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Animal Production

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Assessing the value of genetic linear profiles for selecting for sport performance of riding horses

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Session 8
(abstract no. 36618)

Outline

❖ routine genetic evaluations for riding horses
  ◆ data sources and trait definitions
  ◆ complementary tools for breeders

❖ study approach to close an information gap
  ◆ material and methods
  ◆ results

❖ implications for breeding applications

Background

- routine data collection of the studbooks
  - detailed information on specifically defined traits (linear description)
  - early and targeted breeding support (genetic linear profiles)
- data from equestrian sport
  - information on the ultimate breeding goal traits
  - challenging data structure, trait definition, modeling
  - late availability of genetic proofs for competition performance

  ➢ suitability and value of linear conformation and performance traits as indicator traits in sport horse breeding

Study approach

- routine genetic evaluations → estimated breeding values (EBV) for a representative and variable sample of horses
  - EBV for linear conformation and performance traits from the genetic evaluation of the Oldenburg studbooks (OL, OS)
  - EBV for sport traits from the national genetic evaluation for riding horses in Germany (FN) → OL/OS mare population
- different definitions of sport traits
  - rank-based → individual ranking among all starters
  - level-based → highest level achieved (lifetime summary)
  - ➢ dressage (DR, DL) and show-jumping (JR, JL)

Routine genetic evaluations I

EBV for linear traits (LIN-EBV)

- OL+OS linear data 2012-2020
- 27,786 linear profiles of 26,069 horses
- 46 traits: conformation, special remarks, gaits, jumping

single- / multiple-trait repeatability linear animal models:

$y_{ijknop} = \mu + SB_i + EVENT\text{-}TEAM_j + AGE\_M_k + SEX_l + animal_o + e_{ijklop}$ (foals)

$y_{ijmnop} = \mu + SB_i + EVENT\text{-}TEAM_j + AGE\_Y_m + PTYPE_n + animal_o + pe_o + e_{ijmnop}$ (adults)

fixed effects: SB = studbook (OL, OS), EVENT-TEAM = date, place, assessor, assistance, SEX = male / female, AGE_M (AGE_Y) = age in months (years), PTYPE = presentation type (assessment in hand, free, under rider); random effects: animal = additive genetic effect, pe = permanent environmental effect of the animal

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Routine genetic evaluations II

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$y_{ijmnop} = \mu + SB_i + EVENT\text{-}TEAM_j + AGE\_Y_m + PTYPE_n + animal_o + pe_o + e_{ijmnop}$ (adults)

fixed effects: SB = studbook (OL, OS), EVENT-TEAM = date, place, assessor, assistance, SEX = male / female, AGE_M (AGE_Y) = age in months (years), PTYPE = presentation type (assessment in hand, free, under rider); random effects: animal = additive genetic effect, pe = permanent environmental effect of the animal

EBV for sport performance: dressage (D), show-jumping (J)

- sport data 1995-2020 (national /FN, international/FEI)
- 5.8m starts of 266k horses for D, 13.2m starts of 311k horses for J
- 2 traits per discipline: ranking (R) and highest level achieved (L)

single- / multiple-trait repeatability linear animal models:

$y_{ijklop} = \mu + COMP_i + SEX_j \times AGE_k + RIDER_l + animal_o + pe_o + e_{ijklop}$ (DR, JR)

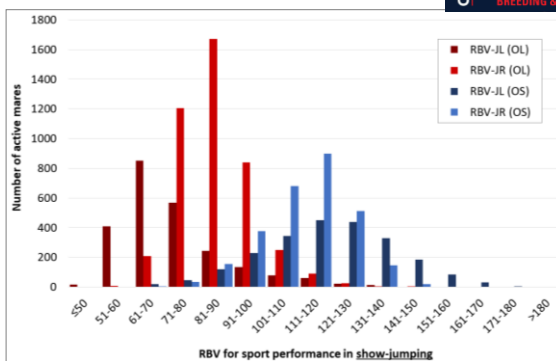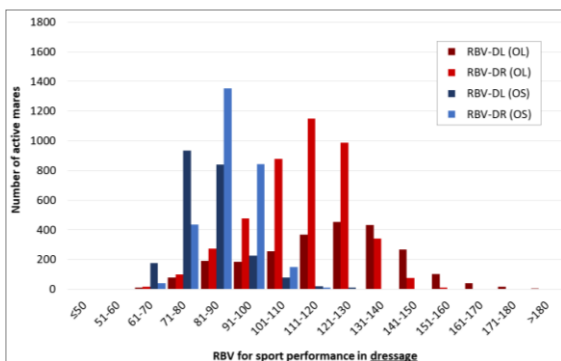$y_{jmnop} = \mu + Sex_j + L\_AGE_m + L\_YEAR_n + animal_o + e_{jmnop}$ (DL, JL)

fixed effects: COMP = individual competition, SEX = stallions / gelding / mare, AGE (L_AGE) = competition age (age at achieving highest level) in years, RIDER = rider category or individual rider, L_YEAR = year of achieving highest level; random effects: animal = additive genetic effect, pe = permanent environmental effect of the animal

Study sample

- results of routine genetic evaluations 2020
  - EBV for linear traits for 10,768 mares
  - EBV for sport traits for 7,198 mares

- only mares with own performance or at least 2 adult progeny
  - linear EBV: 9,436 mares
  - sport EBV: ~2,000 mares (N_{DL}=1,783, N_{DR}=1,761, N_{JL}=2,293, N_{JR}=2,175)

- ~600 mares with average EBV reliabilities > 40% for both trait groups (N_{DL}=615, N_{DR}=607, N_{JL}=638, N_{JR}=621)

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EBV for sport traits

Sport trait		OL+OS			OL			OS		
(L level, R rank)		N	mean EBV	std EBV	N	mean EBV	std EBV	N	mean EBV	std EBV
Dressage	DL	4,687	101.9	25.8	2,402	120.8	21.9	2,285	82.1	9.9
	DR	7,135	102.9	17.6	4,305	112.7	15.1	2,830	88.0	8.0
Show-jumping	JL	4,687	95.4	28.9	2,402	73.4	15.9	2,285	118.7	19.8
	JR	7,135	95.9	17.2	4,305	85.8	11.1	2,830	111.2	13.1

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Methodology

- statistical analyses using SAS software
  - EBV for indicator traits (linear description)
  - EBV for target traits (sport performance; DL, DR, JL, JR)
- EBV correlations → Pearson correlation coefficients
- analysis of variance
  - linear regression
  - class variable (LIN-EBV <90, 90-110, >110) → Least Square Means
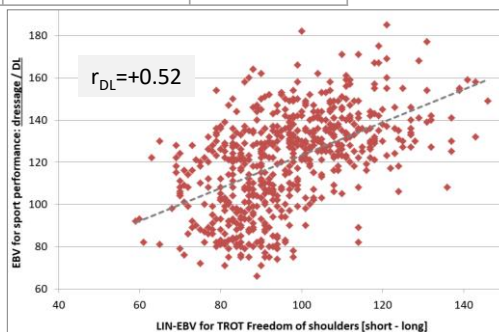
Association patterns I

Linear trait group	Pearson correlation coefficients		Indicator value
	D (DL, DR)	J (JL, JR)	
Conformation, special remarks	-0.26 to +0.32	-0.14 to +0.21	**?**
Gaits	+0.12 to +0.53	-0.37 to +0.28	D+
Jumping	-0.51 to -0.25	+0.09 to +0.55	J+

$r_{DL}=+0.26$
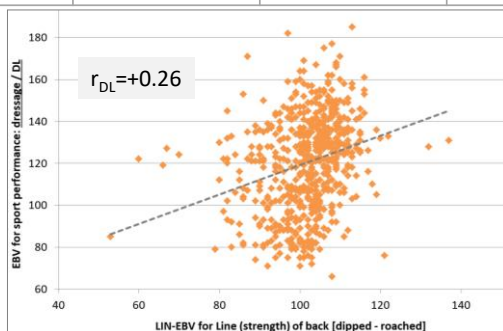
Association patterns II

Linear trait group	Pearson correlation coefficients		Indicator value
	D (DL, DR)	J (JL, JR)	
Conformation, special remarks	-0.26 to +0.32	-0.14 to +0.21	?
Gaits	+0.12 to +0.53	-0.37 to +0.28	D+
Jumping	-0.51 to -0.25	+0.09 to +0.55	J+

$r_{DL}=+0.53$

$r_{DL}=+0.52$

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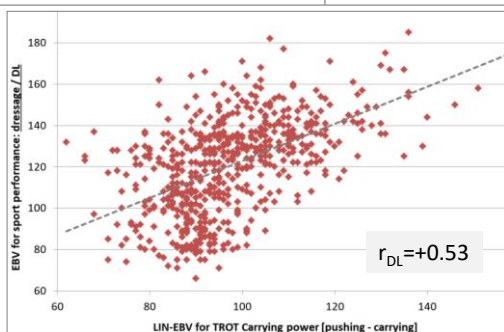
Association patterns III

Linear trait group	Pearson correlation coefficients		Indicator value
	D (DL, DR)	J (JL, JR)	
Conformation, special remarks	-0.26 to +0.32	-0.14 to +0.21	?
Gaits	+0.12 to +0.53	-0.37 to +0.28	D+
Jumping	-0.51 to -0.25	+0.09 to +0.55	J+

$r_{JL}=+0.55$

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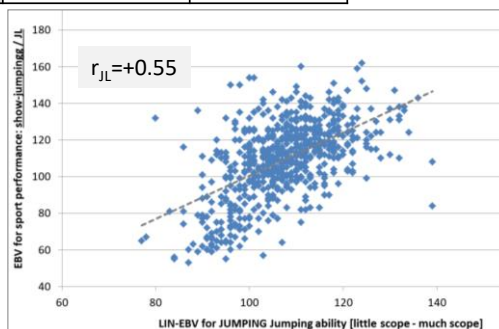
Summary of results

- **linear conformation traits** (conformation, special remarks)
  - mostly absent or low EBV correlations of -0.2 < r < +0.2
  - functionally plausible indications of relevance for dressage performance: conformation of neck (shape, muscling) and back (strength)

- **linear performance traits** (gaits, jumping)
  - mostly significant correlations (P < 0.001) within discipline
  - ANOVA: slightly different patterns for sport trait definitions L and R
  - correlations of r > 0.5:
    reach of hind limbs in WALK, carrying power and freedom of shoulders in TROT, direction of movement in CANTER (D); jumping ability (J)

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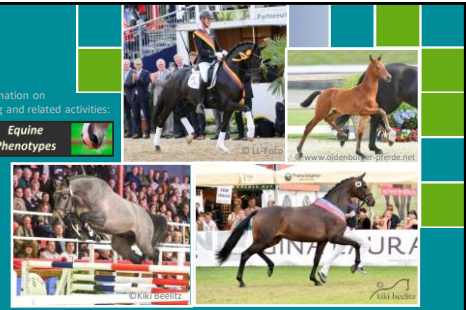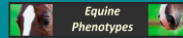
Implications

- **genetic linear profiles as appreciated tool for breeders**
  - early and specific information on the inheritance of stallions
  - targeted support of mating decisions (wide range of traits)

- **reasonable correlations between EBV for linear traits and for sport performance in dressage and show-jumping implying suitability of the linear system to strengthen sport horse breeding programs**

- ➤ high value of the refined linear phenotypes for current and future breeding applications for sport horses
- ➤ linear traits as appropriate targets for genomic tools

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Further information on
linear profiling and related activities:

Equine Phenotypes

➢ high value of the refined linear phenotypes for current and future breeding applications for sport horses
➢ linear traits as appropriate targets for genomic tools

Thank you !