Animal-human-technology interactions: novel means of phenotyping cattle health and welfare

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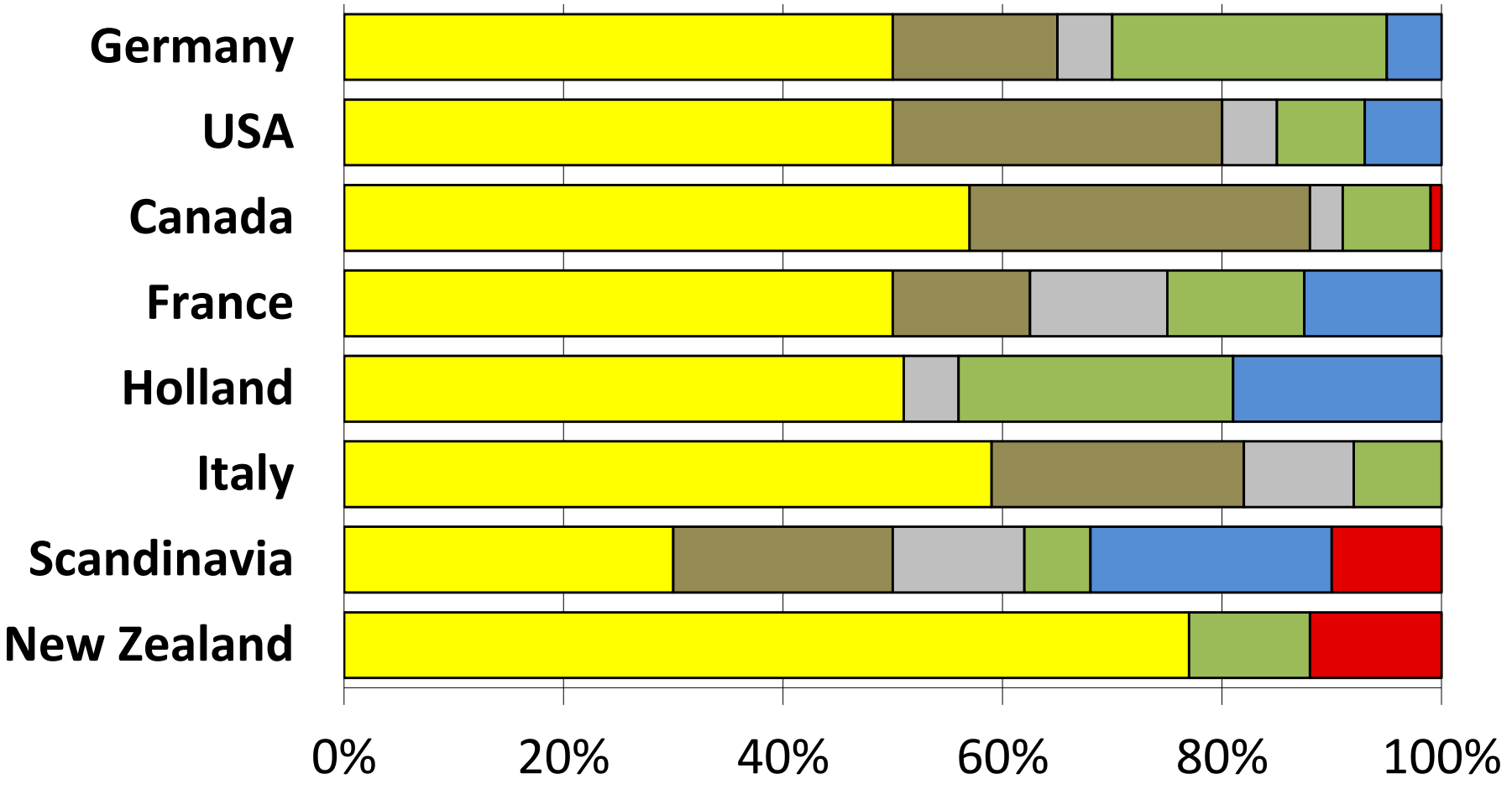
Status quo behaviour & health traits

- Health traits:
  - Generally recorded via indicator traits (somatic cell score, conformation,…)
  - > limited selection response
  - Exceptions: e.g. Scandinavia

Relative weight of different traits in overall breeding value



Status quo behaviour & health traits

- Health traits:
  - Generally recorded via indicator traits (somatic cell score, conformation,…)
  - > limited selection response
  - Exceptions: e.g. Scandinavia
- Behaviour traits (Temperament):
  - Culling of negative extremes by farmers
  - Breeding values for milking temperament, milkability (selection intensity?)
  - Recording via scores, speed of milking

Behaviour traits in dairy cattle

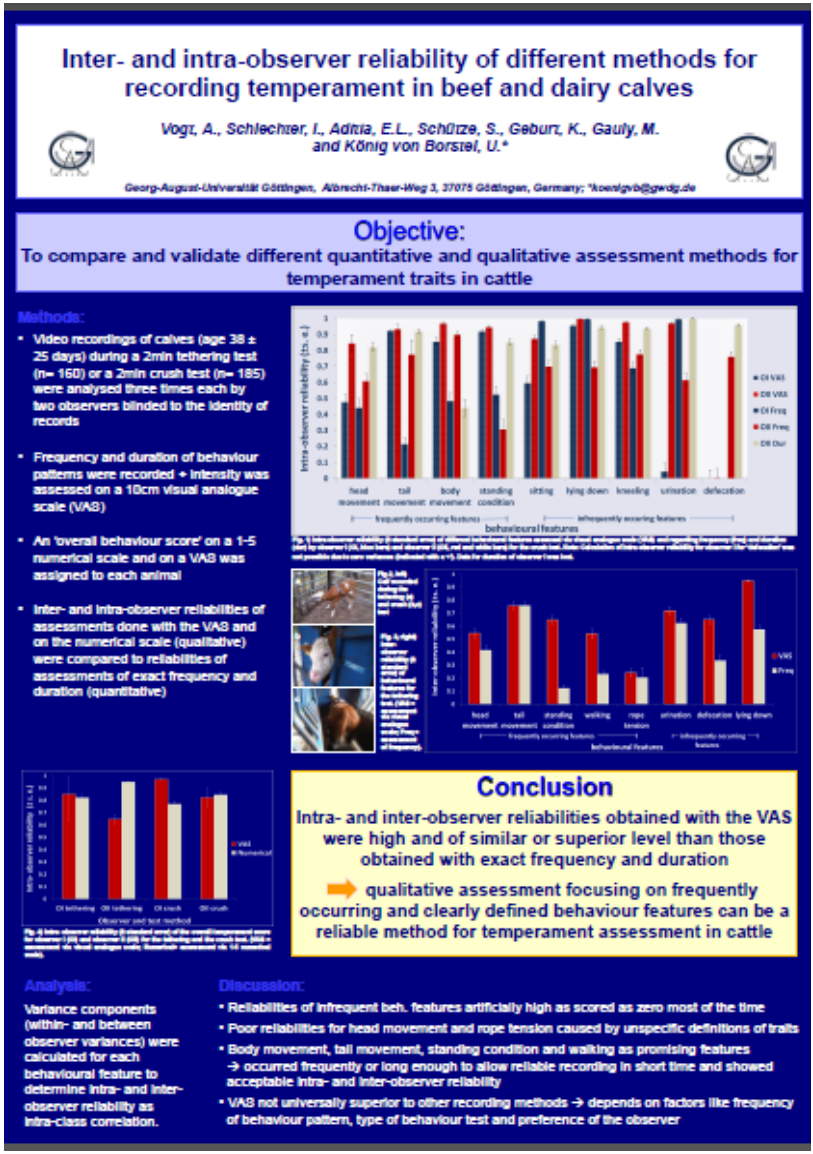
- Selection for behaviour driving force in domestication
- Generally $h^2 \sim 0.1 – 0.4$ (KvB, 2013)

- Problems:
  - Evaluation manually & time consuming, heifers only
  - Behaviour by definition plastic
  - Subjective evaluations

Comparison of objective and subjective methods for temperament recording

- Generally, superior inter- and intra observer reliabilities for <u>subjective</u> assessment methods (visual analogue scale)

- Still: manual recording -> time consuming



Inter- and intra-observer reliability of different methods for recording temperament in beef and dairy calves

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Objective:
To compare and validate different quantitative and qualitative assessment methods for temperament traits in cattle

Methods:
- Video recordings of calves (age 38 ± 25 days) during a 2min tethering test (n= 160) or a 2min crush test (n= 185) were analysed three times each by two observers blinded to the identity of records
- Frequency and duration of behaviour patterns were recorded + intensity was assessed on a 10cm visual analogue scale (VAS)
- An 'overall behaviour score' on a 1-5 numerical scale and on a VAS was assigned to each animal
- Inter- and intra-observer reliabilities of assessments done with the VAS and on the numerical scale (qualitative) were compared to reliabilities of assessments of exact frequency and duration (quantitative)

Conclusion
Intra- and inter-observer reliabilities obtained with the VAS were high and of similar or superior level than those obtained with exact frequency and duration
➡ qualitative assessment focusing on frequently occurring and clearly defined behaviour features can be a reliable method for temperament assessment in cattle

Analysis:
Variance components (within- and between observer variances) were calculated for each behavioural feature to determine intra- and inter-observer reliability as intra-class correlation.

Discussion:
- Reliabilities of infrequent beh. features artificially high as scored as zero most of the time
- Poor reliabilities for head movement and rope tension caused by unspecific definitions of traits
- Body movement, tail movement, standing condition and walking as promising features → occurred frequently or long enough to allow reliable recording in short time and showed acceptable intra- and inter-observer reliability
- VAS not universally superior to other recording methods → depends on factors like frequency of behaviour pattern, type of behaviour test and preference of the observer

Cows reaction to touching the udder as indicator for milking behaviour

- Recorded primi- and multiparous cows (n = 1141)

- Repeatability : 0.31
- Heritability: 0.10

- Phenotypic correlation to conventional milkability: 0.32

- -> possibility to increase reliabilities of breeding values

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- -> possibility to increase reliabilities of breeding values

- But: recording manually, time consuming
- In future: data from automated milking systems

Automated recording of activity (heat, lameness, health & welfare)

Accelerometers, Cameras, GPS, sound analysis

- Lying time - calves (Finney et al., 73)
  - dairy cows (Henriksen & Munksgaard, 54)
- Lameness - ear sensors (Link et al., 57)
- Movement on pasture - GPS, accelerometer (Maxa et al., 56)
- Activity (Ipema et al, 56)
- Real time image analysis, sound analysis, sensor signals (Berckmanns, 69)
- Social interactions - Ultra Wide Band (UWB) technology (Medisetti et al., 73); social rank (Gabrieli, 69)

Automated recording of feeding & drinking -> metabolic disorders, calving

Pressure, rumen temperature, pH

- Eating (Ipema et al, 56)
- Grass intake (Zom et al., 56)
- Rumination – calving (Clark and Garcia, 57)
- Modeling feed /DMI intake (Richter et al., 57)
- Rumen temperature – feed efficiency (Fischer & Faverdin, 44)

- Rumen pH - Water intake (Mottram and Bradley, 57)

Automated recording of physiological parameters

Picture: Medria

- body core temperature – calving
- Body temperature measurement in teats of automatic drinkers - Calf health surveillance
- respiration rate (developmental stage) (Pinto et al., 54)
- behaviour and health – review (De Vries, 57)

Further applications & challenges

- Conformation -> Cameras (Salau et al., 57)

Problem: Data interpretation!!

- EU-PLF- course (Faure et al., 69)

How about harsh environments?

Challenges:

- Cold climates:
  - Battery functioning!
- Humid climates:
  - equipment longevity
- Remote locations:
  - Signal & power availability
  - Animal tracing & identification (beef cattle) (Pires, 69)
- Industrial locations:
  - Signal disturbance (airports, high-voltage power lines)

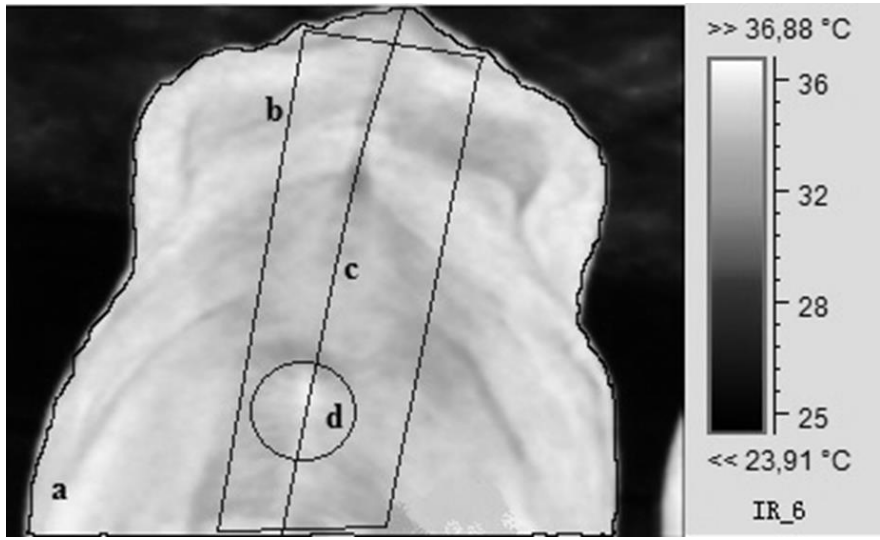
- Hot climates:
  - Equipment functioning ok, but novel traits: heat stress

Thermography – heat stress

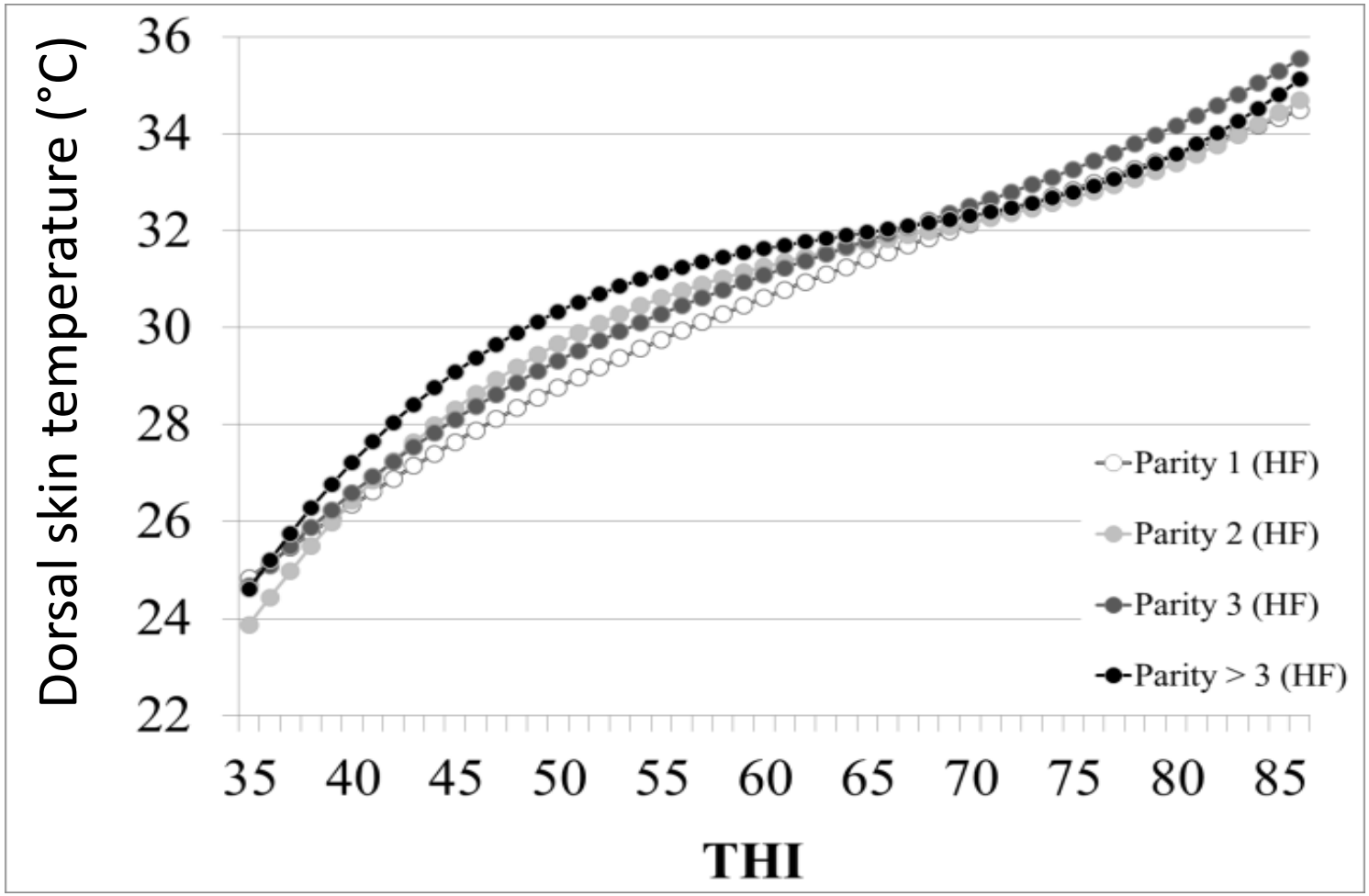
- n = 163 Holstein and German Black Pied cattle
- Longitudinal (2 years) recording of:
- Respiration rate
- Rectal, vaginal, skin temperature in 4 different body parts

- In-barn temperature
  and humidity (THI – index)

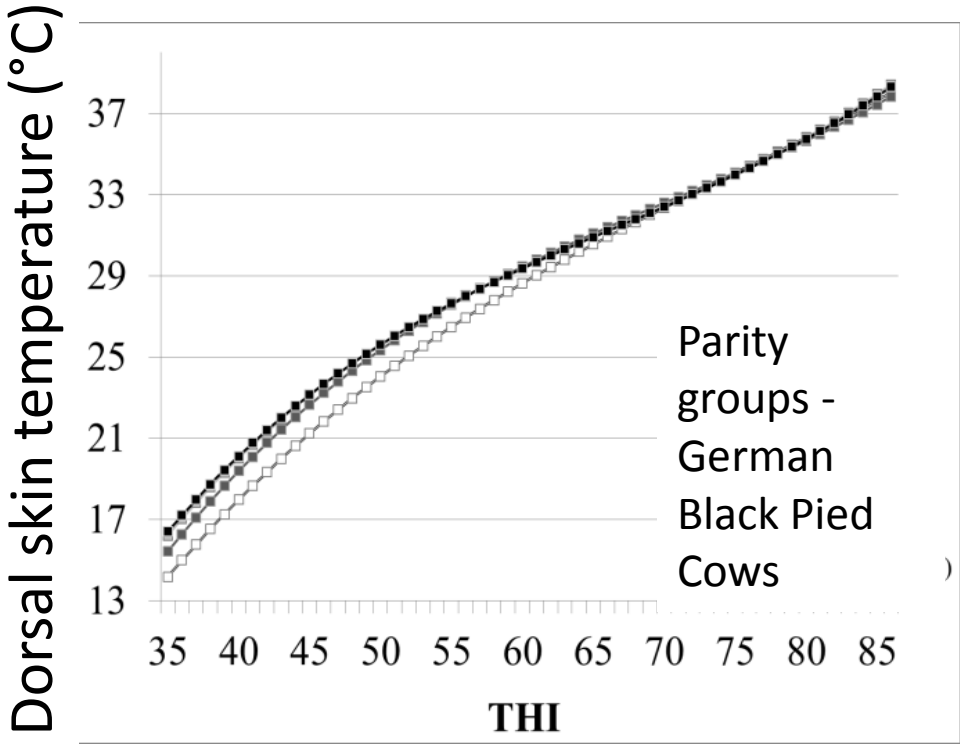
(Al-Kanaan et al., 2015)

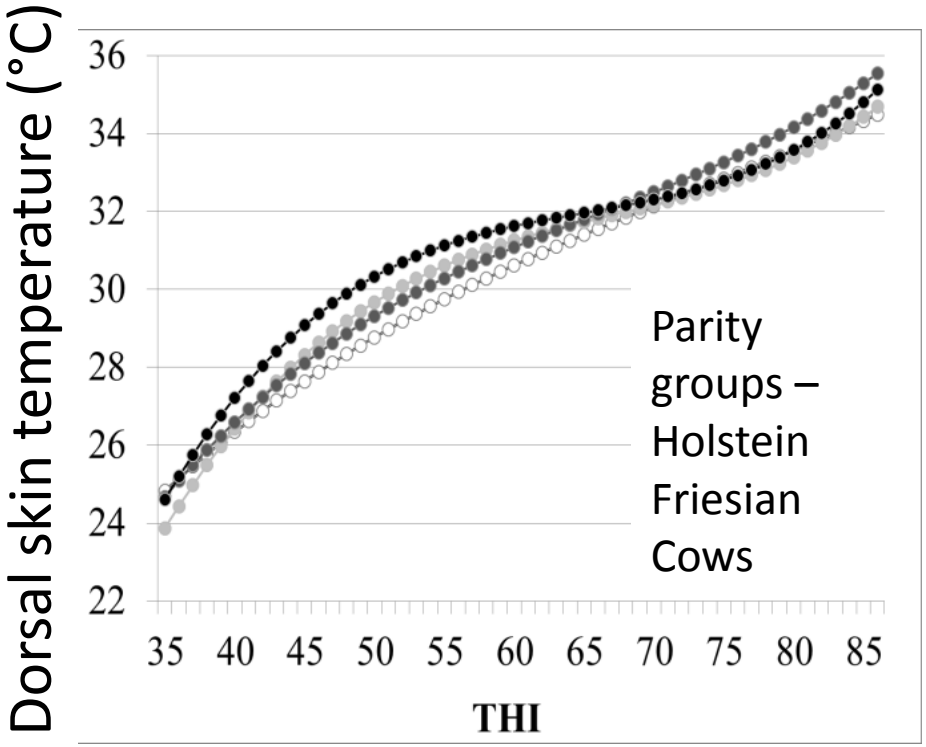


Skin temperature by Temperature-Humidity Index for Holstein Friesian Cattle of different parities

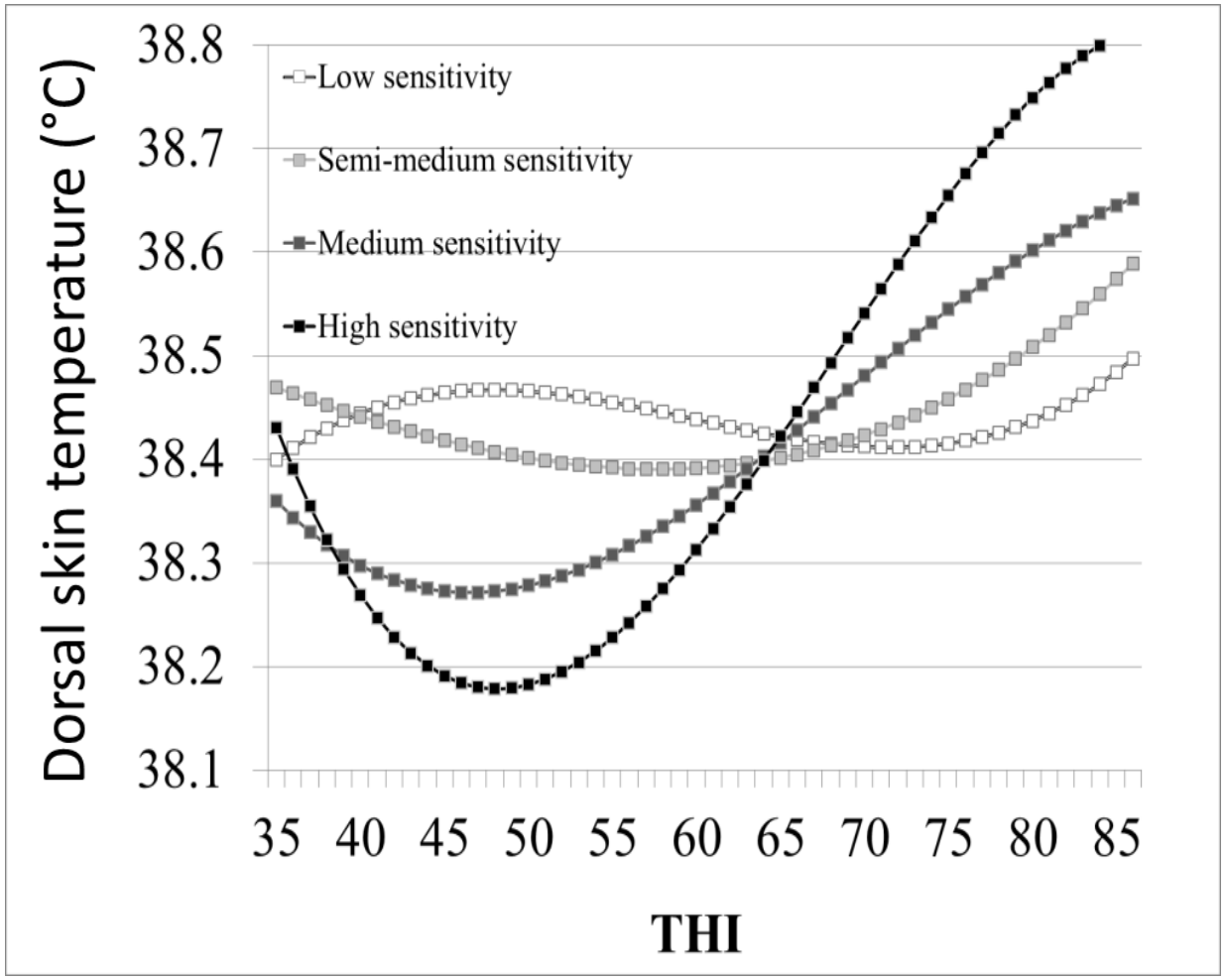


Skin temperature by Temperature-Humidity Index for Holstein and German Black Pied Cattle of different parities





Body temperature by THI for cows with different individual heat stress sensitivity



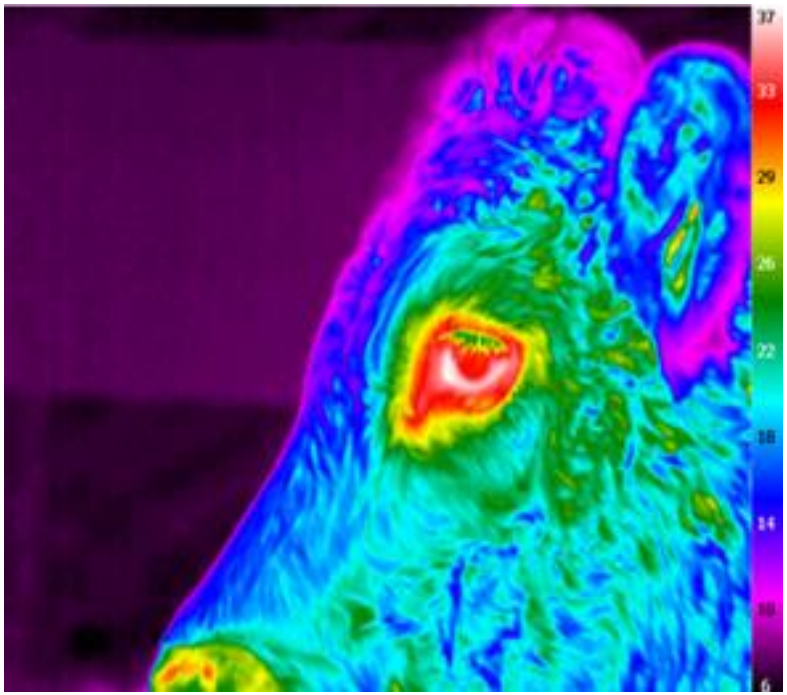
Heat stress indicators

- All parameters (respiration rate, temperatures) responded to increasing THI
- Differences between breeds, parities, milk yield, individual sensitivity

- Skin temperature may be a particular valuable tool for phenotyping heat stress

(Al-Kanaan et al., 2015)

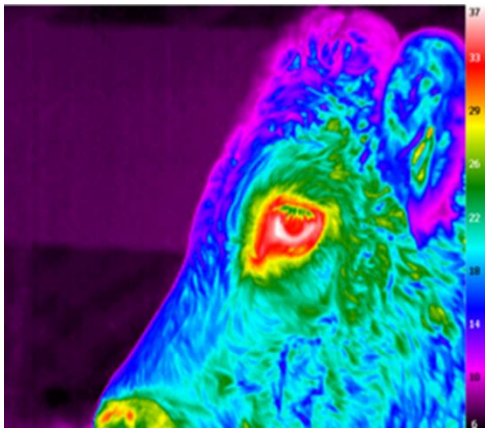
Body temperature & psychological stress



- Assessed cows' (n= 40) eye temperature, heart rate, cortisol, behaviour in handling (stress) situations

Phenotypic correlations
eye temperature – handling tests

	Cortisol	Heart rate	Handling score	time to separation
Eye temperature	0.62	0.68	0.68	0.75
Heart rate	0.50	-	0.45	0.52



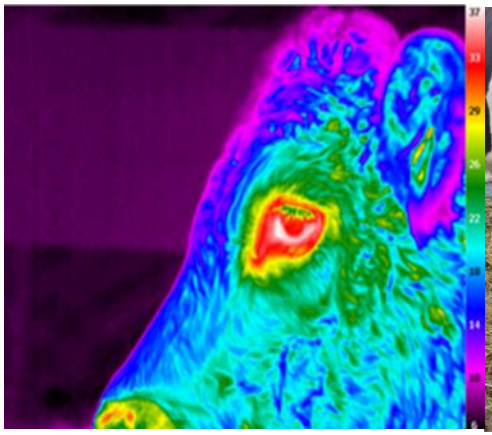
Geburt et al., 2015 a, b

Conclusion

- There are a myriad of new technologies available for novel phenotyping strategies

- Usually indicators - data interpretation a challenge
- Novel behaviour recording strategies promising – but economic value in future?

- Particularly (heat) stress recording is practical and may gain importance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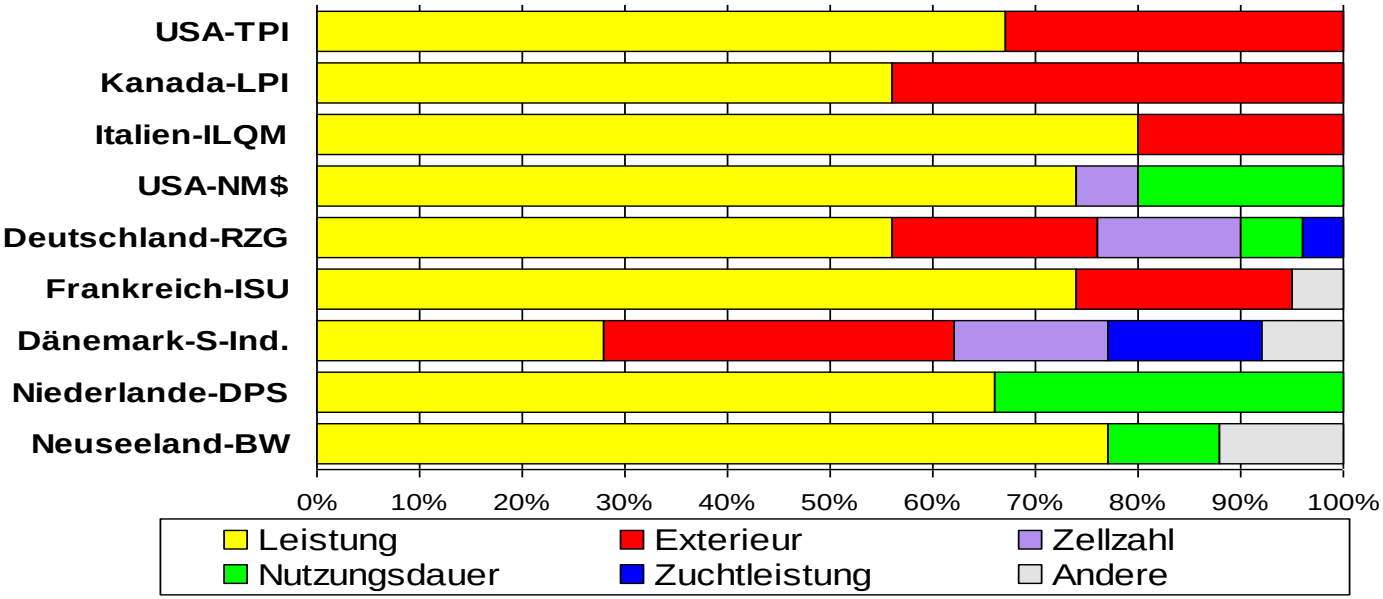
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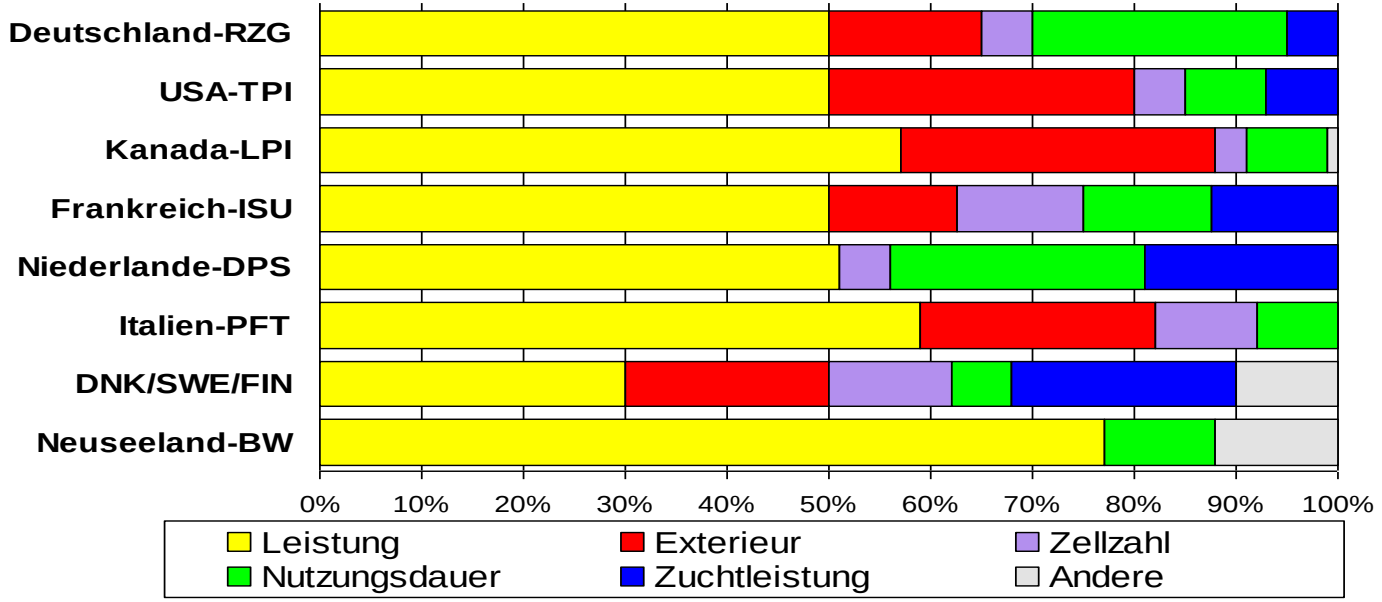
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