

# **Usability of detailed information on movement characteristics of mares and foals for breeding purposes in the German Warmblood horse**



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# Background

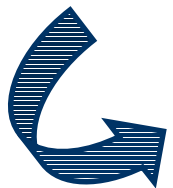
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- quality of gaits  
as important selection criterion in the Warmblood horse  
→ considerable breeding progress in movement characteristics
  - early reports on sporadic occurrence of equine incoordination  
(familial disposition)  
↔ little knowledge about slight deviations from desirable even  
and balanced movement
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# Background

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## **Aim of this study:**

genetic analyses of desirable and undesirable  
movement characteristics of Warmblood mares and foals  
→ opportunities for breeding use of mare and foal data

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# Sources of data

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## Oldenburg Horse Breeders Society (OLD)

### **I. detailed information on movement characteristics**

- foal registrations
  - selected foal registration dates in 2009 (n = 65)
  - foals and mares
- mare shows (studbook inspections)
  - selected mare shows in 2009 (n = 12)
  - mares

### **II. regular scores for movement**

- studbook inspections
    - mares presented for studbook entry in 2009
    - mares
-

# Sources of data

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Type of data	Age group	Evaluation event	Number of evaluated horses	Documentation	
				SJ	RJ
detailed information (descriptive notes)	FOALS	foal registration	2,631	X	X
	MARES	foal registration	2,226	X	
		mare show	<u>319</u> 2,542	X	X
regular scores	MARES	studbook inspections	1,987		X

- in total 5,630 OLD-registered foals in 2009  
⇒ detailed movement evaluations for  
47% of registered foals and 40% of mares with registered foals
  - regular breeding events  
⇒ regular judges (RJ) + specific judge (SJ)
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# Detailed movement evaluations (data structure)

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## FOALS (n = 2,631)

- 1,293 colts, 1,338 fillies
- evaluation age:  
10 days to 7 months ( $\bar{x}$  2.33  $\pm$  1.04 months)
- descending from 389 sires  
→ numbers of offspring per sire: 1-97 ( $\bar{x}$  6.76  $\pm$  12.32)

## MARES (n = 2,542)

- evaluation age:  
3-24 years ( $\bar{x}$  9.81  $\pm$  4.94 years)\*
- descending from 1,157 sires  
→ numbers of offspring per sire: 1-112 ( $\bar{x}$  3.40  $\pm$  7.58)

\* mare shows (n = 319):  $\bar{x}$  3.24  $\pm$  0.44 years

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# Detailed movement evaluations (data collection)

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- evaluation conditions
    - foals free
    - mares at hand
  - descriptive documentation
    - a) conformation and gaits (FOALS)
      - standardization of evaluator-specific notes
      - ⇒ 'scores', e.g. for quality of gaits (range -4 to 4)
    - b) deviations from even and balanced movement  
(focus on: head / neck, tail, hindlegs, general motion pattern)  
preliminary analyses within and between evaluators (13 traits)
      - ⇒ binary coded composite traits
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# Regular SBI evaluations (data structure)

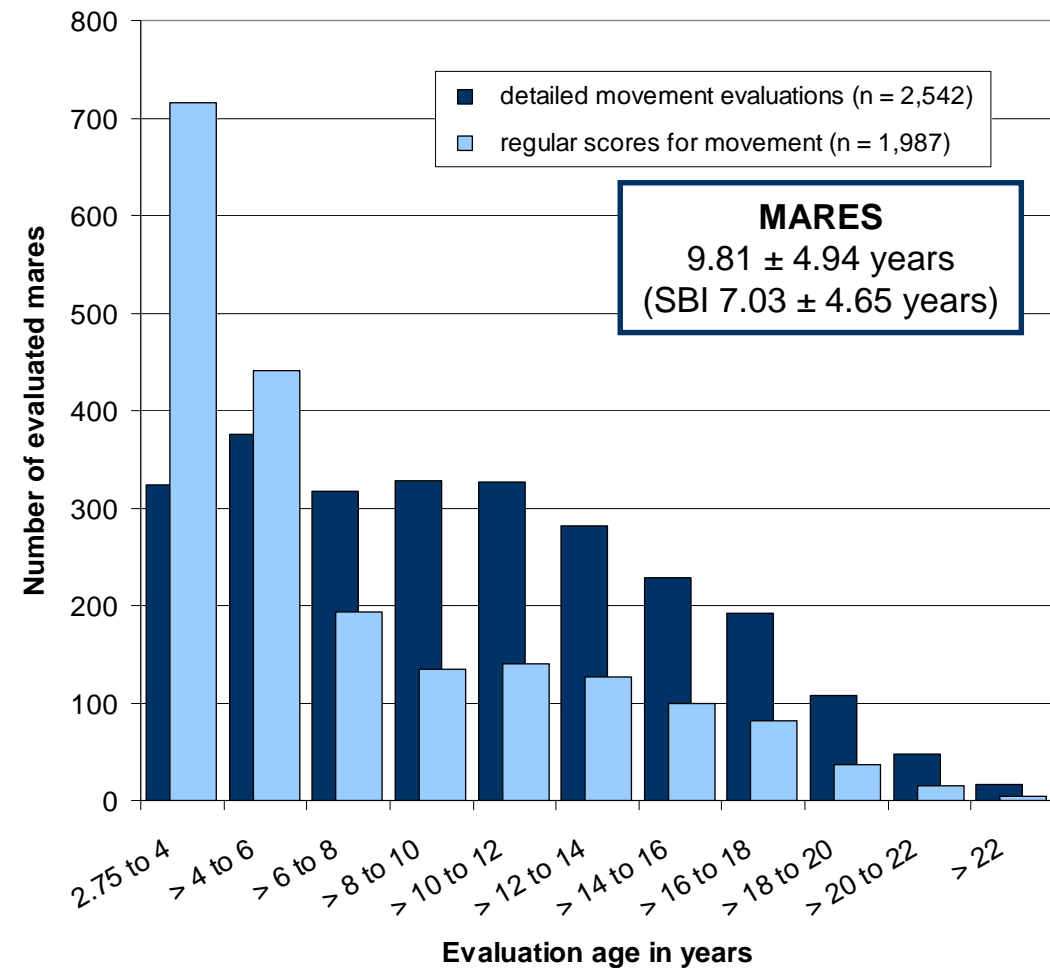
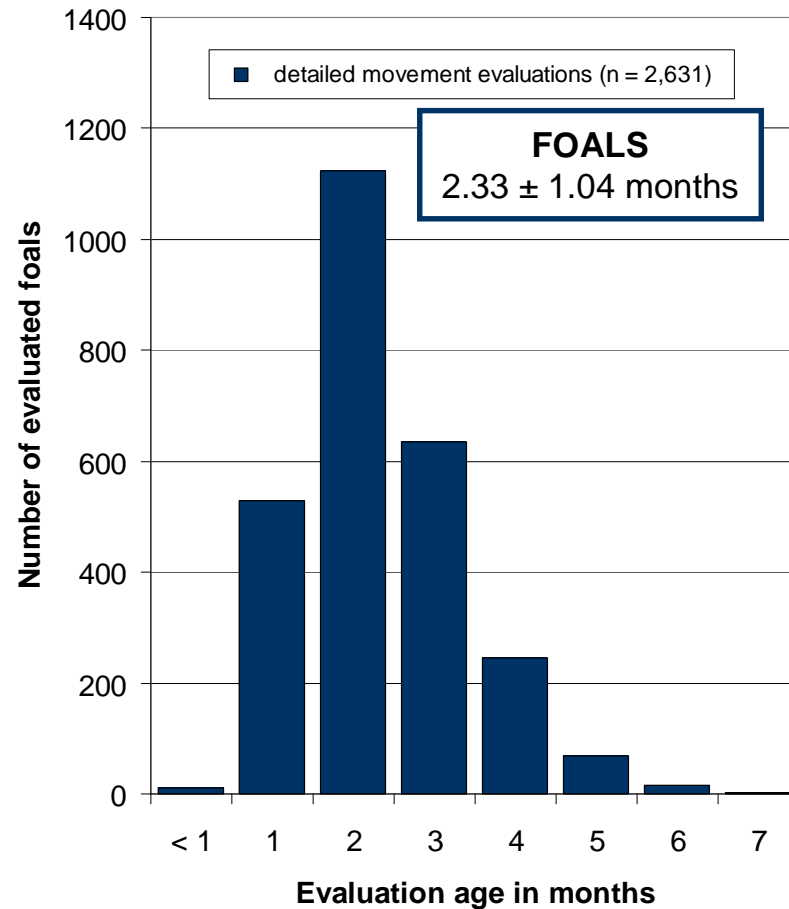
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## MARES (n = 1,987)

- complete SBI records:  
withers height, scores (1-10) for 12 conformation traits  
→ movement traits:  
correctness of gaits, impetus and elasticity, walk
  - evaluation age:  
3-23 years ( $\bar{7.03} \pm 4.65$  years)
  - descending from 866 sires  
→ numbers of offspring per sire: 1-52 ( $\bar{2.29} \pm 4.05$ )
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# Evaluation age



# Movement scores (I)

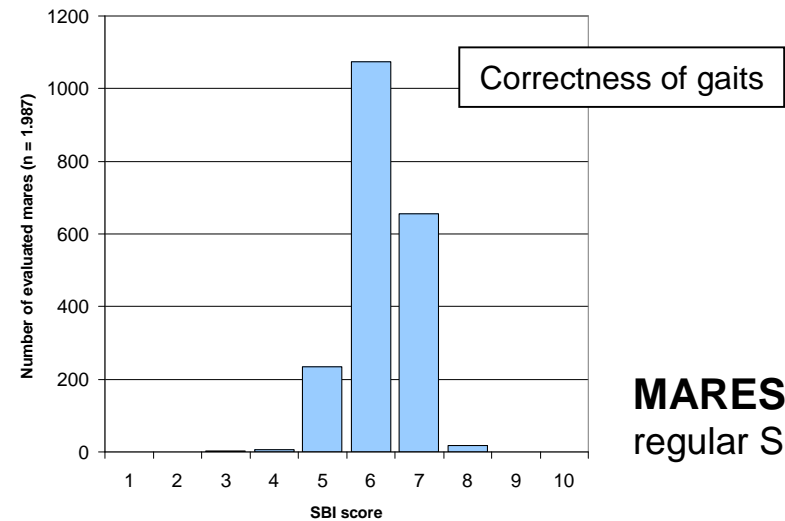
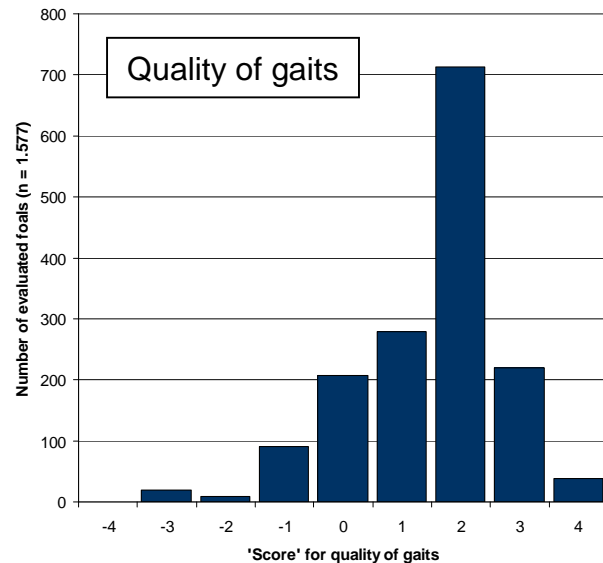
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overlap between datasets (MARES):  
 mares with complete SBI records, i.e. studbook entry in 2009  
 + detailed movement evaluations

Parameter	All mares with SBI (n = 1,987)	Mares with SBI+ (n = 600)
Evaluation age	7.03 ± 4.65 (3 - 23)	5.89 ± 4.26 (3 - 22)
SBI scores		
Correctness of gaits	6.22 ± 0.67 (3 - 8)	6.28 ± 0.65 (5 - 8)
Impetus and elasticity	6.58 ± 0.74 (5 - 9)	6.67 ± 0.78 (5 - 9)
Walk	6.56 ± 0.67 (5 - 9)	6.66 ± 0.72 (5 - 9)

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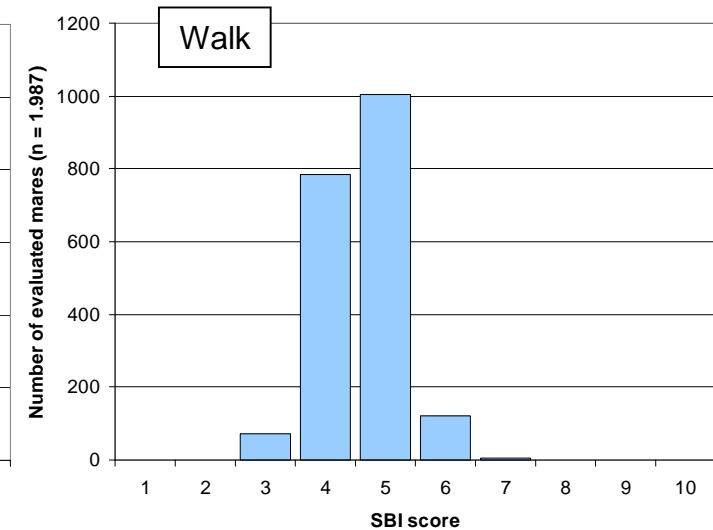
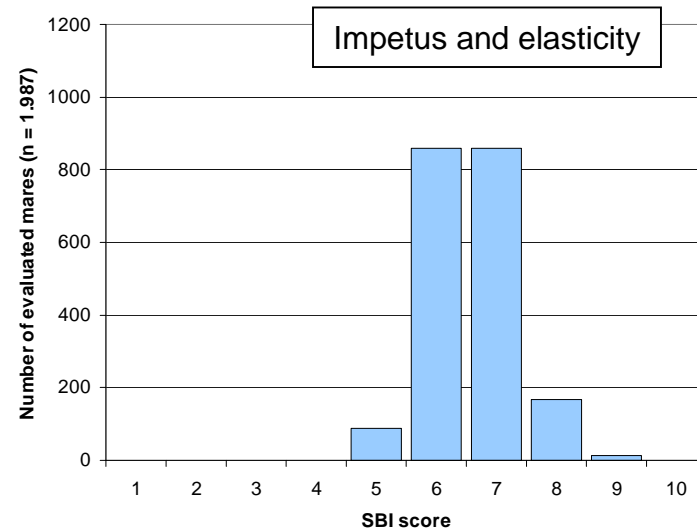
# Movement scores (II)



**MARES**  
regular SBI scores

## FOALS

'score' from detailed  
movement evaluations



# Indications of imbalance (prevalences of composite traits)

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Trait	FOALS (n = 2,631)		MARES (n = 2,542)	
	absolute	relative	absolute	relative
Irregular tail tone and/or posture ( <i>Tail</i> )	134	5.09%	114	4.49%
Irregular motion pattern in hindlegs ( <i>Mot_H</i> )	57	2.17%	35	1.38%
General gait irregularity ( <i>Mot_G</i> )	31	1.18%	22	0.87%
Indications of imbalance ( <i>Imb</i> )	183	6.96%	129	5.08%

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# Estimation of genetic parameters (I)

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## Traits

- movement scores  
FOALS: quality of gaits  
MARES: correctness of gaits, impetus and elasticity, walk  
→ quasi-continuous
- indications of imbalance  
FOALS, MARES: irregular tail tone and/or posture (*Tail*), irregular motion pattern in hindlegs (*Mot\_H*), general gait irregularity (*Mot\_G*), indications of imbalance (*Imb*)  
→ binary

## Pedigree

- unified animal ownership database (vit)
  - 4 ancestral generations (relationship matrix: 35,476 horses)
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# Estimation of genetic parameters (II)

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## Course of analyses

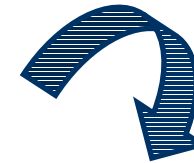
- 1) variance component estimation with REML (VCE)
  - univariate and multivariate analyses  $\Rightarrow h^2, r_g$
  - linear animal model
    - $\Rightarrow$  binary traits (indications of imbalance): transformation to the liability scale, i.e. to threshold model
- 2) prediction of breeding values using BLUP (PEST)
  - univariate genetic evaluations
  - linear animal model
  - correlation analyses (Pearson correlation coefficients)

$$y_{ijklmn} = \mu + b * AGE_i + BMONTH_j + JUDGE_k + date_l + a_m + e_{ijklmn}$$

# Genetic parameters

## movement scores (FOALS ↔ MARES)

Trait	$h^2$
<i>Quality of gaits</i> (FOALS)	$0.62 \pm 0.07$
<i>Correctness of gaits</i> (MARES)	$0.09 \pm 0.04$
<i>Impetus and elasticity</i> (MARES)	$0.28 \pm 0.04$
<i>Walk</i> (MARES)	$0.25 \pm 0.04$



foal data as valuable  
source of information  
(desirable movement)



Traits	BV correlations	
	Parents of informants	Sires with ≥ 5 informative offspring
<i>Quality of gaits</i> (FOALS)		
– <i>Correctness of gaits</i> (MARES)	0.24	0.14
– <i>Impetus and elasticity</i> (MARES)	0.44	0.46
– <i>Walk</i> (MARES)	0.24	0.19

# Heritabilities

uni- and multivariate estimates (before / after transformation)

Trait (prevalences)	FOALS (n = 2,631)		MARES (n = 2,542)	
	univariate	bivariate	univariate	bivariate
<b><i>Tail</i></b> (F 5.09%, M 4.49%)	0.03 ± 0.02 <b>0.14 ± 0.10</b>	0.11 ± 0.03 <b>0.48 ± 0.13</b>	0.01 ± 0.01 <b>0.02 ± 0.03</b>	0.04 ± 0.01 <b>0.17 ± 0.05</b>
<b><i>Mot_H</i></b> (F 2.17%, M 1.38%)	0.03 ± 0.02 <b>0.20 ± 0.14</b>	0.04 ± 0.02 <b>0.28 ± 0.13</b>	0.02 ± 0.02 <b>0.28 ± 0.24</b>	0.02 ± 0.01 <b>0.22 ± 0.16</b>
<b><i>Mot_G</i></b> (F 1.18%, M 0.87%)	0.09 ± 0.02 <b>1.05 ± 0.27</b>	0.15 ± 0.02 <b>1.79 ± 0.25</b>	0.00 ± 0.00 <b>0.00 ± 0.00</b>	0.09 ± 0.02 <b>1.33 ± 0.33</b>
<b><i>Imb</i></b> (F 6.96%, M 5.08%)	0.07 ± 0.03 <b>0.26 ± 0.09</b>	0.12 ± 0.03 <b>0.44 ± 0.11</b>	0.01 ± 0.01 <b>0.04 ± 0.03</b>	0.03 ± 0.01 <b>0.15 ± 0.05</b>



genetic influences on  
undesirable movement characteristics (FOALS)

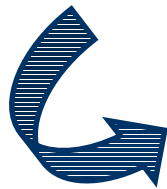
*Tail* = irregular tail tone and/or posture; *Mot\_H* = irregular motion pattern in hindlegs;  
*Mot\_G* = general gait irregularity; *Imb* = indications of imbalance



# Genetic correlations

correlation analyses between age groups

Trait	Additive-genetic correlation	BV correlation	
		Parents of informants	Sires with $\geq 5$ informative offspring
<i>Tail</i>	1.0000 $\pm$ 0.0000	<b>0.211</b>	<b>0.188</b>
<i>Mot_H</i>	1.0000 $\pm$ 0.0051	<b>0.160</b>	<b>0.121</b>
<i>Mot_G</i>	1.0000 $\pm$ 0.0003	-	-
<i>Imb</i>	1.0000 $\pm$ 0.0003	<b>0.050</b>	<b>0.066</b>



**(some) overlap of genetic factors influencing analogous indications of imbalance in mares and foals**  
 [→ verification studies with additional (mare) data]

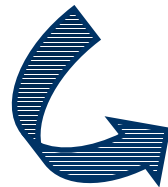
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# Genetic correlations

## correlation analyses within age groups

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Traits	BV correlations (sires with $\geq 5$ informative offspring)	
	FOALS	MARES
<i>Tail – Mot_H</i>	0.245	0.359
<i>Tail – Mot_G</i>	0.274	-
<i>Mot_H – Mot_G</i>	0.309	-



some overlap of genetic factors influencing different indications of imbalance

*Tail* = irregular tail tone and/or posture; *Mot\_H* = irregular motion pattern in hindlegs;  
*Mot\_G* = general gait irregularity; *Imb* = indications of imbalance

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# Summary

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- genetic variation with regard to detailed movement evaluations
    - desirable and undesirable movement characteristics
    - FOALS > MARES
  - genetic determination of slight deviations from desirable even and balanced movement (indications of imbalance):  
 $h^2 = 0.1-0.4$
  - positive genetic correlations, but no genetic identity
    - between analogous traits in FOALS and MARES
    - between different traits within age groups
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# Conclusions

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- usability of detailed information on movement characteristics for breeding purposes
  - much efforts to implement detailed movement evaluations in regular breeding events  
→ need for standardized protocols
  - foal data as valuable source of information for desirable and undesirable movement characteristics
  - future work:
    - verification studies with more data (MARES)
    - further correlation analyses (undesirable and desirable movement characteristics vs. conformation and performance)
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# Thank you!

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