

Available conformation and gait traits

Subjective valuating score (judgement)

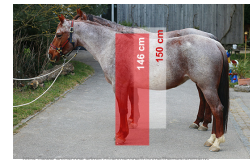
- Range: dislike ↔ like

Linear profiling score

- Range: predefined extremes
- Central score = population mean

Measures

- e.g. height at withers



Similar conformation traits between cattle and horse

Hock angle



Croup inclination



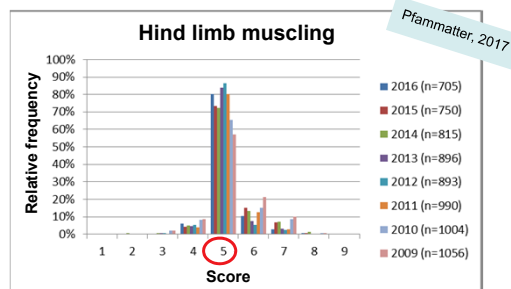


What we learned about horse scoring data...

- Low to medium heritability (Burren et al. 2015)
- Breed-specific (small sample sizes)
 - 9 judges, few horses (<1000 per year)
- Subjectively scored ↔ low inter-rater reliability (Gmel et al. 2020)
- Data not well distributed, tends to the optimum (Burren et al. 2015, Pfammatier 2017)



Suisse. Naturellement.



Measuring conformation traits: Horse shape space model

- Model by Druml et al. 2015
- Geometric morphometrics: extract information on shape of a morphological structure

Journal of Animal Breeding and Genetics

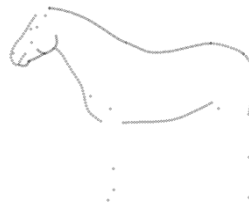
The use of novel phenotyping methods for validation of equine conformation scoring results

T. Drost, M. Delebringer and C. Bruns

Received: 14 August 2015; Accepted: 12 February 2016

In this paper we will describe a novel method of shape analysis that is based on the use of the so-called shape space model. This model is based on the use of geometric morphometrics (GM) to extract information on the shape of a morphological structure. The shape space model is a statistical model that describes the shape of a morphological structure in terms of its position in a high-dimensional space. The shape space model is a statistical model that describes the shape of a morphological structure in terms of its position in a high-dimensional space. The shape space model is a statistical model that describes the shape of a morphological structure in terms of its position in a high-dimensional space.

Digitisation

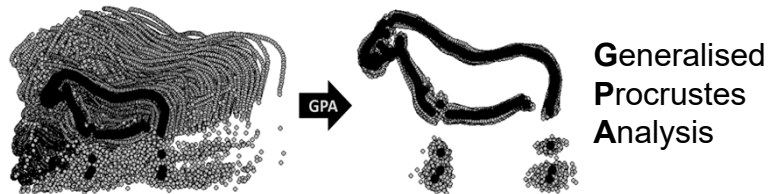


Point	X	Y
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2	100.0000	200.0000
3	100.0000	300.0000
4	100.0000	400.0000
5	100.0000	500.0000
6	100.0000	600.0000
7	100.0000	700.0000
8	100.0000	800.0000
9	100.0000	900.0000
10	100.0000	1000.0000
11	100.0000	1100.0000
12	100.0000	1200.0000
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97	100.0000	9700.0000
98	100.0000	9800.0000
99	100.0000	9900.0000
100	100.0000	10000.0000



Geometric morphometrics – data types

- Superimposed, scaled and rotated to a best-fit consensus



- Centroid size
 - Procrustes Distance
 - Relative warp scores
 - Angles between landmarks
- } Data quality validation
- } Phenotypes

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Genome wide association studies

Phenotypes

- Joint angles as phenotypes (independent of sample)
- Inclusion of the Lipizzan horse breed shapes



	FM	Lipizzan horse
Male	300	125
Female	-	99
Median birth year	2003	2005

Genotypes

Genetic data type	FM	Lipizzan
WGS	12	
50K SNP data imputed to sequence (from Frischknecht et al. 2014)	135	
670K Affymetrix SNP chip	137	224

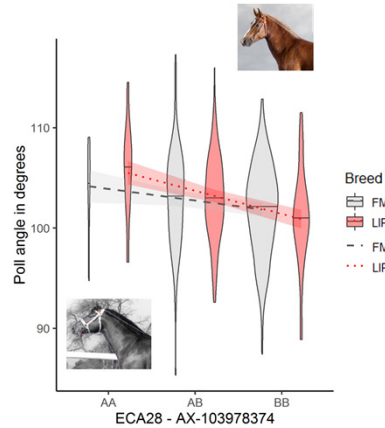
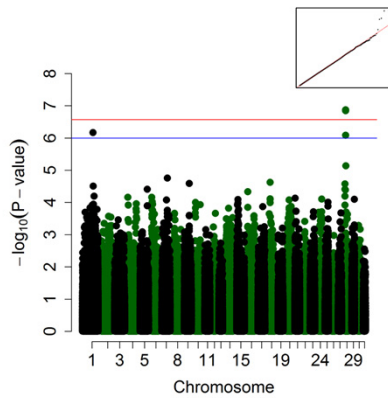
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Results – Poll angle



Repeatability = 0.92
Heritability = 0.38 ± 0.098



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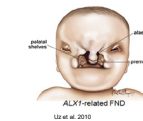
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Poll angle QTL near *ALX1*

- *ALX1*, homeobox associated with the development of the head and spine in mammals. Mutations in this gene cause anomalies in
 - Head shape (Uz et al. 2010) and/or
 - Spina bifida (confirmed in mice model)
- In horses: one QTL near *ALX1* in a GWAS for osteochondrosis (Lykkjen et al. 2010)
- Poll angle phenotype in the horse: Occipitoatlantoaxial malformation caused by a deletion near *HOXD3* gene (also a homeobox gene) (Bordbari et al. 2017)



Source: CDC, Center for Disease Control



(Bordbari et al. 2017)

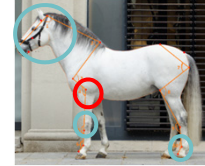
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🇨🇭 Tendencies in our GWAS



- Significant SNPs for elbow joint angle
- Suggestive SNPs for poll, fetlock joint (hind limb) & carpal joint angles



Development:
Homeobox *ALX1, LHX5*
FRG1



Bone metabolism and mineral density:
RSU1, PTER, CALCR

Height:
LCORL/NCAPG
NCAPD3

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🇨🇭 Shape and gaits 2.0 so far



- 511 FM shapes 300 genotyped
- 224 Lipizzaner (shape+geno)
- 32 Shagya Arabians (shape+geno)
- *Swiss Warmblood* → *data collection in progress*
- 109 FM horses at the walk & trot
- Data analysis in progress
- *Swiss Warmblood* → *data collection in progress*

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- + More Lipizzaner
- + *German Warmblood*
- + *Black forest horses*
- + *Arabians*

More field work in 2021



Future steps – creating synergies

- 3D scan of horses with Agroscope Posieux



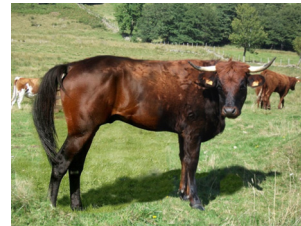
- Cattle shape space?



 **Thank you for your attention!**



Interested in the shape space?



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