye (fish eye)								marked blue eye (fish eye)
			☐unilateral				☐bilateral			
	Mouth	short								long
	Length of ears	short								long
	Head-neck connection	heavy								light
	Cheeks (jowl)	heavy								light
	Length of neck	short								long
	Set of neck	low								high
	Muscling area of neck	ewe-necked								top line dominated neck
	Shape of neck	straight								arched
	Strength of neck	thin								thick
	Neck connection to withers									marked notch/dip
	Length of withers	short								long
	Height of withers	flat								high
	Length of shoulder	short								long
	Shoulder angle	straight								sloping
	Shoulder position									clearly pushed forward
Topline	Length of back	short								long
	Course of topline	disturbed								straight
	Line (strength) of back	dipped								roached
	Line (strength) of loins	dipped (weak)								roached
	Length of croup	short								long
	Angle (inclination) of croup	flat (level)								sloping
	Shape of croup	angular								round
	Set of tail	low								high
Limbs	Position of carpus	over at knee								back at knee
	Stance of front limbs									camped under
	Length of forelimb pastern	short								long
	Stance of forelimb pastern	upright								sloping (weak)
	Broken toe axis in front limbs									markedly broken toe axis
	Length of cannon bones	short								long
	Definition of foreleg joints	flat (weak)								distinct
	Vertical congruity of forelegs									markedly offset knees
	Carpus-cannon articulation	flat								tied-in
	Elbow position	tied-in elbow								loose elbow
	Stance of hind limbs	camped under								stretched (camped out)
	Length of hind limb pastern	short								long
	Stance of hind limb pastern	upright								weak
	Broken toe axis in hind limbs									markedly broken toe axis
	Hock angulation	straight								angulated
	Hind leg									round
	Capped hock									markedly capped hock
			☐unilateral				☐bilateral			
	Curby hock									markedly curby hock
			☐unilateral				☐bilateral			

	Tarsus-cannon articulation	flat								tied-in
	Size of joints	small								big
	Definition of joints	poorly defined								well defined, bony
	Overall quality of legs	blurred								lean / dry
	Joint effusion									marked joint effusion
	Epiphyseal swelling									marked epiphyseal swelling
	Shape of feet (hoof size)	narrow, small								wide, big
	Heel height	flat hoof (-3), low heels								high heels, club foot (+3)
	Hoof asymmetry (uneven shape of feet)									markedly uneven feet
Correctness / special remarks	**Toe stance of forelegs**	toe-in								toe-out
			☐unilateral				☐bilateral			
	Standing position of front limbs	base-narrow								base-wide
			☐unilateral				☐bilateral			
	Position of carpus - front view	wide at knees (bow-legged)								narrow at knees (knock-kneed)
	Toe stance of hind legs	toe-in								toe-out
			☐unilateral				☐bilateral			
	Standing position of hind limbs	base-narrow								base-wide
			☐unilateral				☐bilateral			
	Position of hock - back view	bow-hocked								cow-hocked
	Correctness of limb movement	plaiting (brushing)								dishing (winging)
			☐unilateral				☐bilateral			
	Rotation in the hock									marked rotation
			☐unilateral				☐bilateral			
	Irregularity									marked irregularity
	☐Lameness									
	Coordination									uncoordinated
	Tail position									markedly off-center
	Tail tone	un-toned								over-toned
	☐Tail plaited ☐Tail toupet									
	Breathing sound									marked breathing sound

MOVEMENT IN HAND		**☐ presented**	**3**	**2**	**1**	**0**	**1**	**2**	**3**	
Walk	**Rhythm**	irregular								regular
	Pace									clear 2-beat (lateral walk)
	Activity	lazy								diligently striding
	Suppleness	stiff								elastic
	Freedom of shoulders	short								long
	Reach of hind limbs (overstepping)	inactive (short)								active (long)
Trot	**Rhythm**	irregular								regular
	Freedom of shoulders	short								long
	Mechanics of front limbs	straight forelimb								much knee action
	Impulsion	weak								powerful
	Thrust (hind limb activity)	inactive, sluggish								active, energetic
	Carrying power	pushing								carrying
	Balance	lack of balance								very balanced
	Suppleness	tense								supple
	Ground covering	little								much
	Direction of movement	downhill								uphill
Behaviour	**Confidence**	timid, shy								confident
	Temperament	very calm								nervous
	Cooperativeness	incooperative, dominant								cooperative, obedient
	Teeth grinding									permanent teeth grinding
Presentation	**Influence of the handler**	negative								positive

FREE MOVEMENT		☐ presented	3	2	1	0	1	2	3	
Walk	Rhythm	irregular								regular
	Pace									clear 2-beat (lateral walk)
	Activity	lazy								diligently striding
	Suppleness	stiff								elastic
	Freedom of shoulders	short								long
	Reach of hind limbs (overstepping)	inactive (short)								active (long)
Trot	Rhythm	irregular								regular
	Freedom of shoulders	short								long
	Mechanics of front limbs	straight forelimb								much knee action
	Impulsion	weak								powerful
	Thrust (hind limb activity)	inactive, sluggish								active, energetic
	Carrying power	pushing								carrying
	Balance	lack of balance								very balanced
	Suppleness	tense								supple
	Ground covering	little								much
	Direction of movement	downhill								uphill
	Movement against the neck									markedly against the neck
Canter	Freedom of shoulders	short								long
	Mechanics of front limbs	straight forelimb								much knee action
	Rhythm	irregular (4-beat)								regular
	Direction of movement	downhill								uphill
	Alignment									markedly skewed
	Thrust (hind limb activity)	inactive, sluggish								active, energetic
	Suppleness	stiff								supple
	Carrying power	pushing								carrying
	Balance	lack of balance								very balanced
	Suspension period / ground covering	little								much
Free jumping	Rhythm	not fluent								fluent
	Elasticity	stiff / tense								elastic
	Balance	poorly balanced								well balanced
	Take-off power	weak								powerful
	Reflexes	slow								quick
	Attention	inattentive								attentive
	Overview	little								much
	Jumping ability	little scope								much scope
	Willingness to perform	little								much
	Preparation	negative								positive
	Foreleg angulation	straight								angulated
	Uneven forelegs									markedly uneven
	Pointing of the forelegs	foreleg under body								reaching-out foreleg
	Back technique (bascule)	hollow back								rounded back
	Alignment									markedly tilted back
	Hind leg technique (haunches)	tight (under the body)								long hind leg
	Tucking up of hind legs	standing hind leg								open
Special remarks	Irregularity									markedly irregular
	☐ Lameness									
	Coordination									uncoordinated
	Tail position									markedly off-center
	Tail tone	un-toned								over-toned
	☐ Tail plaited ☐ Tail toupet									
	Breathing sound									marked breathing sound
Behaviour	Confidence	timid, shy								confident
	Temperament	very calm								nervous
	Cooperativeness	incooperative, dominant								cooperative, obedient

MOVEMENT UNDER RIDER / ON THE LUNGE		☐ presented	3	2	1	0	1	2	3	
Walk	**Rhythm**	irregular								regular
	Pace									clear 2-beat (lateral walk)
	Activity	lazy								diligently striding
	Suppleness	stiff								elastic
	Freedom of shoulders	short								long
	Reach of hind limbs (overstepping)	inactive (short)								active (long)
Trot	**Rhythm**	irregular								regular
	Freedom of shoulders	short								long
	Mechanics of front limbs	straight forelimb								much knee action
	Impulsion	weak								powerful
	Thrust (hind limb activity)	inactive, sluggish								active, energetic
	Carrying power	pushing								carrying
	Balance	lack of balance								very balanced
	Suppleness	tense								supple
	Ground covering	little								much
	Direction of movement	downhill								uphill
	Alignment									markedly skewed
Canter	**Freedom of shoulders**	short								long
	Mechanics of front limbs	straight forelimb								much knee action
	Rhythm	irregular (4-beat)								regular
	Direction of movement	downhill								uphill
	Alignment									markedly skewed
	Thrust (hind limb activity)	inactive, sluggish								active, energetic
	Suppleness	stiff								supple
	Carrying power	pushing								carrying
	Balance	lack of balance								very balanced
	Suspension period / ground covering	little								much
Jumping	**Rhythm**	not fluent								fluent
	Elasticity	stiff / tense								elastic
	Balance	poorly balanced								well balanced
	Take-off power	weak								powerful
	Reflexes	slow, inflexible								quick, flexible
	Attention	inattentive								attentive
	Overview	little								much
	Jumping ability	little scope								much scope
	Willingness to perform	little								much
	Preparation	negative								positive
	Foreleg angulation	straight								angulated
	Uneven forelegs									markedly uneven
	Pointing of the forelegs	foreleg under body								reaching-out foreleg
	Back technique (bascule)	hollow back								rounded back
	Alignment									markedly skewed
	Hind leg technique (haunches)	tight (under the body)								long hind leg
	Tucking up of hind legs	standing hind leg								open
Special remarks	**Correctness of limb movement**	plaiting (brushing)								dishing (winging)
			☐unilateral				☐bilateral			
	Rotation in the hock									marked rotation
			☐unilateral				☐bilateral			
	Irregularity									markedly irregular
	☐**Lameness**									
	Coordination									uncoordinated
	Tail position									markedly off-center
	Tail swishing									frequent swishing
	Tail tone	un-toned								over-toned
	☐**Tail plaited** ☐**Tail toupet**									
	Breathing sound									marked breathing sound
Behaviour	**Confidence**	timid, shy								confident
	Temperament	very calm								nervous
	Willingness to move	reluctant to move								diligent
	Willingness to perform under rider	little								much
	Cooperativeness	incooperative								cooperative, obedient
	Chewing activity / bit acceptance	pulling against the hands								softly on the bit
	Tongue sticking out									tongue markedly sticking out
	Teeth grinding									permanent teeth grinding
	Rideability	unrideable								eager, easy to ride
Presentation	**Influence of the rider**	negative								positive
	Strength of aids	subtle								strong

Rider (name): _____