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2nd International Workshop
on Linear Profiling in the Warmblood Horse
on February 11-12, 2016, in Warendorf / Germany

Linear profiling in the Oldenburg studbooks - from ideas to successful applications

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Outline

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- approaches to linear profiling in the Oldenburg studbooks:
  - from first pilot study in 2011/2012
  - to routine implementation in 2015
- focus of research and development (science to practice): optimization of recording and use of linear data
  - trait definitions and comparative analyses
  - genetic parameters for linear conformation and performance traits
- use of linear data in the breeding program: prospects and future role of linear data

Approaches to linear profiling

- engagement for improved phenotyping
  - study on new movement traits (indications of imbalance)
  - better use of information from routine assessments


Journal of Animal Breeding and Genetics

ORIGINAL ARTICLE

Genetic analyses of new movement traits using detailed evaluations of warmblood foals and mares

A.-C. Becker[1], K.F. Stock[1,2] & O. Distl[1]


animal

Correlations of unfavorable movement characteristics in warmblood foals and mares with routinely assessed conformation and performance traits

A.-C. Becker[1], K. F. Stock[1,2†] and O. Distl[1]

- development of a refined, comprehensive and reliable recording system fitting the needs of the practice
  - standardized and (more) objective documentation
    → linear descriptive trait definition
  - large-enough set of traits to make personal notes dispensable (established recording practice of experienced judges as 'gold standard')
    - distinct recording options for movement in hand, free and under rider
    - refined documentation also for defect traits / special remarks

Development of linear profiling

- close collaboration of science and practice as key to success
- pilot studies in connection with research projects
  - extra staff for testing and optimizing the system
  - first data screening

  → sound basis for broad implementation of the new system
- continuous monitoring of linear data collection
  - quality and coverage of the linear scheme (lacking traits?)
  - use of traits and scale, internal consistency of linear data, ... (unclear definitions? topics for training sessions and technical meetings)

  → smooth transition to new routine applications (acceptance↑)

  → improved services for the studbooks and for individual breeders

Linear data basis

- linear description in the Oldenburg studbooks (OL, OS)
  - conformation and performance (movement, jumping)
  - 7-point numeric linear scale (-3 to +3)
  - foals, mares, stallions
- extension during 2012-2015
  - selected events only in the pilot phase, most/all events since 2015
    - foal registration
    - studbook inspection
    - mare performance test
    - preselection for licensing
  - in Germany and abroad
- **in total N=9,663 linear profiles of 9,496 horses**
  (different depth = numbers of traits depending on assessment type)

Linear data basis: distribution

Year	Age group	Type of event	OL	OS	Total	
2012	foals	registration	670	148	818	pilot phase (selected events / dates)
	mares	SBI, MPT (+SBI)	412	28*	440	
	stallions	preselection	136	132	268	
2013	foals	registration	788	218	1,006	
	mares	SBI, MPT (+SBI)	250	56*	306	
	stallions	preselection	14	0	14	
2014	foals	registration	1,563	473	2,036	broad testing
	mares	SBI, MPT (+SBI)	1,084	46*	1,130	
	stallions	preselection	169	78	247	
2015	foals	registration	1,599	559	2,158	routine application
	mares	SBI, MPT (+SBI)	920	50*	970	
	stallions	preselection	140	130	270	
Total	**foals**	**registration**	**4,620**	**1,398**	**6,018**	
	mares	**SBI, MPT (+SBI)**	**2,666**	**180***	**2,846**	
	stallions	**preselection**	**459**	**340**	**799**	

SBI = studbook inspection, MPT = mare performance test; * OL/OS distinction only for central MPT in Vechta

Linear traits (I)

- spectrum of traits according to the Oldenburg linear scheme 2015
  - conformation and correctness (N=80 traits)
  - movement in hand (N=19 traits)
  - free movement (N=34 traits) and free jumping (N=15 traits)
  - presentation under rider (without jumping) / in lungeing (N=38 traits)

➢ mobile data collection (tablet PC) making it possible to:
- ➢ efficiently collect detailed linear data (active input of deviations only)
- ➢ directly use maximal information from routine assessments

Tab.: Depth of linear profiles in dependence on the assessment conditions

Age group	Type of event	Conf	MovH	MovF/FJ	MovR	Total
Foals	registration	80	-	29	-	**109**
Mares +Stallions	studbook inspection (SBI)	80	19	-	-	**99**
	mare performance test (MPT)	(80)	(19)	34+15	38	**186**
	preselection for licensing	80	19	34+15	38	**186**

Conf = conformation, MovH (MovF, MovR) = movement in hand (free, under rider), FJ = free jumping

Linear traits (II)

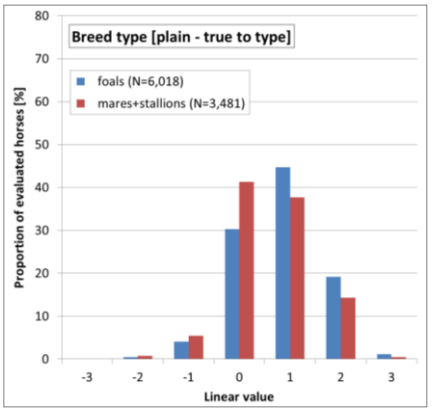
- complexity of linear data structure implying:
  - considerable potential for research
  - highly valued individual assessment reports
- important for data processing and analyses:
  - 'defect traits' in each of the four trait groups (expected variation?)
  - analogous traits across presentation types (optimum modelling?)
- trait definitions within:
  - a.1) age group (foals vs. mares+stallions)
  - a.2) age group and studbook (OL, OS)
  - b.1) within evaluation type (e.g. impulsion in trot under rider)
  - b.2) within trait category (presentations / assessments as repeated observations)

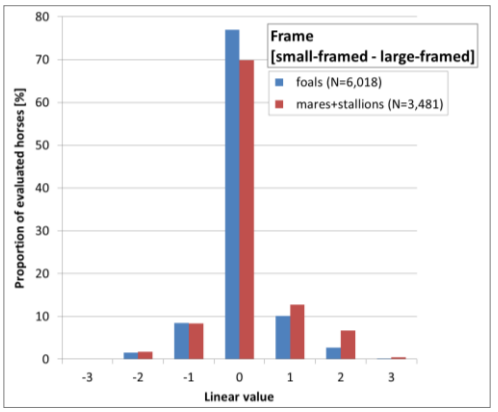
Tab.: Overview of distinct linear traits

Trait category	No. of traits
Conformation	73
Walk (H, F, R)	6
Trot (H, F, R)	11
Canter (F, R)	10
Special remarks (H, F, R)	7
Behavior (H, F, R)	5

H = in hand, F = free, R = under rider

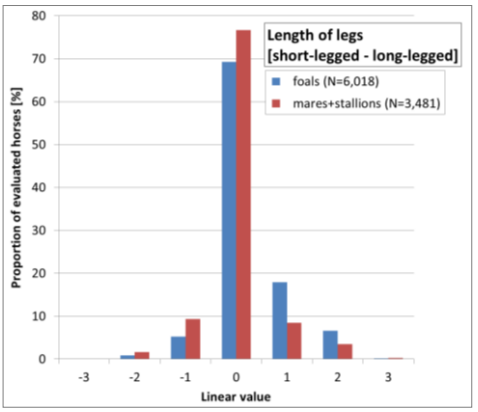
Linear trait distribution (I)

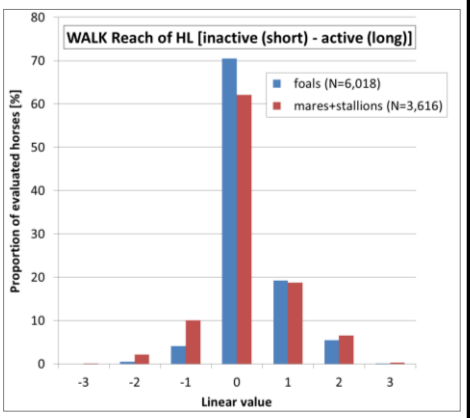




- considerable variation in the distributions of linear traits

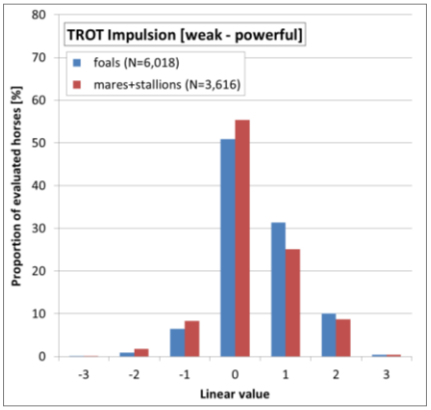
Linear trait distribution (II)

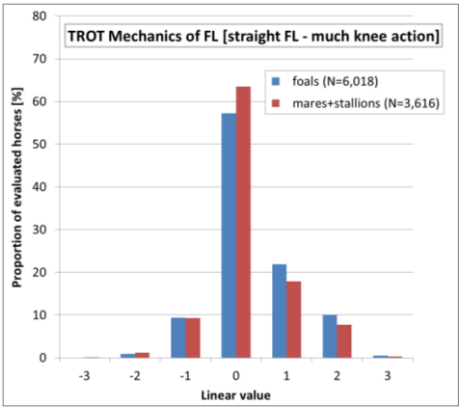




- considerable variation in the distributions of linear traits

Linear trait distribution (III)





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Genetic analyses

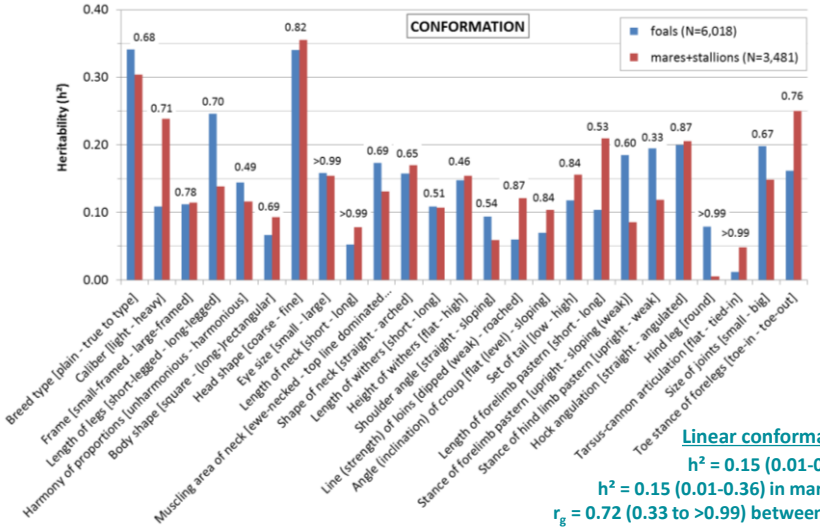
- different trait definitions
- selected linear traits (standard deviation, variance, kurtosis)
  - N=25 conformation traits
  - N=31 performance traits (foals: N=13)
- uni- and multivariate linear animal models
  - foals:

    $y_{ijkno} = \mu + SB_i + EVENT\text{-}TEAM_j + AGE\_M_k + SEX_l + animal_o + e_{ijklop}$
  - mares+stallions:

    $y_{ijmop} = \mu + SB_i + EVENT\text{-}TEAM_j + AGE\_J_m + animal_o + e_{ijmop}$

    $y_{ijmnop} = \mu + SB_i + EVENT\text{-}TEAM_j + AGE\_J_m + PTYPE_n + animal_o + pe_o + e_{ijmnop}$

Genetic parameters (I)



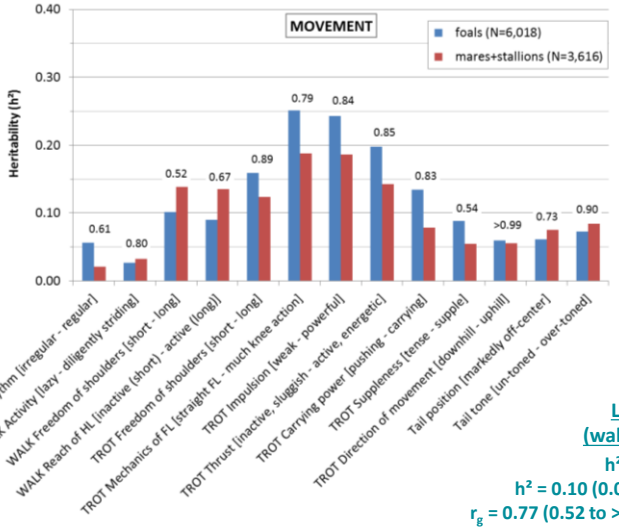
Linear conformation traits:

h^2 = 0.15 (0.01-0.34) in foals

h^2 = 0.15 (0.01-0.36) in mares+stallions

r_g = 0.72 (0.33 to >0.99) between age groups

Genetic parameters (II)



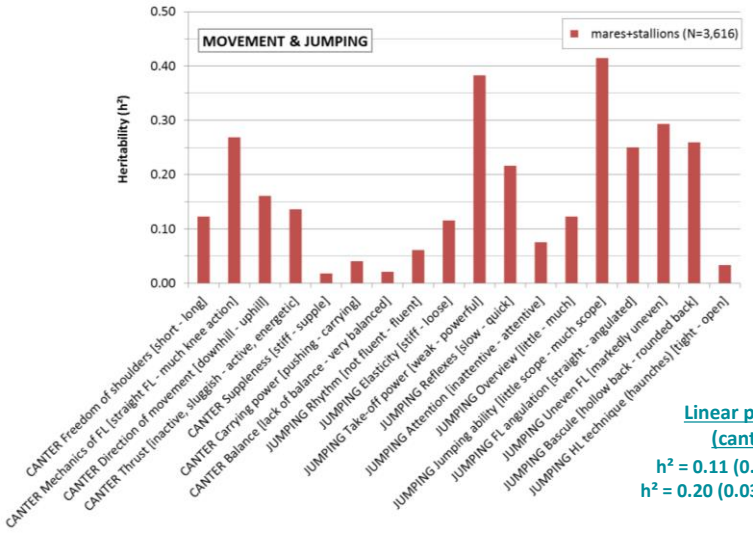
Linear performance traits (walk, trot, special remarks):

h^2 = 0.12 (0.03-0.25) in foals

h^2 = 0.10 (0.02-0.19) in mares+stallions

r_g = 0.77 (0.52 to >0.99) between age groups

Genetic parameters (III)



Linear performance traits (canter, free jumping):

h^2 = 0.11 (0.02-0.27) for canter

h^2 = 0.20 (0.03-0.41) for jumping

Summary & conclusions

- new traits with specific distribution patterns requiring thorough monitoring of data quality and selection of traits for further analyses
- extensive comparative analyses revealing:
  - significant differences in distribution patterns between studbooks
  - plausible and consistent results within and across age groups
  - mostly minor differences between uni- and multivariate estimates
  - moderate heritabilities of linear conformation and performance traits with moderate to high additive genetic correlations between age groups
- ➢ substantial improvement of routine phenotype recording
  - ➢ highly valued increase of transparency
  - ➢ much better use of routine assessments (standardized detailed output)
  - ➢ basis of successful future breeding programs with move from genetic to genomic evaluations

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Thank you!

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