ESTIMATION OF GENETIC PARAMETERS FOR RACING PERFORMANCES IN GERMAN TROTTERS AFTER CONSIDERATION OF INDIVIDUAL RACES

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INTRODUCTION

The estimation of breeding values of German trotters has changed last year from BLUP sire model using traits such as average racing time per year and money earnings per year (Katona and Distl, 1989; Schmitt, 1996) to a multiple trait BLUP animal model which utilises individual race results for the traits rank at finish, racing time and earnings (Röhe *et al.*, 2001).
In several genetic evaluation procedures in Europe annual records of racing perfomances are used for estimation of breeding values (e. g. Langlois *et al.*, 1997; Arnason, 1999). The main disadvantage of using annual records is that all available information, for example level of a race, driver, starting lane or race track, cannot be considered because they change from race to race. The environmental effects can be estimated much more accurately by using individual race results. That means, track conditions at each single record can be estimated directly and no pre-adjustment of records for these effects are necessary. Also, the effect of every single race can be estimated when using individual records of trotters. The genetic-statistical model of Röhe *et al.* (2001) included only the effect race track. In order to avoid possible bias it would be better to consider the effect of every single race instead of the effect race track. The inclusion of the race effect may also improve the genetic-statistical estimation for the trait rank at finish.
The objectives of this study were (1) creation of a more appropriate genetic statistical model for evaluation of breeding values, (2) comparison of two different genetic statistical models regarding the individual race effect as fixed as well as ignoring this effect and (3) estimation of genetic parameters for the German trotter population using the most appropriate multiple-trait genetic model.

MATERIAL AND METHODS

Data of the present analyses consisted of 1,357 races from 4,249 trotters with records from the year 2001. In this data, only races with more than 4 starters and trotters with more than 4 observations were considered. Starting method was in all races the auto start also known as flying start behind a car. The total data set consisted of 48,942 individual race performances.

Table 1. Means (8), standard deviations (s) and variation (CV) for analysed racing performances

Trait	*N*	8	*s*	*CV (%)*
Rank at finish ($\sqrt{y}$)	48942	1.961	0.588	30
Racing time (s/km)	48942	79.652	2.33	3
Earnings (log y)	33076	6.319	0.922	15

The analysed traits were rank at finish, racing time per km and earnings per race. In order to achieve a reasonable approximation to the normal distribution, rank at finish was transformed by its square root and for earnings the log transformation was used. Observations with zero earnings were treated as missing values. The means of the traits are presented in table 1.

Variance components were estimated using REML procedure as implemented in the program VCE (Neumaier and Groeneveld, 1998). The following genetic-statistical model was used:

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Z_1a} + \mathbf{Z_2pe} + \mathbf{e} \qquad [1]$$

where **y** is the vector of observations containing the traits of each trotter recorded at each individual race as square root of rank at finish, racing time per km and the log of earnings per start. Vector **b** represents the fixed effects including the effects of sex (stallion, mare, gelding), age of trotter (age classes of 2, ..., 10 and >10 year old trotters; the age classes of 2 and 3 year old trotters were divided by the birth month into two subclasses; the first subclass contained the birth months from January to March and the second subclass included the birth months from April to August), year-season of race (three months were combined to one season), driver (1,..., 1444), starting lane (1, ..., 10), condition of the race track (fast, good, medium, heavy, muddy), distance of race (8 distance classes) and each individual race (1, ..., 1357). The vector **a** represents the random additive genetic effects assumed to be distributed as N**(0, G** ⊗ **A)**, where **G** is the additive genetic variance-covariance matrix among traits, and **A** is the additive genetic relationship matrix among horses, and the ⊗ denotes the Kronecker product between the matrices. Permanent environmental effects are estimated as random effect vector **pe** and are assumed to be distributed as N**(0, PE** ⊗ **A)**, where **PE** is the permanent environmental variance-covariance matrix among traits and **I** is the identity matrix. Vector **e** refers to the residual effects and is distributed as N**(0, R** ⊗ **A)**, where **R** is the residual variance-covariance matrix among traits. The known incidence matrices **X**, $\mathbf{Z_1}$, $\mathbf{Z_2}$ relate the observation to corresponding fixed and random effect levels.

RESULTS AND DISCUSSION

The biological age of young horses in the same age class differs by several months. This age difference based on the birth month showed a significant influence on racing performance by young german trotters. Two-year old trotters born from January to March were 2.4 seconds faster than two-year old trotters born from April to August. The racing time per km decreased by 3.9 seconds when age of trotters increased from 2 to 11 years. The effect sex had also a significant influence on all traits. Stallions were 0.7 and 0.5 seconds/km faster than mares and geldings. The distance effect showed only a significance for the trait racing time per km. The other fixed effects, such as year-season, age of trotters, sex, driver, starting lane, condition of the race track and race were significant for all traits. Table 2 shows the heritabilities and correlations for the three traits which were estimated with the presented model.

Table 2. Genetic parameters of the three traits estimated with the presented model considering each individual race effect[A]

Trait	(1)	(2)	(3)
Rank at finish ($\sqrt{y}$) (1)	**0.07**	0.82	-0.99
Racing time (s/km) (2)	0.46	**0.23**	-0.88
Earnings (log y) (3)	-0.94	-0.51	**0.09**

[A]Heritabilities on the diagonal, genetic correlations above and phenotypic correlations below the diagonal.

Racing time per km showed about 2.6 to 3.3 times higher heritability than earnings and rank at finish. The genetic correlations between rank at finish as well as racing time per km and earnings per start were very high.
The genetic-statistical model of Röhe *et al.* (2001) differs from the presented model in some fixed effects. Röhe *et al.* (2001) considered instead of individual race effect the effect of different race tracks. Also, their model did not include the fixed effects starting lane and birth month. The age classes in their study were divided into one year periods. The heritabilities and correlations in table 3 which were estimated with the genetic model of Röhe *et al.* (2001), will be compared with the new model as presented in table 2.

Table 3. Genetic parameters of three traits considering the effect race track[A] (Röhe *et al.*, 2001)

Trait	(1)	(2)	(3)
Rank at finish ($\sqrt{y}$) (1)	**0.05**	0.81	-0.98
Racing time (s/km) (2)	0.35	**0.29**	-0.89
Earnings (log y) (3)	-0.57	-0.36	**0.09**

[A]Heritabilities on the diagonal, genetic correlations above and phenotypic correlations below the diagonal.

The inclusion of each individual race effect (table 2) instead of the fixed effect race track (table 3) into the genetic-statistical model means a slight decrease in heritability for the trait racing time per km. The main problem of estimation of the race effect is its close confounding to genetic effects. Koerhuis *et al.* (1998) included the race effect in a test model for the trait racing time and established that the race effect contained a large proportion of the genetic variance. In the presented study the race effect did not involve much of the genetic variance. This agrees with Thuneberg-Selonen *et al.* (1999) who also considered the race effect in their statistical model. Heritabilities for the trait earnings and the genetic correlations among traits showed great similarity between different use of statistical models (table 2 and 3). The heritability for the trait rank at finish increases when considering each individual race effect in the genetic model. After consideration of each individual race in the statistical model, phenotypic correlations among traits increased. In particular, the phenotypic correlation between rank at finish and earnings increased, which shows the close association between these traits. That means, rank at finish can be used as a good estimate for earnings, with the advantage of having records on all trotters and not only the placed horses.

CONCLUSION

These results showed that the individual race effect can be considered in the statistical model in order to avoid possible bias in estimation of genetic parameters. The inclusion of this fixed effect in the genetic-statistical model avoids likely overestimation of heritability for the trait racing time per km which is the most important trait for selection because it showed the highest heritability ($h^2 = 0.23$) of all analysed racing performances. Also the heritability for the trait rank at finish can be estimated much more accurately considering individual race effect in the statistical model. Based on the present results the fixed effects starting lane and birth month by young trotters have to be included in the model.

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REFERENCES

Arnason, T. (1999) *J. Anim. Breed. Genet.* **116** : 387-398.

Katona, Ö. and Distl, O. (1989) *EAAP Publication No.* **42** : 55-61.

Koerhuis, A. N. M. and Schepers, A. J. (1998) *Diploma theses, Wageningen, Netherlands.*

Langlois, B., Blouin, C. and Ricard, A. (1997) *48th Annual Meeting EAAP, Vienna, Austria*.

Neumaier, A. and Groeneveld, E. (1998) *Genet. Sel. Evol.* **30** : 3-26.

Röhe, R., Savas, T., Brka, M., Willms, F. and Kalm, E. (2001) *Arch. Tierz.* **44** : 579-587.

Schmitt, A. (1996) *Züchtungskunde* **68** : 81-91.

Thuneberg-Selonen, T., Pösö, J., Mäntysaari, E. and Ojala, M. (1999) *Agricultural and Food Science in Finland* **8** : 353-363.