

WBFSH general assembly & seminar
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Linear profiling in the Warmblood horse – review & preview

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Outline

- general information on linear systems
 - What is linear scoring and how is it used?
 - terminology issues ('scoring' versus 'profiling')
- status quo in the Warmblood horse
 - research versus routine use
 - comparison between different implementations
- current & future role of linear profiling in horse breeding
 - spectrum of traits
 - quality of phenotype data

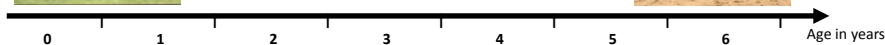


Data in Warmblood breeding

- collection of breeding goal related information
 - competition results (sport data)
 - routine assessments of breeding organizations (performance tests, studbooks inspections; foals, mares, stallions)
- breeding progress (genetic gain)
 - dependent on time and accuracy of selection
 - aim: broad & early availability of reliable predictors of genetic disposition passed to the next generation

$$\Delta G = (i * r * \sigma_a) / L$$

i = selection intensity,
 r = selection accuracy,
 σ_a = genetic variance,
 L = generation interval



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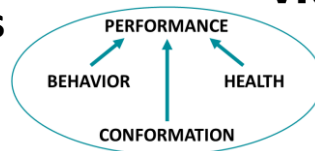
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trait (phenotype) requirements

- clear & unambiguous definition (objective)
- precise assessment (comparable, repeatable) under field conditions
- early assessment (expressed at young age)

Phenotypes in riding horses



Breeding goal	Availability of trait information		Trait / measure - TRADITIONAL SYSTEM -
	time	amount (F=foals, M=mares, S=stallions)	
performance under rider - mainly dressage and/or jumping - international competitiveness	late (sport > performance tests)	+/- strong preselection	sport success
talent / performance without rider (quality of gaits, jumping ability)	early to relatively early (gaits < free jumping)	++ weak (F,M) to moderate preselection (S)	valuating scores
conformation - functionality - esthetic aspects	early	+++ weak (F,M) to moderate preselection (S)	valuating scores
health - longevity, short- & long-term usability (ability to perform) - animal welfare	(relatively early)	- strong preselection (S)	acceptable Y/N
behavior (interior) - learning, willingness to perform, ... - compatibility with intended use	late	+/- strong preselection	valuating scores

Phenotypes in riding horses: conformation

overall assessment using **valuating scores** (unfavorable to favorable):
'nice horse' = overall score ↑



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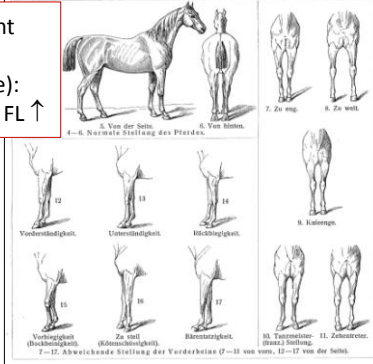
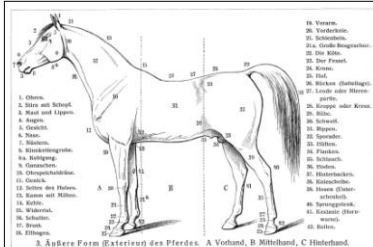
Phenotypes in riding horses: conformation



overall assessment using **valuating scores** (unfavorable to favorable): 'nice horse' = overall score ↑

identification of traits

more detailed assessment using **valuating scores** (unfavorable to favorable): 'nice front limbs' = score FL ↑



Source: Meyers Großes Konversations-Lexikon (Vol.15), Leipzig 1908.

Phenotypes in riding horses: conformation

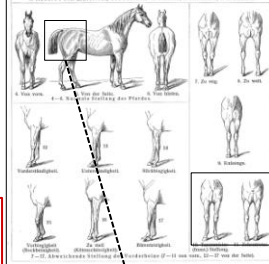
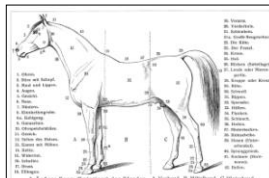


overall assessment using **valuating scores** (unfavorable to favorable): 'nice horse' = overall score ↑

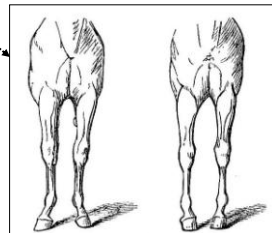
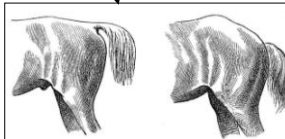
identification of traits

more detailed assessment using **valuating scores** (unfavorable to favorable): 'nice front limbs' = score FL ↑

detailed assessment using **linear values** (descriptive): 'sloping croup' = LIN croup shape ↑
'regular toe stance' = LIN toe FL ↓



Source: Meyers Großes Konversations-Lexikon (Vol.15), Leipzig 1908.



Phenotype assessment

trait (phenotype) requirements

- clear & unambiguous definition (objective)
- precise assessment (comparable, repeatable) under field conditions
- early assessment (expressed at young age)

■ evaluation

- subjective evaluation
- valuating scores, scale "very bad" (1) to "excellent" (10), relative to breeding goal (more/less favorable)

■ linear description

- visual assessment relative to biological extremes
- linear values, scale minimum to maximum expression (e.g. "very short" to "very long", "very steep" to "very sloping"), independent of breeding goal specific optimum expression

■ measurement

- objective determination of lengths, angles, ... (often difficult in the field)
- trait-specific values / units (highly complex interpretation)



Comparison of assessment systems

Criterion	Scoring (valuating scores)	Linear profiling (linear values / 'scores')
trait definition clear & unambiguous	- few, broadly defined traits <i>e.g. neck, trot</i>	+ larger no. of specifically defined traits <i>e.g. neck - length, shape, angle (set of neck); trot - rhythm, length of stride, front limb mechanics (knee action), impulsion, thrust, balance (carrying power), suppleness</i>
assessability early & broad	+ simplified data collection	- to + dependent on data collection system
objectivity	- low comparability	+/- dependent on measures to ensure data quality
information value specific & breeding goal related	+/- clear ranking, but often poor individual differentiation (unsatisfactory use of score scale)	+/- detailed & specific information on individuals (improved use of scale), but more complex interpretation

TRADITIONAL SYSTEM of conformation & performance evaluation

PRO: easy to use / fast, clear ranking
CONTRA: subjective, loss of detailed information

LINEAR PROFILING as highly reputed alternative system

PRO: more objective, specific trait definition, better discrimination
CONTRA: requirements of time / personnel



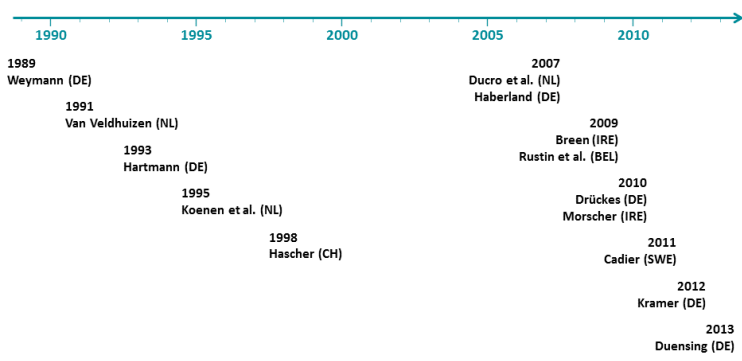
REVIEW: Linear profiling

- conformation traits in several species
 - e.g. cattle, sheep, pigs
 - dairy cattle: introduction of linear conformation traits in the 1970s, today basis of routine national & international genetic evaluations
- conformation and performance traits in the (Warmblood) horse
 - intense R&D activities since the late 1980s
 - routines since the 1990s



Linear profiling – research

Published research on linear profiling (Warmblood horse):



different approaches how to implement linear profiling:

- simplified linear schemes
- documentation assistance for selected events
- efficient documentation in (all) regular breeding events



Linear profiling – routines

- lead of KWPN regarding routine implementation of linear profiling
→ adoption of KWPN system by other studbooks (BWP, ISH)
- from 2010 onwards increase of own R&D → current situation:
 - different sets of linear traits
 - different linear scales, e.g. a to i, 1 to 9, -3 to +3

Country & studbook(s)	Conformation	Performance	Implementation *
The Netherlands (KWPN)	X	X	1989
Switzerland (CH sport horses)	X	X	1991
Belgium (BWP)	X	X	2003
Ireland (ISH, IDH)	X	X	2008
Germany (Holstein)	X	-	2010 (foals)
	X	X	2013
Germany (OL, OS)	X	X	2011/2012
Germany (Mecklenburg-Vorpommern)	X	X	2012 (mares)
Denmark (DWB)	X	X	2012-2014
Sweden (SWB)	X	X	2012-2014

* broad pilot or routine use at regular studbook events

Development of linear systems (I)

- start / pilot studies
specific trait definitions (broad spectrum), refined multi-level scales
→ challenging documentation,
often infeasible for broad use under field conditions
- implementation
compromises (course and/or detailedness of description) OR
optimized documentation for specifically defined traits

Parameter	Approach 1	Approach 2
documentation method	=	efficiency ↑
course of assessment	time per horse ↑	=
trait spectrum	no. of linear 'obligatory traits' ↓, options for suppl. documentation ↑	=



CAVE incomplete use of opportunities of linear descriptions,
information gaps → commentary / free text fields, ...
⇒ usability for analyses? time efforts (in total)?

Linear scheme KWPN



Location:	Date:	Judge:
Horsename:	Horse number:	Cat. N°:

- score sheet with 28 (dressage) or 36 (jumping) linear traits
→ 9-point linear scale: a-b-c---d-e-f--g-h-i (grouping 'obvious' vs. 'average')
- facultative supplementary documentation for 20 traits ('defects')
- overall evaluation: linear profile + valuating scores (independent)

CONFORMATION/TRAIT		obvious	average	obvious	Fault/defect	
Condition					<input type="checkbox"/> fat <input type="checkbox"/> poor	
Mouth					<input type="checkbox"/> undesirable <input type="checkbox"/> overbite	
Head					<input type="checkbox"/> convex profile <input type="checkbox"/> coarse <input type="checkbox"/> long	
1. Body shape	rectangular	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	square
2. Body direction	uphill	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	downhill
3. Head-neck connection	light	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	heavy
4. Length of neck	long	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	short
5. Position of neck	vertical	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	horizontal
6. Muscling of neck	heavy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	poor
7. Height of withers	high	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	flat
8. Position of shoulder	steep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	straight
9. Line of back	reached	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	weak
10. Line of loin	reached	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	weak

EVALUATION	CONFORMATION:	MOVEMENT:									DRESSAGE
		Walk:	Trot:	Canter:	Posture:						
		a	b	c	d	e	f	g	h	i	
11. Shape of croup	steep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	flat
12. Length of croup	long	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	short
13. Stance of forelegs	over at knee	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	back at knee <input type="checkbox"/> tied in <input type="checkbox"/> standing under
14. Stance of hind legs	wide	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	narrow <input type="checkbox"/> tied in <input type="checkbox"/> abnormal hook <input type="checkbox"/> abnormal stifle
15. Stance of pastern	weak	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	upright
16. Shape of feet	wide	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	narrow <input type="checkbox"/> different
17. Heels	high	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	low <input type="checkbox"/> different
18. Quality of legs	lean	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	thickened
19. Substance of legs	heavy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	fine
MOVEMENT/TRAIT		evoked	average	evoked							Fault/defect
20. Walk: length of stride	long	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	short <input type="checkbox"/> irregular
21. Walk: correctness	loose in	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	tied out <input type="checkbox"/> on co-ordinated
22. Trot: length of stride	long	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	short
23. Trot: elasticity	awake	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	stiff <input type="checkbox"/> irregular
24. Trot: impulsion	powerful	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	weak <input type="checkbox"/> on co-ordinated
25. Trot: balance	laming	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	pushing
26. Canter: length of stride	long	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	short
27. Canter: impulsion	powerful	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	weak
28. Canter: balance	laming	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	pushing
Attitude (subject of assessment)	rich	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	low

Fig.: KWPN linear score sheet DRESSAGE (trait-by-trait documentation on paper) http://www.kwpn.org/downloads/LS_dressage_ENG.pdf

Linear scheme CH-spothorse



- score sheet with 24 linear traits
→ 9-point linear scale: 1-9 (marked optima)
- facultative supplementary documentation for 9+ traits ('defects')
- overall evaluation: linear profile + valuating scores (independent)
- FOALS: reduced scheme (12 linear traits)

LINEARE BESCHREIBUNG FÜR CH-PFERDE (3-jährig und älter)
DESCRIPTION LINEAIRE POUR CHEVAUX CH (3 ans et plus)

Schwarz/Concours: Datum/Date: Rücken/Länge: D-Nr.: Wert/Poins: Rasse: DS HF
Geburtsdatum/Date de naissance: m. f. Rasse DS HF

Typ/Type: = Optimistischer / Note optimale

Gesamteindruck/Impression générale	Körperbau/Conformation	Gänge/Mouvements	Blockmass/ht. au garrot								
1-2-3-4-5-6-7-8-9	1-2-3-4-5-6-7-8-9	extrém	Manger/Defaults								
1. Kopfansicht Expression de la tête	ausdruckslos sans expression	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	ausdruckslos expressive
2. Gangschon Gangschon	weil doux	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	trau doux
3. Halslänge Long. de la structure	kurz courte	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	lang longue
4. Halsbau Attache de l'encolure	hoft bas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	hoch haut
5. Hinterhandbau Musculation de l'enc.	stark serré	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	schwach maigre
6. Widerristhöhe Hauteur au garrot	hoch élevé	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	hoch haut
7. Widerristlänge Longueur de garrot	kurz court	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	lang long
8. Schulterlänge Longueur de l'épaule	kurz courte	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	lang longue
9. Schulterbreite Indic. de l'épaule	steil obtus	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	schief oblique
10. Rückenlänge Longueur du dos	kurz court	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	lang long
11. Rückenbau Ligne du dos	weich doux	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	gerade recto
12. Kreuzenlänge Long. de la croupe	kurz courte	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	lang longue
13. Kreuzenbreite Indic. de la croupe	horizontal horizontale	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	abfallend oblique
14. Behabung Finesse	stark serré	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	viel laine
15. Vorderbein Carrure antérieure	rücklings arrière	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	vorfällig avant
16. Strömungsrichtung Angle des jarrets	schief oblique	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	senkrecht vertical
17. Fesselstellung Angle des pastilles	steil obtus	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	weich doux
18. Fundament Fondement	schwerfällig lourd	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	lockert doux
19. Beinbau Pied	kurz court	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	ausgeworfen ouvert
20. Beinbau Trot	kurz court	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	hohl cavé
21. Beinbau Trot	stark serré	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	schief oblique
22. Beinbau Trot	stark serré	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	schief oblique
23. Konnektivität Conectivité	schief oblique	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	senkrecht vertical
24. Typ Typ	stark serré	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	weich doux

Bemerkungen/Remarques:

Fig.: CH-spothorse linear score sheet (trait-by-trait documentation on paper) http://www.swisshorse.ch/fileadmin/bilder-inhalt/2_Service-Events/Zucht/3j-Feldtest-SBC/lineare_Beschreibung.pdf

Development of linear systems (II)

- start / pilot studies
specific trait definitions (broad spectrum), refined multi-level scales
→ challenging documentation,
often infeasible for broad use under field conditions
- implementation
compromises (course and/or detailedness of description) OR
optimized documentation for specifically defined traits

Parameter	Approach 1	Approach 2
documentation method	=	efficiency ↑
course of assessment	time per horse ↑	=
trait spectrum	no. of linear 'obligatory traits' ↓, options for suppl. documentation ↑	=

CAVE incomplete documentation (trait spectrum, expressions)
⇒ usability for analyses?, high demands on conscientiousness
of assessors!



Documentation efficiency

departure from trait-by-trait documentation on paper:
Oldenburg linear system with comprehensive linear scheme
(conformation and performance traits) and mobile recording



- **until 2011: linear descriptive handwritten notes**
(supplementary to valuating scores for standard set of traits)
 - common to necessary (questions of breeders to individual horses)
 - individual differences (form, extent, detailedness)
- **2011/2012: R&D on linear profiling**
aim: maximum use of advantages without changes in assessment schedules
 - broad trait spectrum (according to spectrum of personal notes)
 - linear profiles for all horses compiled by responsible judge(s)
 - mobile data collection (tablet PC) with documentation assistance and reduction of active documentation (deviations from average expression)
- **2012-2013: broad praxis test of the linear system** (foals, mares, stallions)

Linear system Oldenburg



- mobile system with in total > 100 linear traits → active documentation of deviations from average expression (default value 0); 7-point linear scale: -3 to +3
- refined documentation for defect traits (half scale: 0 to +3)
- additional recording options, e.g. for studbook category

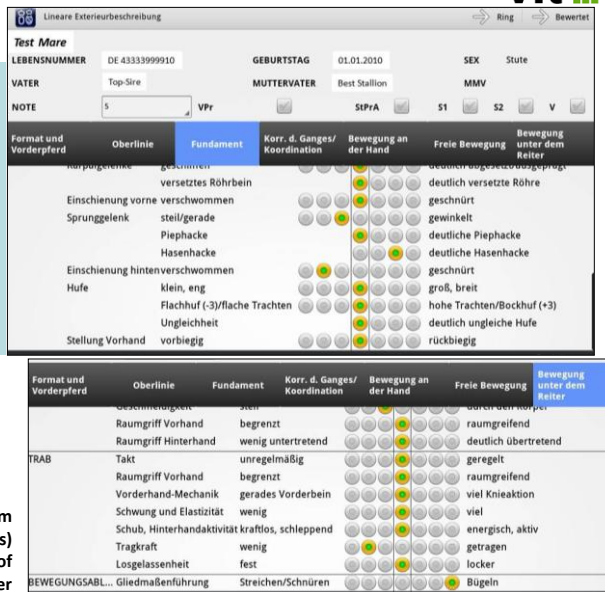
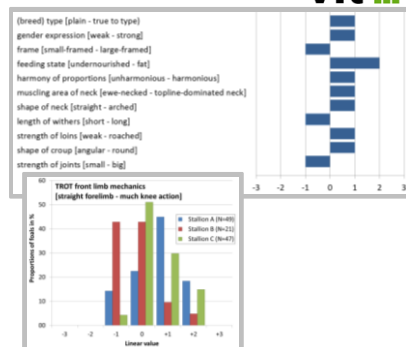


Fig.: Oldenburg linear system (mobile recording of deviations) – examples from conformation of limbs and movement under rider

Use of linear data



- individual linear profiles – **phenotypic profiles**
 - detailed information for breeders on individuals and progeny groups
 - basis of targeted advisory service (breeding, use / management, ...)
- standardized documentation of defects → status quo and continuous monitoring (studbook)
- improved information basis for selection decisions: estimation of genetic parameters and genetic evaluation → **genetic profiles** as basis of targeted breeding measures



Population genetic studies

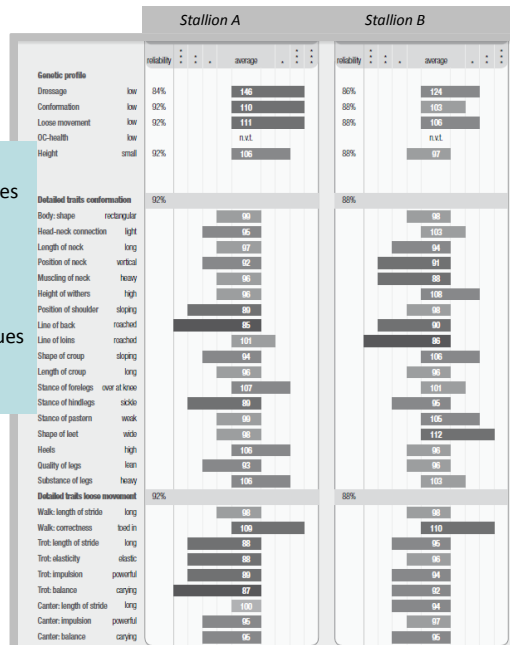
relevant genetic determination of specific trait characteristics in riding horses
+ significant positive genetic correlations with 'ultimate' breeding goal traits
(success / longevity in sports)

Studbook (country)	Linear scale (N=numerical)	No. of traits and heritability			Reference
		conformation*	performance		
			dressage	jumping	
KWPN (The Netherlands)	+1 to +40 (N40)	N = 20 $h^2 = 0.18$ (0.09-0.28)	N = 6 (W,T) $h^2 = 0.18$ (0.12-0.22)	-	Koenen et al. 1995 (10,665 mares)
	+1 to +40 (N40)	-	N = 10 (W,T,C) $h^2 = 0.24$ (0.15-0.32)	N = 8 (FJ) $h^2 = 0.28$ (0.22-0.37)	Ducro et al. 2007 (36,110 horses)
CH-sporhorse (Switzerland)	+1 to +9 (N9)	N = 10 ** $h^2 = 0.22$ (0.14-0.34)	N = 2 (T) $h^2 = 0.21$ (0.09-0.32)	-	Hascher 1998 (3,755 foals)
	+1 to +9 (N9)	N = 19 ** $h^2 = 0.16$ (0.08-0.28)	N = 5 (W,T) $h^2 = 0.28$ (0.16-0.42)	-	Hascher 1998 (2,026 riding horses)
BWP (Belgium)	-20 to +20 (N9)	N = 27 $h^2 = 0.30$ (0.15-0.55)	N = 6 (W,T) $h^2 = 0.41$ (0.33-0.52)	-	Rustin et al. 2009 (987 mares)
Hannover (Germany)	+1 to +9 (N9)	N = 24 → 19 $h^2 = 0.31$ (0.02-0.74)	N = 4 (W,T) $h^2 = 0.33$ (0.20-0.48)	-	Weymann 1989 (521 mares)
Brb., Meckl., Sax., S.-Anh., Thu. (Germany)	+1 to +9 (N9)	N = 53 → 35 ** $h^2 = 0.30$ (0.12-0.50)	N = 18 → 16 (W,T) $h^2 = 0.26$ (0.11-0.43)	-	Hartmann 1993 (1,753 horses)
	-3 to +3 (N7)	N = 71 → 21 $h^2 = 0.14$ (0.00-0.36)	N = 28 → 10 (W,T,C) $h^2 = 0.20$ (0.00-0.37)	-	Stock et al. 2013 (1,755 foals)
OL, OS (Germany)	+1 to +9 (N9)	N = 71 → 33 $h^2 = 0.12$ (0.00-0.46)	N = 70 → 38 (W,T,C,R) $h^2 = 0.16$ (0.00-0.55)	N = 12 → 6 (FJ) $h^2 = 0.10$ (0.00-0.35)	Stock et al. 2013 (1,005 adult horses)

* conformation + correctness, ** correctness of gaits under dressage performance; W= walk, T = trot, C = canter, R=rideability, FJ = free jumping

Breeding values for linear traits KWPN (dressage)

- indices ('genetic profile')
high = favorable breeding values
- breeding values for individual linear traits ('detailed traits conformation', 'detailed traits loose movement')
interpretation of breeding values according to linear scale (often: low = favorable)



Conclusions

■ feasibility of routine linear profiling in the Warmblood horse

- independent of age (possible in foals)
- at regular breeding events (different approaches)
- conformation and performance phenotypes (according to assessment conditions and intentions / use of linear profiles)

clear & unambiguous	✓
early & broad	✓
objective	(✓)
specific & breeding goal related	✓

■ challenges of implementation

- minimizing additional efforts
time & personnel, data collection & processing
→ technical solutions / mobile systems, documentation assistance
- maximizing use of opportunities of improved phenotyping
education & training, information / explanation, workshops, ...
→ short- and long-term data quality, interpretation of linear profiles



Perspectives

■ successful R&D base work

- comprehensive linear schemes for Warmblood horses (conformation, performance incl. behavior)
- improved individual characterization (refined phenotypes)
- promising results of genetic analyses of linear traits *

⇒ improved breeding programs: genetic gain ↑

■ parallel move towards linear profiling in several studbooks implying mutual benefits from synergistic actions

- exchange of information and experiences
- transparency with regard to linear schemes and trait definitions
- regular training (within and across studbooks)
- collaboration to facilitate set-up of new data logistics

* TO DO: genomic studies



Perspectives → recent activities

- Dec. 2011 workshop on linear profiling in the Warmblood horse
→ international linear profiling working group
with representatives from breeding and science
- working group meetings and actions to support wider use of
linear profiles in Warmblood breeding
 - literature review incl. 'national science' (theses etc.)
Duensing et al. (JEVS, in press)
 - linear trait inventory (sets of traits, trait definitions)
to be made available online
 - regular exchange (theoretical and practical)

**International Workshop on linear profiling in the Warmblood horse
on November 28th, 2013, in Vechta / Germany**

- registration until 2 Nov 2013
- max. 3 persons per studbook or organization

Thank you!



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**Looking forward
to see you in Vechta
on Nov 28th 2013**