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Genetic evaluation of station performance test results of Dutch Friesian horses

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1. Introduction

The Friesian horse, originating from the Friesland province, is the oldest and largest indigenous horse breed in the Netherlands. The current breeding population includes approximately 100 stallions and 8000 mares. Since 1879, the Royal Friesian Horse Studbook (FPS) has registered Friesian horses and has performed the selection of breeding stallions.
Traits in the breeding objective include conformation, driving, show-driving and riding. Recorded data include, amongst others, type traits and results from 5-week station performance tests (SPT). Historically, selection decisions used to be based on pedigree information and unadjusted phenotypic data. While a genetic evaluation for conformation based on linear scores has been run since 1998, selection for performance is predominantly based on unadjusted phenotypic scores. A genetic evaluation of performance data is likely to improve selection efficiency. The high costs of SPT tests significantly limits the number of tested horses which means that the reliability of breeding values for performance based on SPT results only will not be very high. Another problem is that SPT-tested horses are often pre-selected on conformation of their parents which could bias estimated breeding values.
The reliability of performance breeding values may be increased if also indirect information is available. Ducro *et al.* (2005) showed that a selection of subjectively scored conformation traits can be used as an efficient predictor of performance of the Dutch Warmblood. The advantage of conformation is that it is scored routinely on a large scale and that horses scored for conformation are generally less pre-selected. Selection procedures for performance of the Dutch Friesian horse may therefore be more efficient and less-biased if they consider information on SPT and conformation simultanously. An optimal simultaneous use of SPT results and conformation scores for selection on performance ability requires knowledge of the appropriate parameters, which are not yet known. Hence, the aim of this study is to estimate the genetic parameters of SPT scores and their relation to conformation scores in the Friesian Horse population.

2. Material and methods

2.1. Data

The SPT data included the scores of 1282 Friesian horses that were centrally tested between 11 June 1994 and 27 December 2003 (49 tests). Originally, the SPT test only included horses that were tested on a voluntary base. From 2000 onwards, also 20 offspring of young breeding stallions have had to be tested to fulfil the requirements of studbook acceptance. Each offspring group included 10 horses that were submitted by the stallion owner and 10 horses that were randomly selected by the FPS studbook. Tested horses were most frequently 3-year-old mares (55%), 3-year-old stallions (17%) or 4-year-old mares (17%). Horses were scored for 5 performance traits including the basic gaits under rider (walk, trot and canter), riding ability and driving ability. Performance was scored by a group of three judges on a subjective scale (1 = bad - 10 = excellent) with increments of 0.2. The final score is the average of two judgements.

The conformation data included observations of 14,011 horses scored at 468 locations between 1 May 1994 and 8 January 2004. Scores were recorded when mares were submitted for studbook entry or when stallions participated in the stallion selection procedure. Five traits were scored:

type, body shape, legs and walk and trot at hand (Koenen, 2001). Walk and trot were not yet scored during the first year. Horses received scores on a subjective scale (1 = bad - 10 = excellent) with increments of 0.5. The majority of horses (85%) were 3-year-old and 4-year-old mares.

2.2. Statistical analyses

Initial analyses of the SPT scores using PROC GLM (SAS®, 1990) showed a significant effect of test and sex ($P < 0.05$). Least-squares means of stallions were higher than those of mares except for walk. Age had no significant effect ($P > 0.05$).

The SPT scores were analysed using the following animal model:

$$y_{ijk} = test_i + sex_j + ani_k + e_{ijk}$$

where

y_{ijk} = unadjusted score;
$test_i$ = effect of test (49 levels);
sex_j = effect of sex (stallion, mare);
ani_k = random animal effect; and
e_{ijk} = random residual.

Conformation scores were analysed using the following animal model as used in the routine genetic evaluation (Koenen, 2001):

$$y_{ijk} = test_i + age.sex_j + ani_k + e_{ijk}$$

where

y_{ijk} = unadjusted score;
$test_i$ = effect of test location (450 - 468 levels);
$age.sex_j$ = interaction between age (3, 4, ≥5 years) and sex (stallion, mare);
ani_k = random animal effect (13.991 - 14.011 levels); and
e_{ijk} = random residual.

Pedigree of all horses with observations was traced for 3 generations and included 21,027 horses. Variance components were estimated using VCE software (Groeneveld, 1998). Correlations within the groups of SPT and conformation traits were estimated in two multivariate analyses. Correlations between SPT and conformation traits were estimated in bivariate analyses as one multivariate analysis including all 10 traits simultaneously was computationally not feasible.

3. Results

Descriptive statistics and estimated genetic parameters of SPT traits are shown in Table 1. Mean scores ranged from 6.18 (canter) to 6.59 (trot). Variation in scores for canter is clearly lower than for other SPT traits. Heritability estimates were on average 0.33 and ranged from 0.25 (canter) to 0.38 (driving ability). Genetic correlations among individual SPT traits are moderate to high (0.50 - 0.97). Riding and driving ability have a higher genetic correlation with trot and canter than with walk. The high genetic correlation of 0.97 between riding and driving ability suggests that these traits are genetically almost identical.

Table 1. Number (n), mean and standard deviation (x ± sd), heritabilities (diagonal), genetic correlations (above diagonal) and error correlations (below diagonal) of station performance test traits.

	n	x ± sd	walk	trot	canter	riding ability	driving ability
walk	1282	6.26 ± 0.75	<u>0.31</u>[1]	0.50	0.64	0.71	0.73
trot	1282	6.59 ± 0.72	0.56	<u>0.36</u>	0.77	0.93	0.94
canter	1281	6.18 ± 0.53	0.47	0.67	<u>0.25</u>	0.96	0.82
riding ability	1280	6.43 ± 0.68	0.63	0.79	0.80	<u>0.33</u>	0.97
driving ability	1282	6.54 ± 0.75	0.68	0.81	0.54	0.67	<u>0.38</u>

[1]Standard error of estimated heritabilities ranged from 0.05 to 0.07.

Heritability estimates of subjectively scored conformation traits (Table 2) were on average 0.26 and ranged from 0.14 (legs) to 0.36 (type). Scores for type and body shape seem to be almost identical from a genetic point of view (r = 0.95). The estimated genetic correlation between walk and trot at hand (0.82; Table 2) is clearly higher than under rider (0.50; Table 1).

Table 2. Number (n), mean and standard deviation (x ± sd), heritabilities (diagonal), genetic correlations (above diagonal) and error correlations (below diagonal) of subjectively scored conformation traits.

	n	x ± sd	type	body shape	legs	walk	trot
type	14,003	6.76 ± 0.65	<u>0.36</u>[1]	0.95	0.79	0.71	0.74
body shape	14,011	6.49 ± 0.60	0.66	<u>0.27</u>	0.82	0.73	0.77
legs	13,911	6.35 ± 0.73	0.32	0.36	<u>0.14</u>	0.79	0.74
walk	13,410	6.20 ± 0.75	0.31	0.34	0.47	<u>0.19</u>	0.82
trot	13,412	6.41 ± 0.89	0.36	0.39	0.46	0.55	<u>0.33</u>

[1]Standard errors of estimated heritabilities were 0.01.

Conformation scores had moderate to high genetic correlations with SPT traits (Table 3). Walk and trot at hand (scored at conformation scoring) had high genetic correlations (0.85 - 0.86) with walk and trot under rider (scored at SPT test). Walk and trot at hand also had high genetic correlations with canter, riding ability and driving ability.

Table 3. Genetic correlations between subjectively scored conformation traits and station performance traits.

	walk	trot	canter	riding ability	driving ability
type	0.46	0.56	0.43	0.55	0.64
body shape	0.45	0.63	0.54	0.65	0.67
legs	0.41	0.53	0.39	0.50	0.56
walk	0.86	0.70	0.64	0.74	0.79
trot	0.56	0.85	0.75	0.80	0.83

[1]Standard errors of genetic correlations ranged from 0.04 to 0.10.

4. Discussion

The moderate heritabilities of SPT scores (Table 1) indicate that a genetic evaluation based on these scores can be used to identify differences between offspring of different stallions. In practice, however, the reliability is limited by the small groups of tested offspring, e.g., the reliability of a stallion's breeding value for the highest heritable trait (driving ability) only based on 20 SPT-tested offspring is approximately 68%. These breeding values can also be biased as stallion owners may select the group of tested horses based on their or their dam's conformation and/or performance (Pollak *et al.*, 1984).

Based on the high genetic correlations between conformation and SPT scores and the large numbers of offspring having conformation scores it can be expected that the simultaneous use of both information sources will increase the reliability and will reduce selection bias. The FPS studbook has therefore run a routine genetic evaluation for SPT traits since 2004. This evaluation combines direct information (SPT scores) and indirect information (conformation). Walk under rider is predicted by walk at hand whereas the other SPT traits are predicted by trot at hand. Estimated breeding values are transformed to a publication scale with a mean of 100 and a standard deviation of 4.

The breeding objective includes driving performance and performance under rider. Traditionally, breeding values for conformation have had a large effect on selection decisions as they were expected to predict later performance. This study clearly shows that subjectively scored conformation traits favourably relate to performance at SPT tests.
A recent review of SPT tests designed for warmblood riding horses (Thorén *et al.*, 2005) has shown that SPT results generally have high genetic correlations with later sport performance. It can therefore be expected that genetic variation in SPT scores more closely relates to the genetic variation in the breeding objective than conformation scores.
Direct observations on driving and riding performance of Friesian horses, e.g. competition data, are not yet used for genetic evaluations. Selection efficiency is expected to increase even further when future evaluations consider conformation scores, SPT scores and competition results simultaneously (e.g., Ducro *et al.*, 2005; Huizinga *et al.*, 1991).

5. Conclusions

- The SPT scores have a moderate heritability.
- Riding and driving ability have high genetic correlations with walk, trot and canter.
- Subjectively scored conformation traits have a high genetic correlation with SPT traits.
- Routine genetic evaluations of SPT traits based on SPT and conformation scores at hand are expected to increase efficiency of selection for performance.

6. References

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