



From Track to Field: Insights from Racehorse Biomechanics for Sports Science

Lecture 6

Zoe Chan, PhD
Postdoc Researcher
Faculty of Kinesiology, University of Calgary

21 July 2026



**CUHK SPORTS
MEDICINE**
中大運動醫學



About me

- Live in Calgary, Alberta CA
- Postdoctoral researcher at the University of Calgary
 - Quadrupedal Biomechanics Team
- Instructor at Mount Royal University
 - Health and Physical Education Department



UNIVERSITY OF
CALGARY



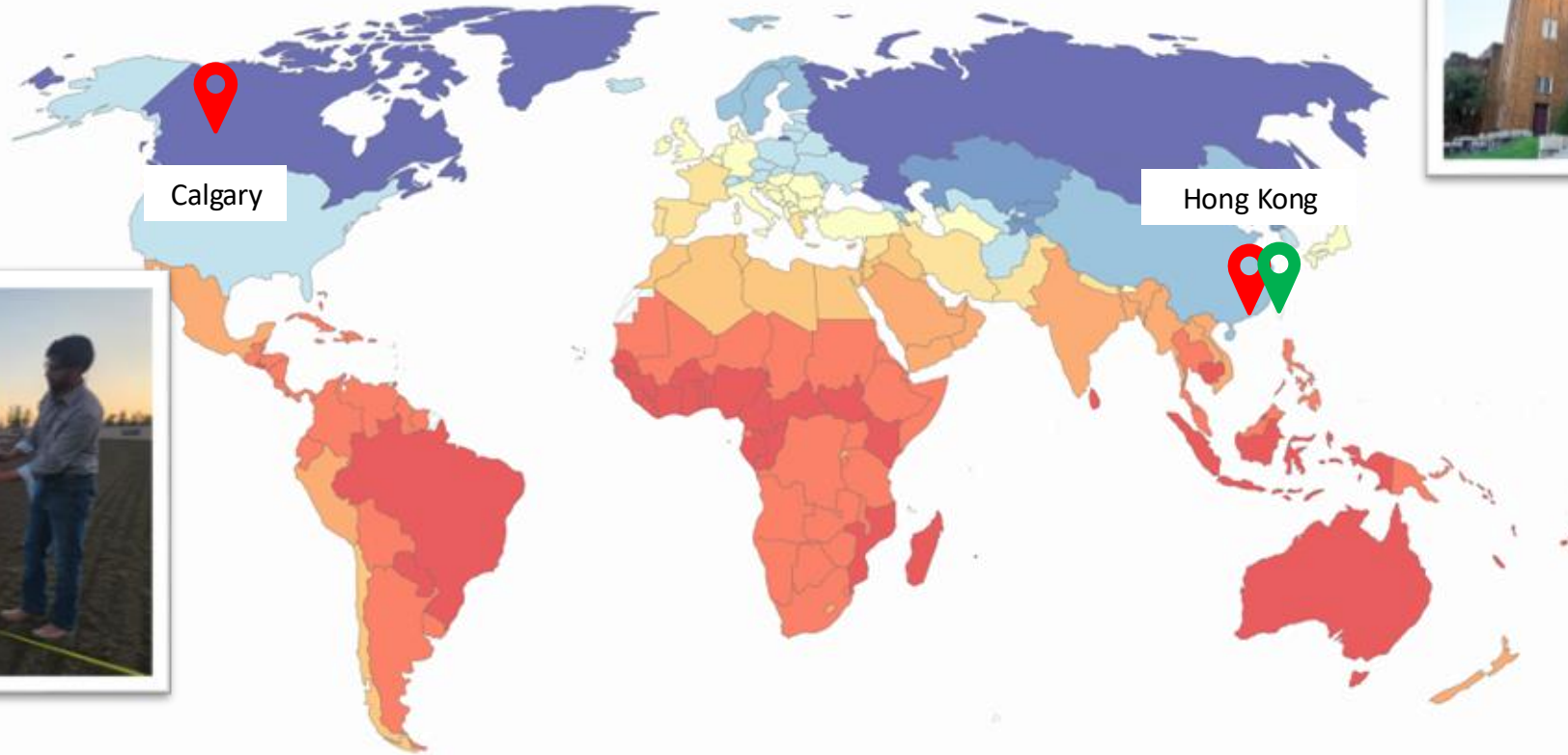
MOUNT
ROYAL
UNIVERSITY



Average monthly surface temperature, Jan 15, 2021

The temperature of the air measured 2 meters above the ground, encompassing land, sea, and in-land water surfaces.

Our World
in Data



No data

-15 °C

-10 °C

-5 °C

0 °C

5 °C

10 °C

15 °C

20 °C

25 °C

Data source: Contains modified Copernicus Climate Change Service information (2026)

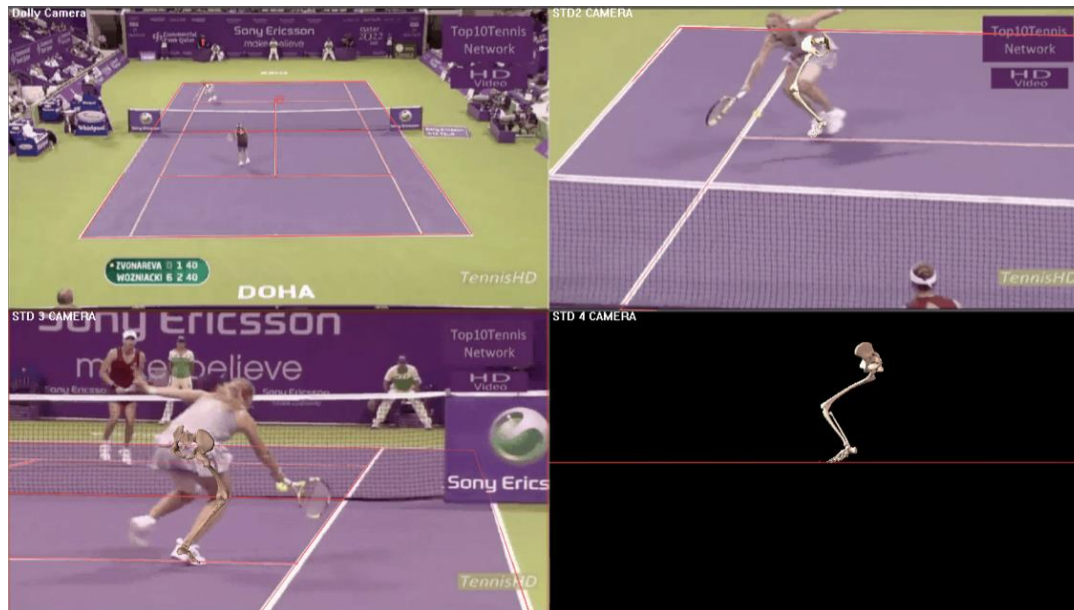
OurWorldinData.org/climate-change | CC BY



My Research Journey

BEng @ CUHK

Sideward cutting motion in tennis - MBIM



Comparison between injured and non-injured motions



First research presentation – i-FAB 2014 @ Busan, Korea





My Research Journey

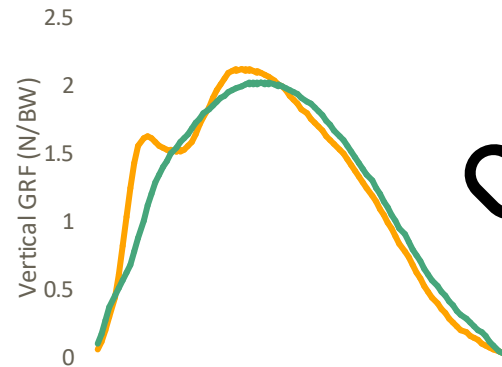
BEng @ CUHK

MPhil @ HKPolyU

- Gait & Motion Analysis Lab



Distance running



Impact loading



Running-related injuries



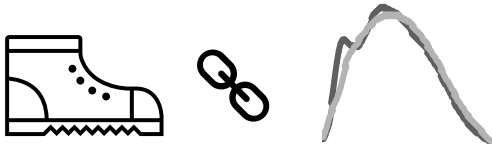


My Research Journey

BEng @ CUHK

MPhil @ HKPolyU

- Footwear properties and impact loading





My Research Journey

BEng @ CUHK

MPhil @ HKPolyU

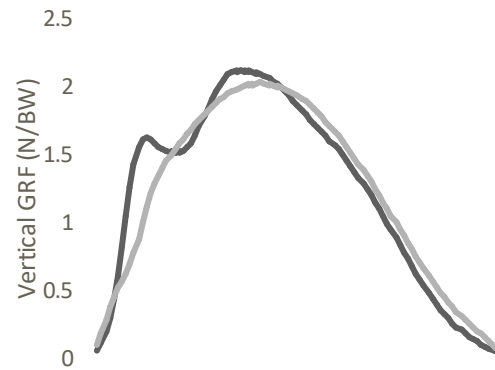
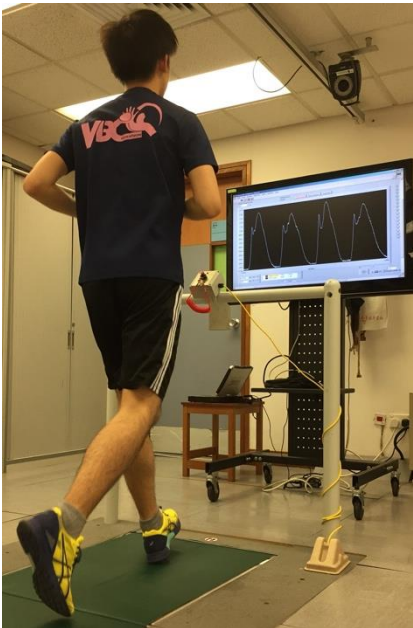
- Gait retraining for novice runners
- Mid-foot strike gait retraining



Rear-foot strike (RFS)



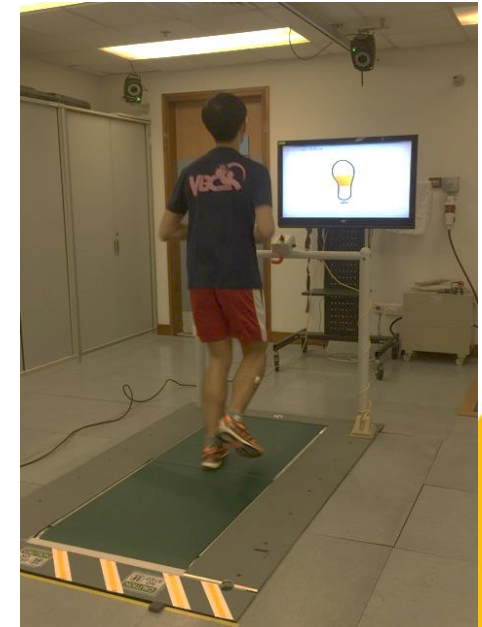
Mid-foot strike (MFS)



Lowers impact loading



Reduces running-related injuries



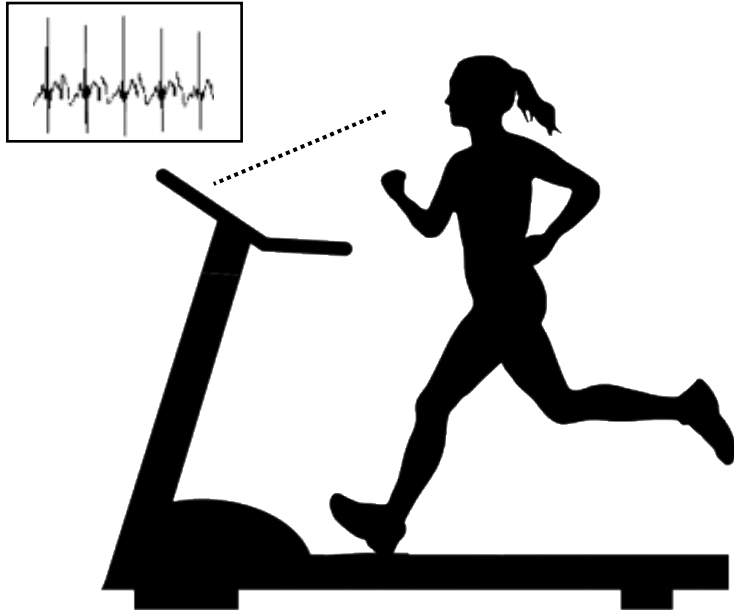


My Research Journey

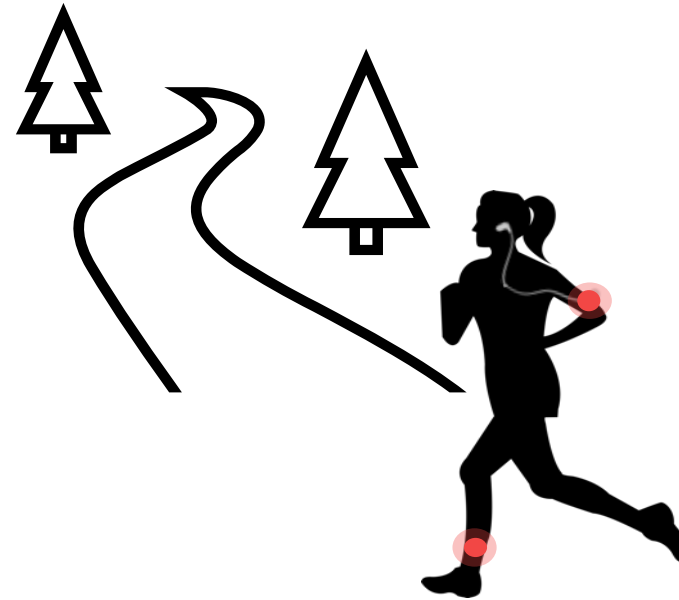
BEng @ CUHK

MPhil @ HKPolyU

PhD @ HKPolyU



Treadmill-based gait retraining



Gait retraining under real-world conditions



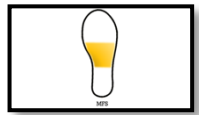
My Research Journey

BEng @ CUHK

MPhil @ HKPolyU

PhD @ HKPolyU

- Carry-over effect of training



Treadmill to overground



Level surface to slopes



My Research Journey

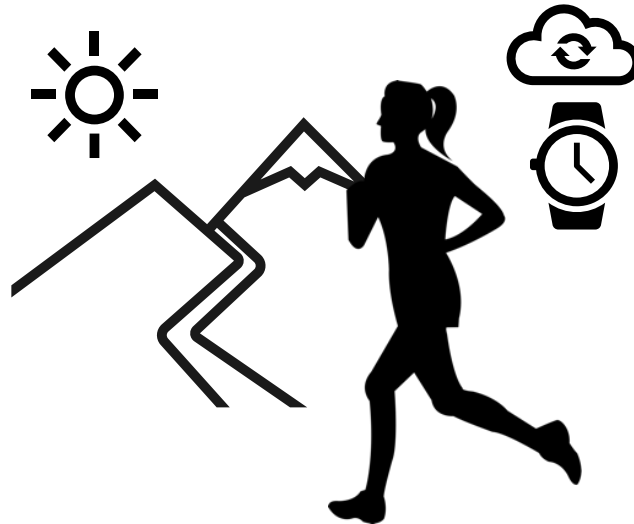
BEng @ CUHK

MPhil @ HKPolyU

PhD @ HKPolyU

PhD @ UCalgary

- Habitual gait adaptation
 - How does slope affect speed and cadence?
- Wearable accelerometers
 - Optimal range
 - Reliability





My Research Journey

BEng @ CUHK

MPhil @ HKPolyU

PhD @ HKPolyU

PhD @ UCalgary



Horseback riding tour with Roy and Janet
Calgary, 2019



My Research Journey

BEng @ CUHK

MPhil @ HKPolyU

PhD @ HKPolyU

PhD @ UCalgary

Postdoc @ UCalgary



Data collection - equine stereotypes study & neck muscle activity study



Lecture Outline

1. Horse Gait and Rider Biomechanics
2. Movement Asymmetry in Horses
3. Research Example: Racing on a Bend
4. Stride Parameters and Injury Prediction





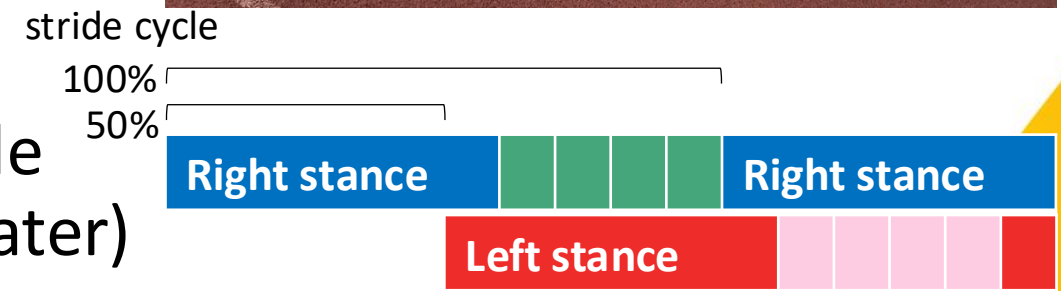
Lecture Outline

1. Horse Gait and Rider Biomechanics
2. Movement Asymmetry in Horses
3. Research Example: Racing on a Bend
4. Stride Parameters and Injury Prediction



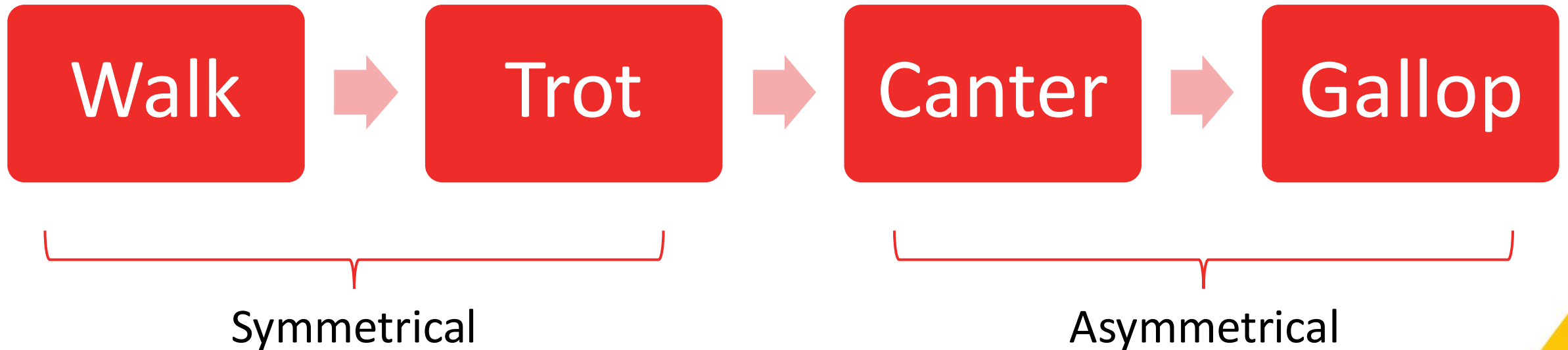
Gait Patterns

- **Gait:** a coordinated, rhythmic pattern of limb movements used for locomotion
- Walk
 - Lower speed
 - Lower ground reaction force (GRF)
- Run
 - Includes a **flight phase** where neither foot contacts the ground
- **Symmetrical gait:** limb pattern on one side repeated on the other side (half a stride later)



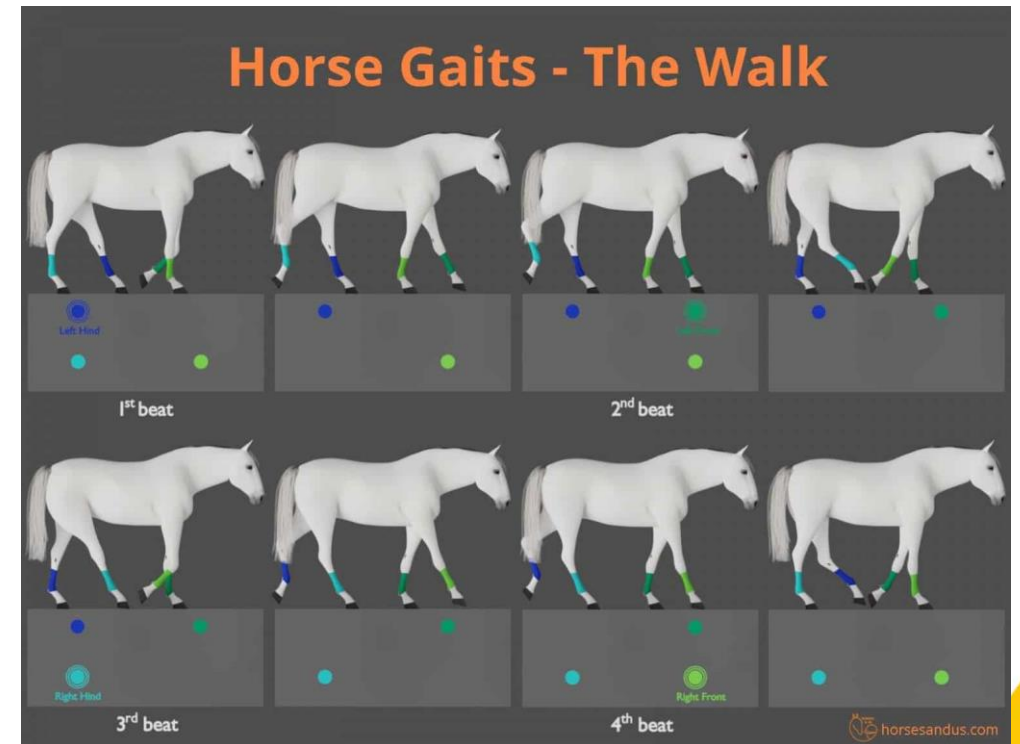
Gait Patterns

- Quadrupeds: animals that utilizes all 4 limbs for locomotion



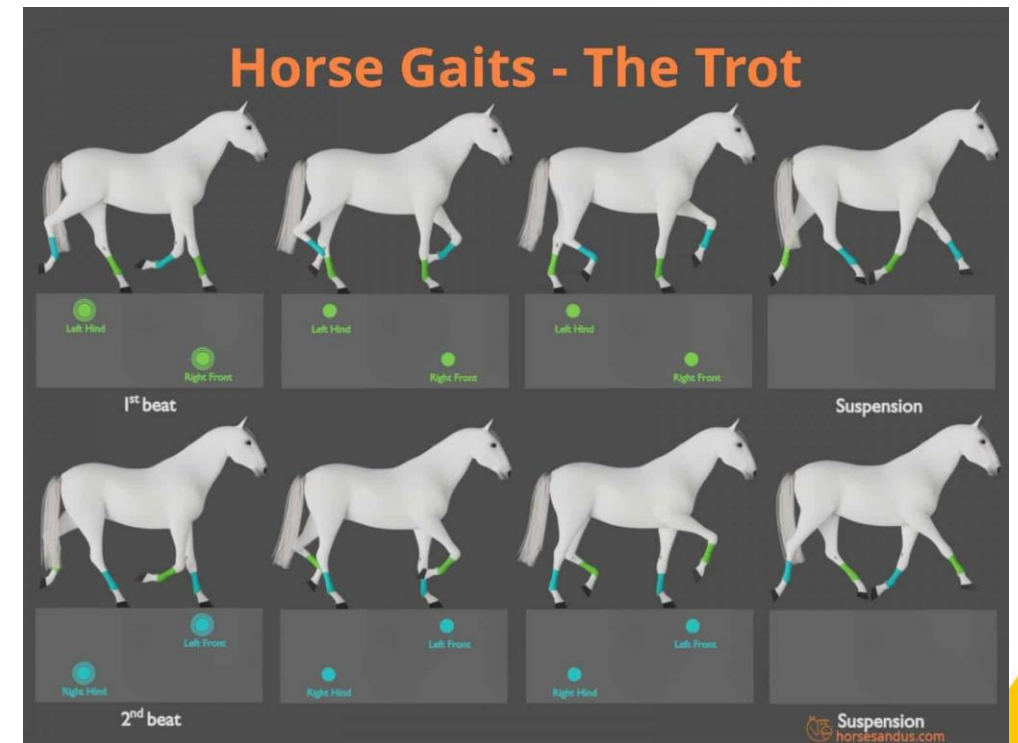
Gait Patterns

- Walk
 - Slow, symmetrical 4-beat gait
 - Each hoof hits the ground at a separate interval
 - No aerial phase, always 2 or 3 hooves on the ground



Gait Patterns

- Trot
 - Rapid, symmetrical 2-beat diagonal gait
 - Left Hind + Right Front
 - Suspension (aerial)
 - Right Hind + Left Front
 - Suspension



Gait Patterns

- Walk or trot

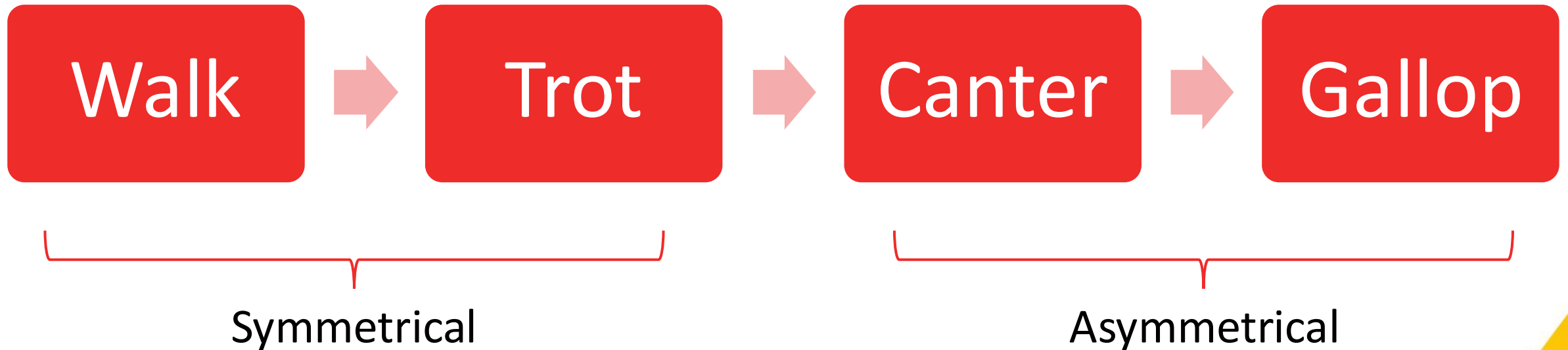


City Slickers Clip - 00:50



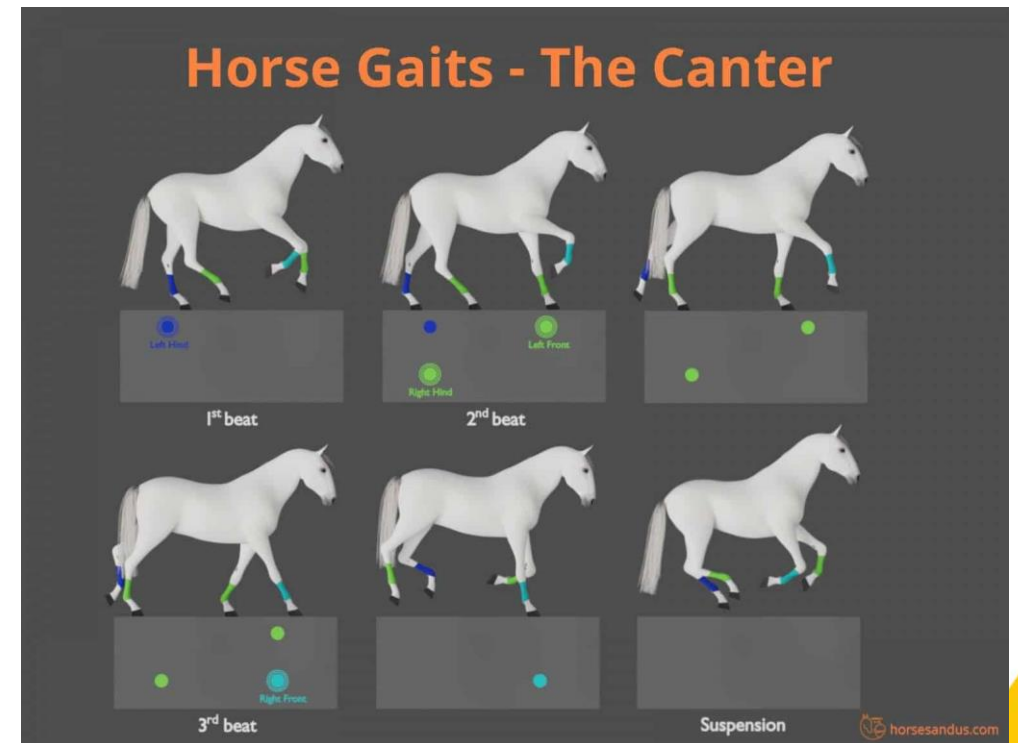
Gait Patterns

- Quadrupeds: animals that utilizes all 4 limbs for locomotion



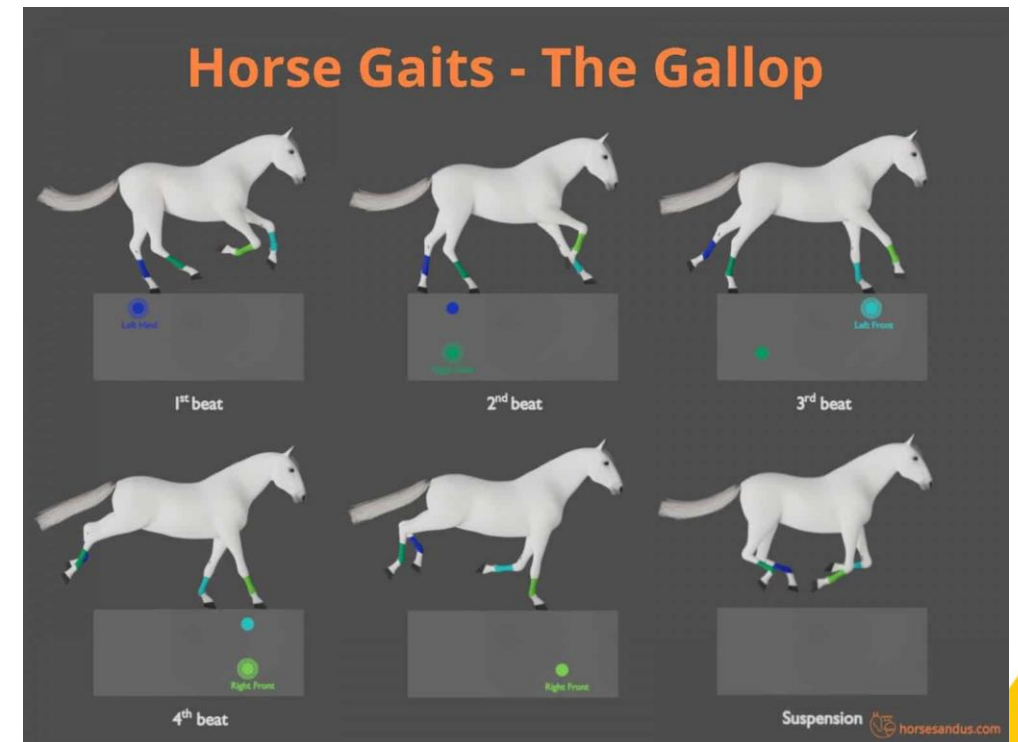
Gait Patterns

- Canter
 - Fast, asymmetrical 3-beat gait
 - **Right Lead Canter:**
Left Hind – Right Hind + Left Front –
Right Front – Suspension
 - **Left Lead Canter:**
Right Hind – Left Hind + Right Front –
Left Front – Suspension



Gait Patterns

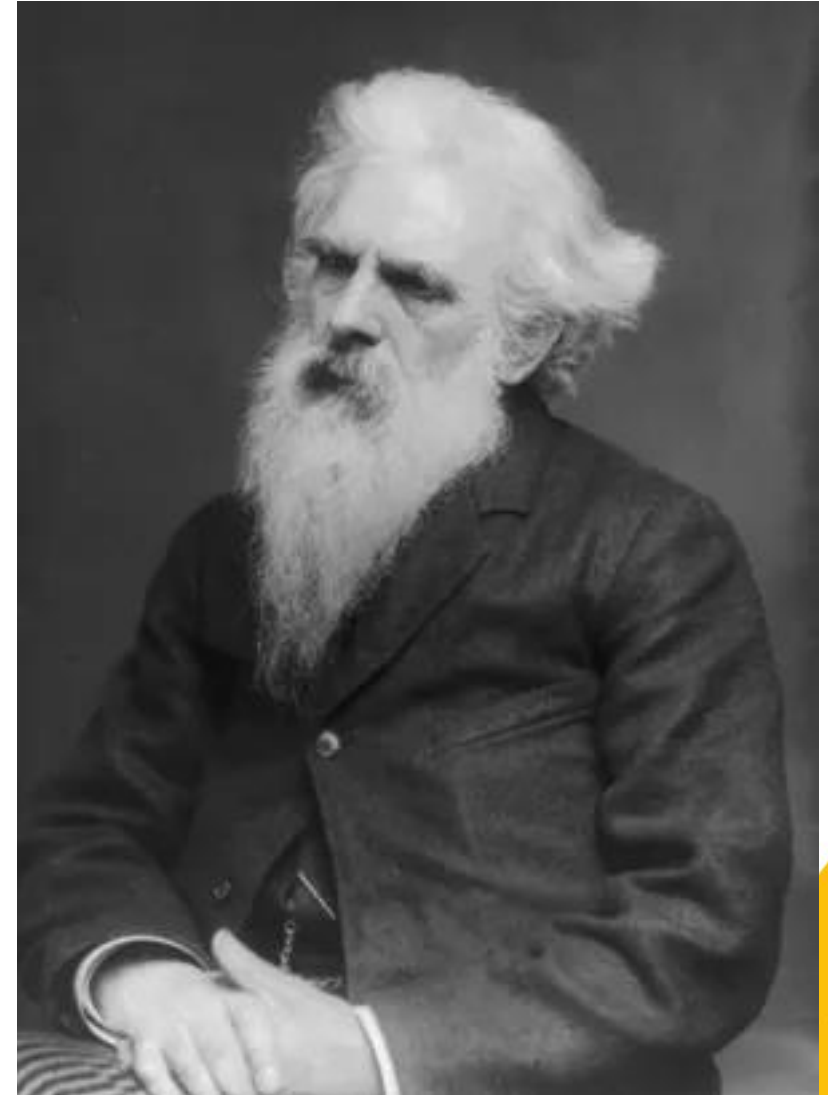
- Gallop
 - Fastest gait
 - Asymmetrical 4-beat gait
 - **Right Lead Gallop:**
Left Hind – Right Hind – Left Front –
Right Front – Suspension
 - **Left Lead Gallop:**
Right Hind – Left Hind – Right Front –
Left Front – Suspension





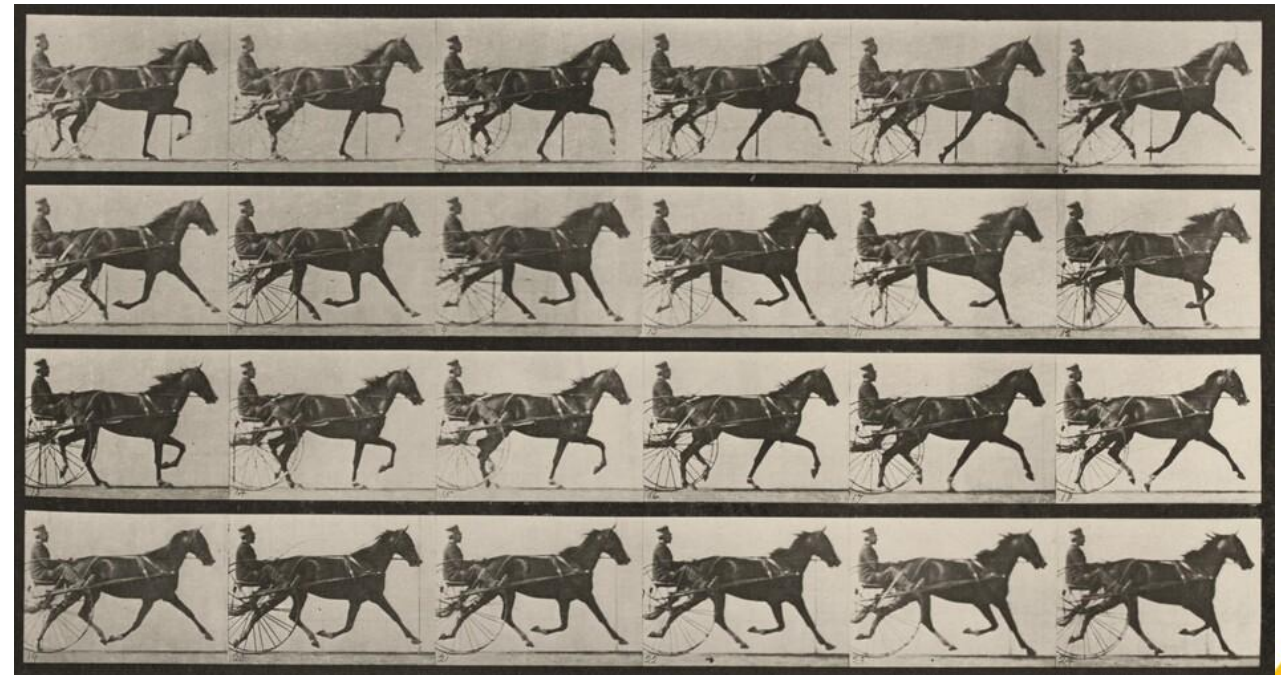
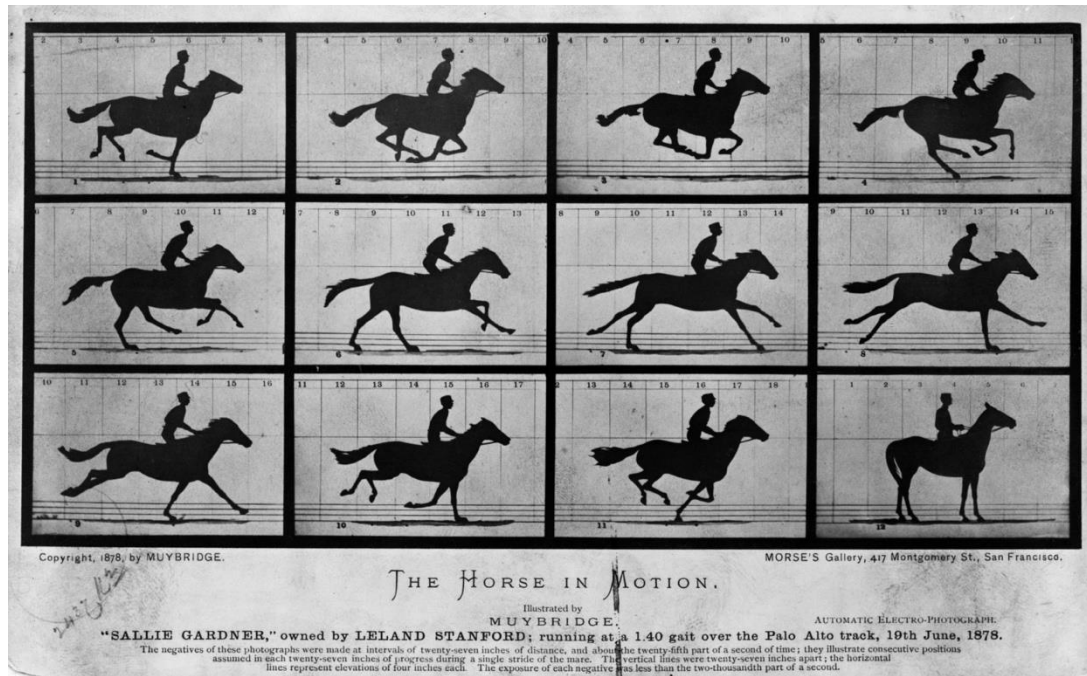
Eadweard Muybridge (1830 – 1904)

- The Muybridge award
 - The most prestigious award of the International Society of Biomechanics (ISB)
 - Recipients include Dr. Irene Davis, Dr. Walter Herzog, Dr. Benno Nigg, Dr. David Winter and Dr. Peter R. Cavanagh
 - The award is named after Eadward Muybridge, an English photographer, who was the first to use cinematography for the study of human and animal movement





The Horse in Motion





A Horse in Motion

- 1878: A wager that changed motion science
 - Racehorse owner Leland Stanford wanted to settle two debates:

"Does a trotting horse ever have all four hooves off the ground at the same time?"

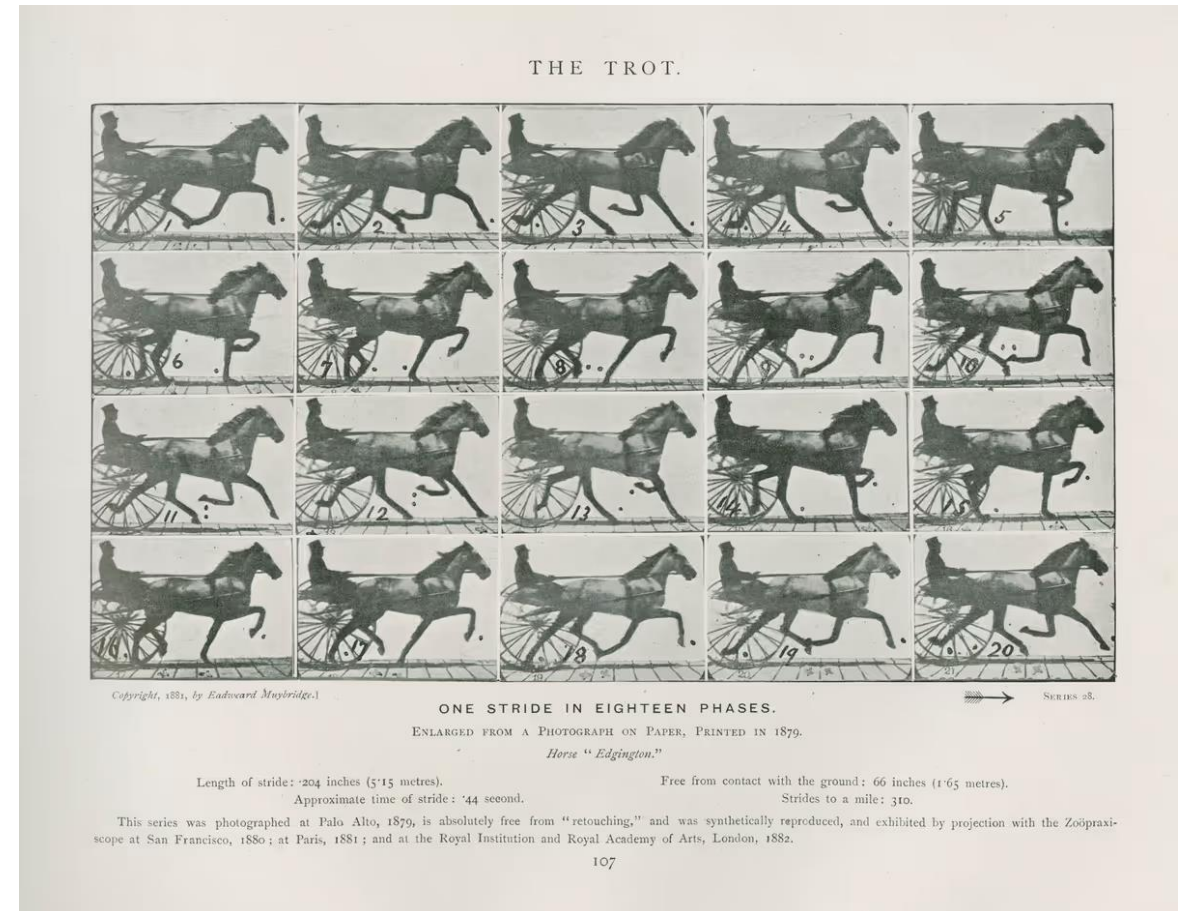


The Flying horse - all four legs outstretched



A Horse in Motion

- Leland Stanford commissioned Muybridge to capture a horse in motion using a series of cameras
- First successful high-speed motion analysis
- The foundation for modern biomechanics, motion capture, and gait analysis





Equestrian Rider Biomechanics

- Kinematics of the horse's trunk are gait-dependent
 - Walk: smooth sinusoidal vertical motion; large left-right tilt
 - Trot: pair of concurrent vertical movement of the cranial and caudal parts of the horse's trunk
 - Canter: forehead rises during suspension; largest pitch (nose up/down)
- Equestrian sports: activity with 2 athletes (horse-rider dyad)
 - Good horse-rider harmony
 - Stable seat
 - Adapted muscle activation pattern, muscle activity and antagonist coactivation



Muscle Activity of a Rider

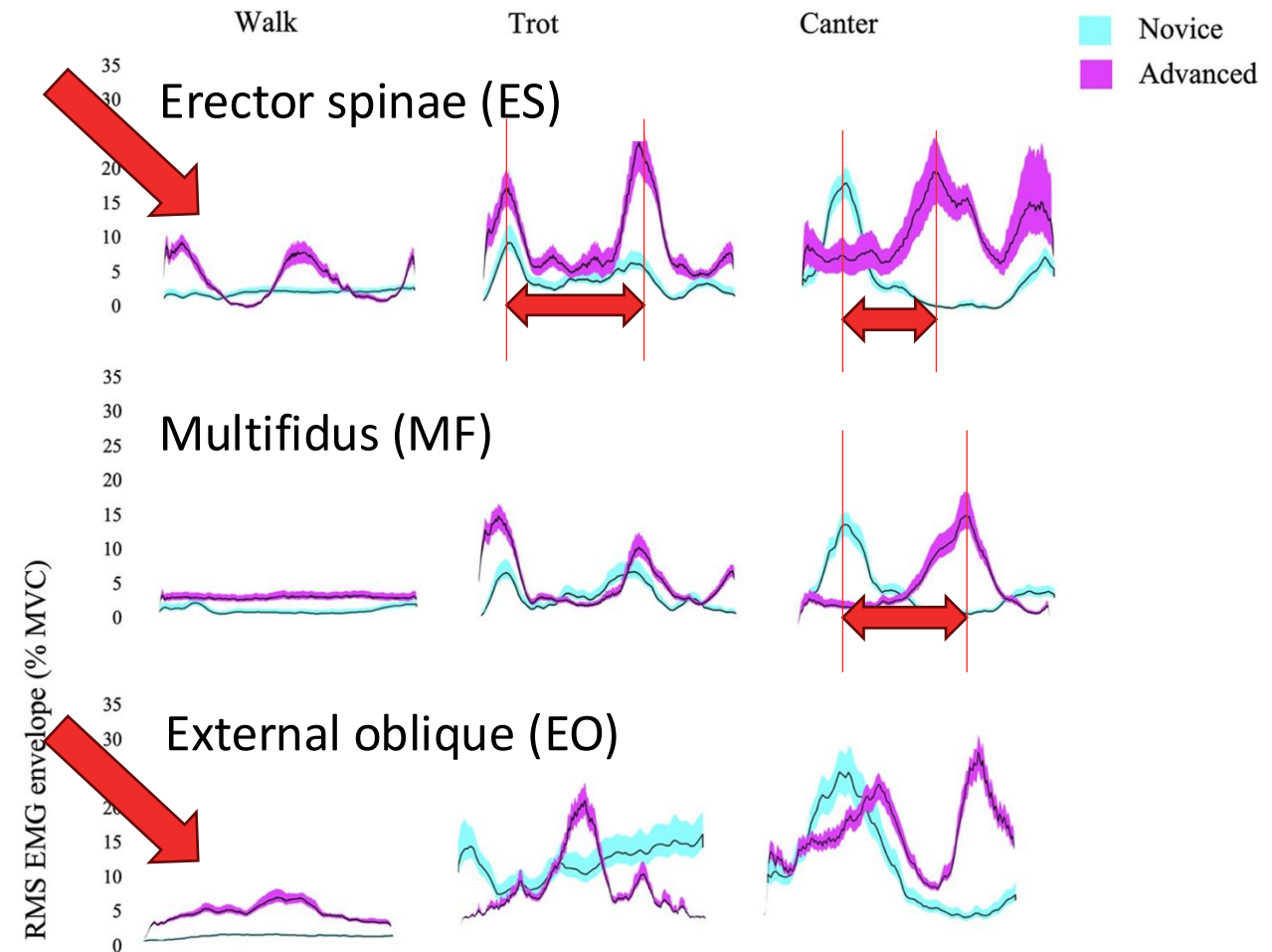
- Different between novice and advanced riders at a neuromuscular level during walk, trot and canter
- Participants
 - 6 recreational riders (2 – 4 hours/week)
 - 9 professional rider (>35 hours/week)
 - 4 horses
- Experimental procedures
 - 30-m straight line; 60 horse strides
 - Walk, (rising) trot and canter (right lead)
- sEMG on left and right side of rider
 - Erector spinae • Vastus lateralis
 - Multifidus • Biceps femoris
 - External oblique • Gastrocnemius lateralis
- sEMG signal processing
 - Normalized (%) to peak value of MVC
 - Onset & offset



Muscle Activity of Advanced Riders

- At walk
 - Higher activity (peak) in ES and EO
- At trot
 - Peak ES activation occurred later
- At canter
 - Peak ES and EO occurred later

Mean $\pm$ SD EMG amplitude of the left muscles during an entire horse stride

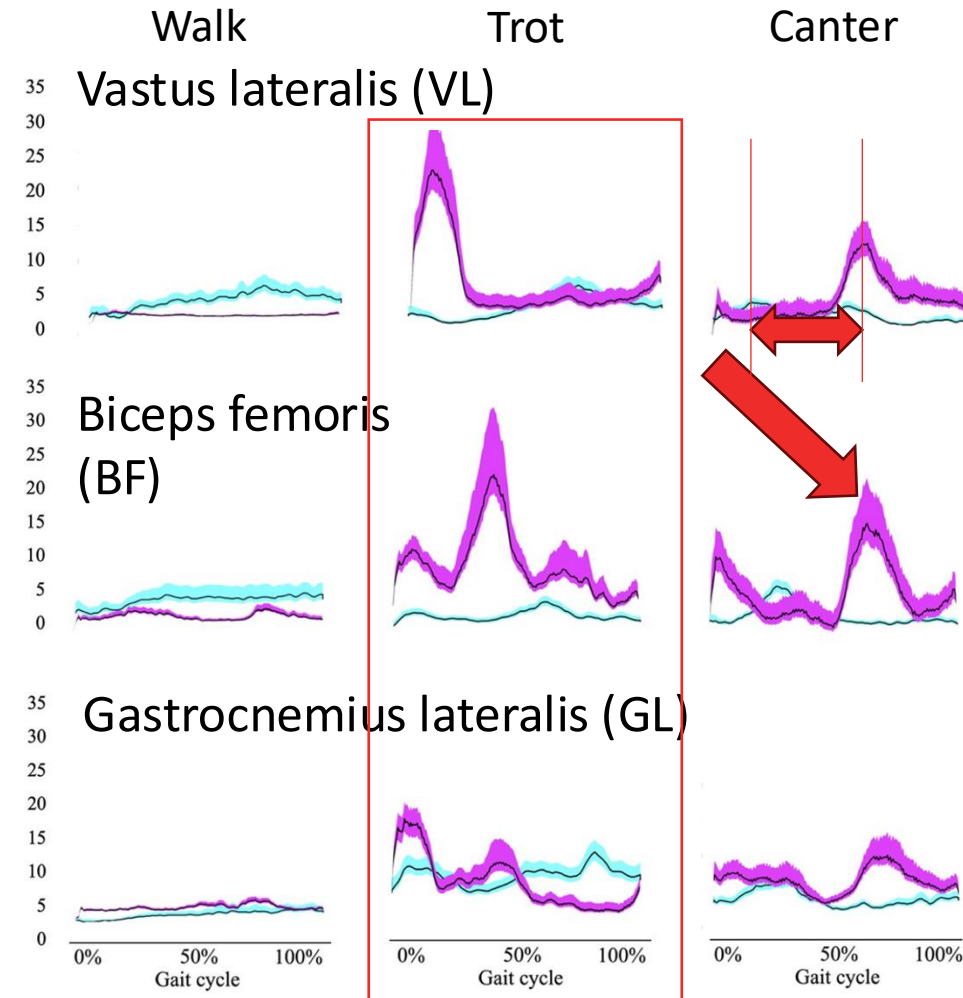




Muscle Activity of Advanced Riders

Mean $\pm$ SD EMG amplitude of the left muscles during an entire horse stride

- At trot
 - Higher activity (peak) in VL and BF
 - Peak VL, BF and GL activation occurred earlier
- At canter
 - Higher activity (peak) in BF
 - Peak VL activation occurred later





What this study found

- At walk
 - Advanced riders: higher and earlier activation of core muscles
 - Core training is a beneficial implementation to riding
- At trot
 - Advanced riders: higher knee extensor activity, a stronger use of the stirrups
- At canter
 - Advanced riders: higher back and leg muscles activity, higher ability to anticipate the impact at a neuromuscular level





What this study found

- Advanced riders
 - Greater activation of deep trunk (core) muscles
 - Better intermuscular coordination
 - More independent muscle control with less unnecessary co-contraction
- Novice riders
 - Higher overall muscle activity
 - More simultaneous activation of agonist and antagonist muscles (co-contraction)
 - Less efficient movement strategy





Hippotherapy

- Equine-assisted therapy
 - A physical or occupational therapy intervention using the movement of the horse as a treatment tool
 - The horse's movement provides rhythmic, repetitive, multidimensional sensory and motor input
 - **Goal:** improve postural control, balance, coordination, gait and functional performance





Hippotherapy

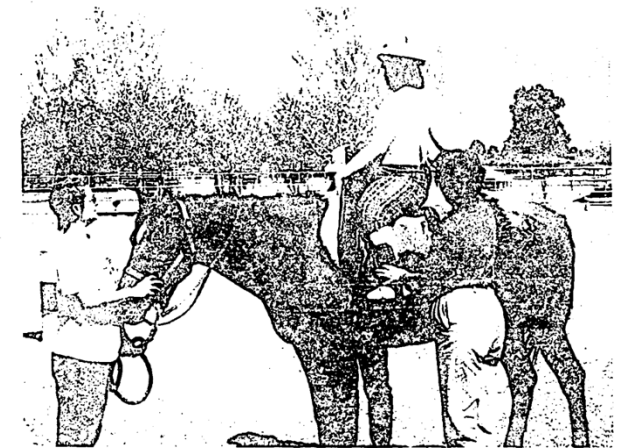
- Clinical indications
 - Cerebral palsy
 - Stroke
 - Multiple sclerosis
 - Spinal cord injury
 - Traumatic brain injury
 - Autism spectrum disorder
 - Down syndrome
 - Psychiatric and behavioural disorders





Hippotherapy and Children with Cerebral Palsy

- RCT: effect on gross motor function
- Participants
 - 92 children (46 in each group; 4-10 years old)
- Experimental procedure
 - 30 mins/session; 2 sessions/week; 8 weeks
 - Soft saddle: maximize contact between patient and pony
 - The protocol included
 - Muscle relaxation
 - Independent sitting
 - Active exercise: stretching and dynamic balance



Patient stretching to improve symmetry of sitting posture on trained hippotherapy horse



Hippotherapy and Children with Cerebral Palsy

- Pre-post GMFM-88
 - Lying and rolling
 - Sitting
 - Crawling and kneeling
 - Standing
 - Walking and running
- Paediatric balance scale
 - Functional balance

Check (3) the appropriate score: if an item is not tested (NT), circle the item number on the right column

Item	A: LYING & ROLLING	SCORE	NT
1.	SUP: HEAD IN MIDLINE: TURNS HEAD WITH EXTREMITIES SYMMETRICAL	0 ☐ 1 ☐ 2 ☐ 3 ☐	1.
* 2.	SUP: BRINGS HANDS TO MIDLINE, FINGERS ONE WITH THE OTHER	0 ☐ 1 ☐ 2 ☐ 3 ☐	2.
3.	SUP: LIFTS HEAD 45°	0 ☐ 1 ☐ 2 ☐ 3 ☐	3.
4.	SUP: FLEXES R HIP & KNEE THROUGH FULL RANGE	0 ☐ 1 ☐ 2 ☐ 3 ☐	4.
5.	SUP: FLEXES L HIP & KNEE THROUGH FULL RANGE	0 ☐ 1 ☐ 2 ☐ 3 ☐	5.
* 6.	SUP: REACHES OUT WITH R ARM, HAND CROSSES MIDLINE TOWARD TOY	0 ☐ 1 ☐ 2 ☐ 3 ☐	6.
* 7.	SUP: REACHES OUT WITH L ARM, HAND CROSSES MIDLINE TOWARD TOY	0 ☐ 1 ☐ 2 ☐ 3 ☐	7.
8.	SUP: ROLLS TO PR OVER R SIDE	0 ☐ 1 ☐ 2 ☐ 3 ☐	8.
9.	SUP: ROLLS TO PR OVER L SIDE	0 ☐ 1 ☐ 2 ☐ 3 ☐	9.
* 10.	PR: LIFTS HEAD UPRIGHT	0 ☐ 1 ☐ 2 ☐ 3 ☐	10.
11.	PR ON FOREARMS: LIFTS HEAD UPRIGHT, ELBOWS EXT., CHEST RAISED	0 ☐ 1 ☐ 2 ☐ 3 ☐	11.
12.	PR ON FOREARMS: WEIGHT ON R FOREARM, FULLY EXTENDS OPPOSITE ARM FORWARD	0 ☐ 1 ☐ 2 ☐ 3 ☐	12.
13.	PR ON FOREARMS: WEIGHT ON L FOREARM, FULLY EXTENDS OPPOSITE ARM FORWARD	0 ☐ 1 ☐ 2 ☐ 3 ☐	13.
14.	PR: ROLLS TO SUP OVER R SIDE	0 ☐ 1 ☐ 2 ☐ 3 ☐	14.
15.	PR: ROLLS TO SUP OVER L SIDE	0 ☐ 1 ☐ 2 ☐ 3 ☐	15.
16.	PR: PIVOTS TO R 90° USING EXTREMITIES	0 ☐ 1 ☐ 2 ☐ 3 ☐	16.
17.	PR: PIVOTS TO L 90° USING EXTREMITIES	0 ☐ 1 ☐ 2 ☐ 3 ☐	17.
TOTAL DIMENSION A			
Item	B: SITTING	SCORE	NT
* 18.	SUP: HANDS GRASPED BY EXAMINER: PULLS SELF TO SITTING WITH HEAD CONTROL	0 ☐ 1 ☐ 2 ☐ 3 ☐	18.
19.	SUP: ROLLS TO R SIDE, ATTAINS SITTING	0 ☐ 1 ☐ 2 ☐ 3 ☐	19.
20.	SUP: ROLLS TO L SIDE, ATTAINS SITTING	0 ☐ 1 ☐ 2 ☐ 3 ☐	20.
* 21.	SIT ON MAT, SUPPORTED AT THORAX BY THERAPIST: LIFTS HEAD UPRIGHT, MAINTAINS 3 SECONDS	0 ☐ 1 ☐ 2 ☐ 3 ☐	21.
* 22.	SIT ON MAT, SUPPORTED AT THORAX BY THERAPIST: LIFTS HEAD MIDLINE, MAINTAINS 10 SECONDS	0 ☐ 1 ☐ 2 ☐ 3 ☐	22.
* 23.	SIT ON MAT, ARM(S) PROPPING: MAINTAINS, 5 SECONDS	0 ☐ 1 ☐ 2 ☐ 3 ☐	23.
* 24.	SIT ON MAT: MAINTAIN, ARMS FREE, 3 SECONDS	0 ☐ 1 ☐ 2 ☐ 3 ☐	24.
* 25.	SIT ON MAT WITH SMALL TOY IN FRONT: LEANS FORWARD, TOUCHES TOY, RE-ERECTS WITHOUT ARM PROPPING	0 ☐ 1 ☐ 2 ☐ 3 ☐	25.
* 26.	SIT ON MAT: TOUCHES TOY PLACED 45° BEHIND CHILD'S R SIDE, RETURNS TO START	0 ☐ 1 ☐ 2 ☐ 3 ☐	26.
* 27.	SIT ON MAT: TOUCHES TOY PLACED 45° BEHIND CHILD'S L SIDE, RETURNS TO START	0 ☐ 1 ☐ 2 ☐ 3 ☐	27.
28.	R SIDE SIT: MAINTAINS, ARMS FREE, 5 SECONDS	0 ☐ 1 ☐ 2 ☐ 3 ☐	28.
29.	L SIDE SIT: MAINTAINS, ARMS FREE, 5 SECONDS	0 ☐ 1 ☐ 2 ☐ 3 ☐	29.
* 30.	SIT ON MAT: LOWERS TO PR WITH CONTROL	0 ☐ 1 ☐ 2 ☐ 3 ☐	30.
* 31.	SIT ON MAT WITH FEET IN FRONT: ATTAINS 4 POINT OVER R SIDE	0 ☐ 1 ☐ 2 ☐ 3 ☐	31.
* 32.	SIT ON MAT WITH FEET IN FRONT: ATTAINS 4 POINT OVER L SIDE	0 ☐ 1 ☐ 2 ☐ 3 ☐	32.



Gross Motor Function

- Post-training, hippotherapy vs. control group
- GMFM-88 ↑
 - Lying and rolling
 - Sitting
 - Crawling and kneeling
 - Standing
 - Walking and running
- Paediatric balance scale
 - Functional balance ↑
- Limitations
 - Fall risk
 - Accessibility and cost



Horse Riding Simulator

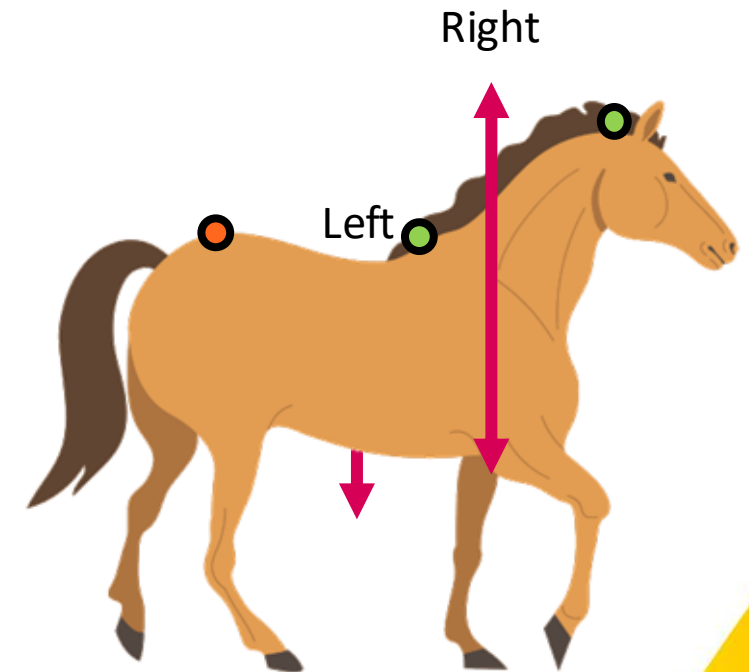


Lecture Outline

1. Horse Gait and Rider Biomechanics
- 2. Movement Asymmetry in Horses**
3. Research Example: Racing on a Bend
4. Stride Parameters and Injury Prediction

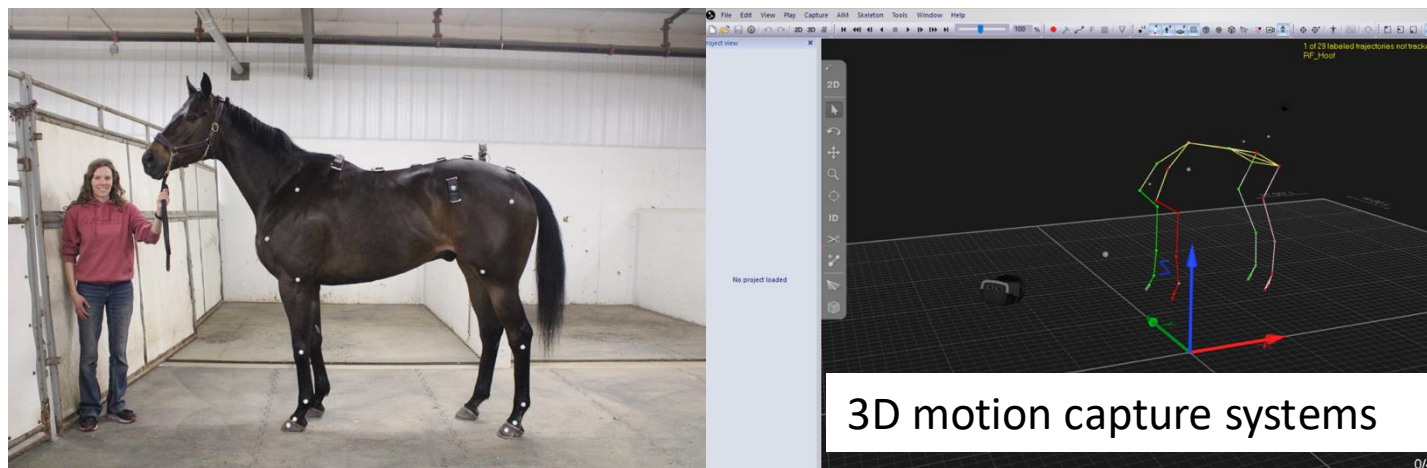
Asymmetry in Horses and Why It's Significant

- Left-right asymmetry
 - Unequal motion pattern between the left and right limbs (on trot)
- Head (poll) or withers
 - Forelimb lameness
- Pelvis
 - Hindlimb lameness
- Subjective evaluation of lameness by equine vets¹
 - Experience and training dependent
 - Low agreement between experienced vets

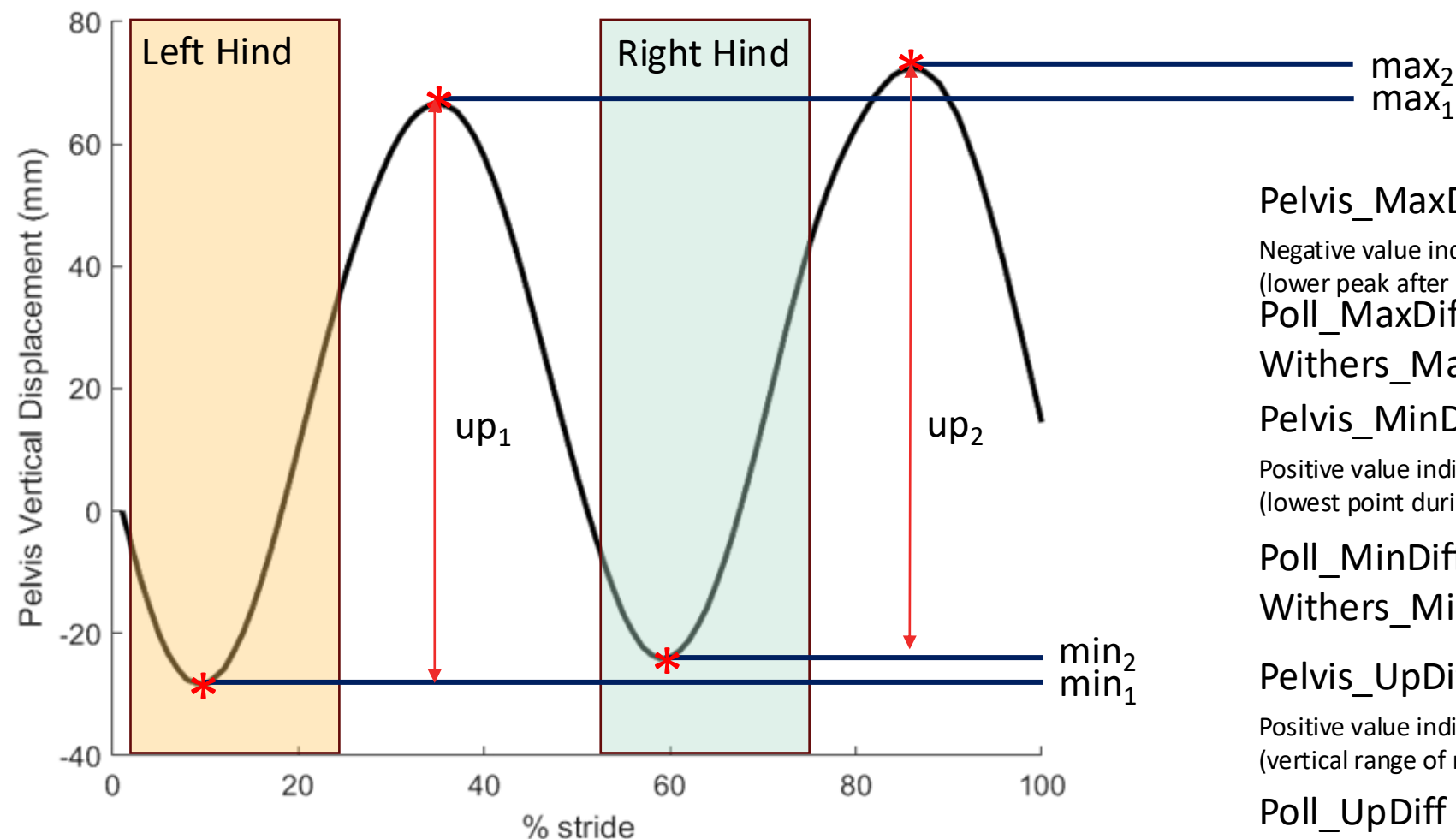


Asymmetry in Horses and Why It's Significant

- Movement asymmetry can be objectively measured



Quantifying Left-Right Asymmetry in Trot



$$\text{Pelvis_MaxDiff} = \text{max}_1 - \text{max}_2$$

Negative value indicates a left-side asymmetry
(lower peak after left hind push-off)

$$\text{Poll_MaxDiff}$$

$$\text{Withers_MaxDiff}$$

$$\text{Pelvis_MinDiff} = \text{min}_2 - \text{min}_1$$

Positive value indicates a right-side asymmetry
(lowest point during stance is lower during left hind contact)

$$\text{Poll_MinDiff}$$

$$\text{Withers_MinDiff}$$

$$\text{Pelvis_UpDiff} = \text{up}_1 - \text{up}_2$$

Positive value indicates a right-side asymmetry
(vertical range of motion smaller second half of stride)

$$\text{Poll_UpDiff}$$

$$\text{Withers_UpDiff}$$

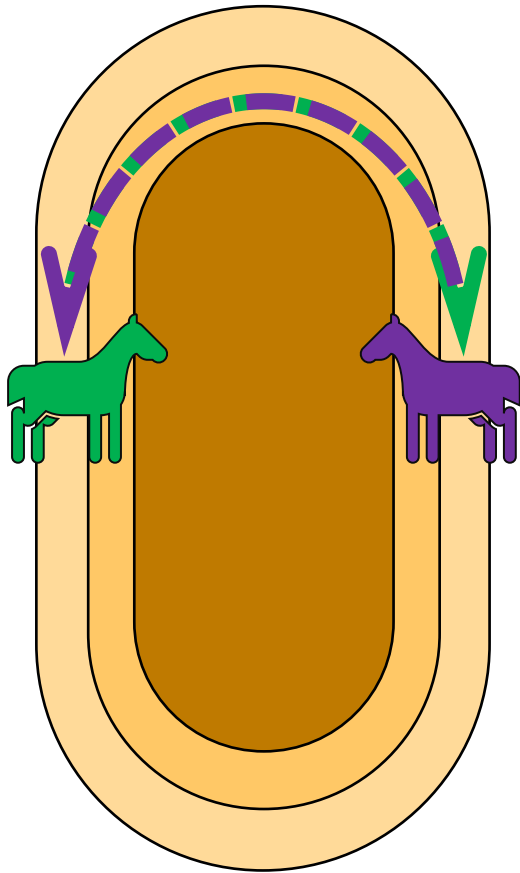


Lecture Outline

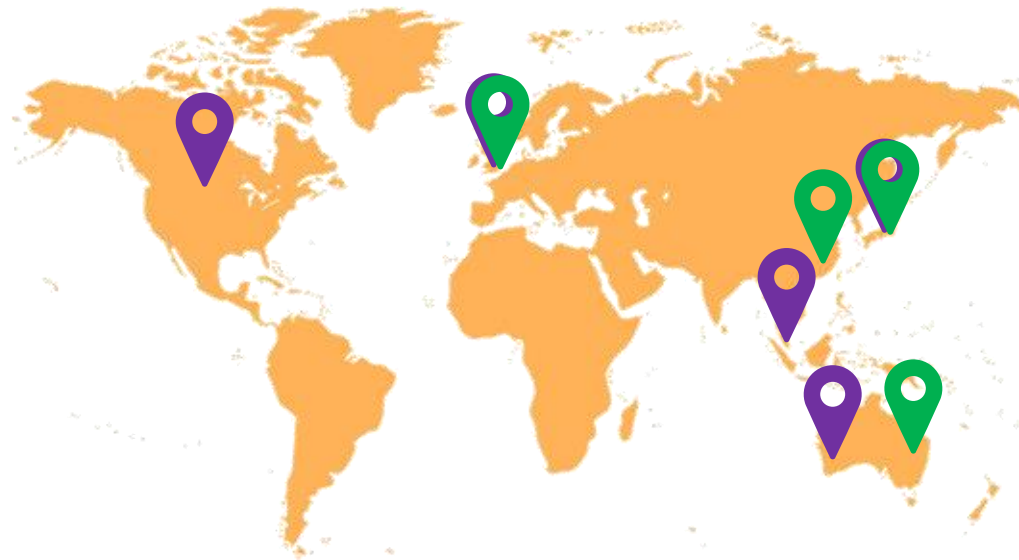
1. Horse Gait and Rider Biomechanics
2. Movement Asymmetry in Horses
3. Research Example: Racing on a Bend
4. Stride Parameters and Injury Prediction



Clockwise or Counter-clockwise Racing



- Counter-clockwise (anti-clockwise or left-handed)
- Clockwise (right-handed)



Counter-clockwise

- North America
- UK
- Australia
- Japan
- Singapore

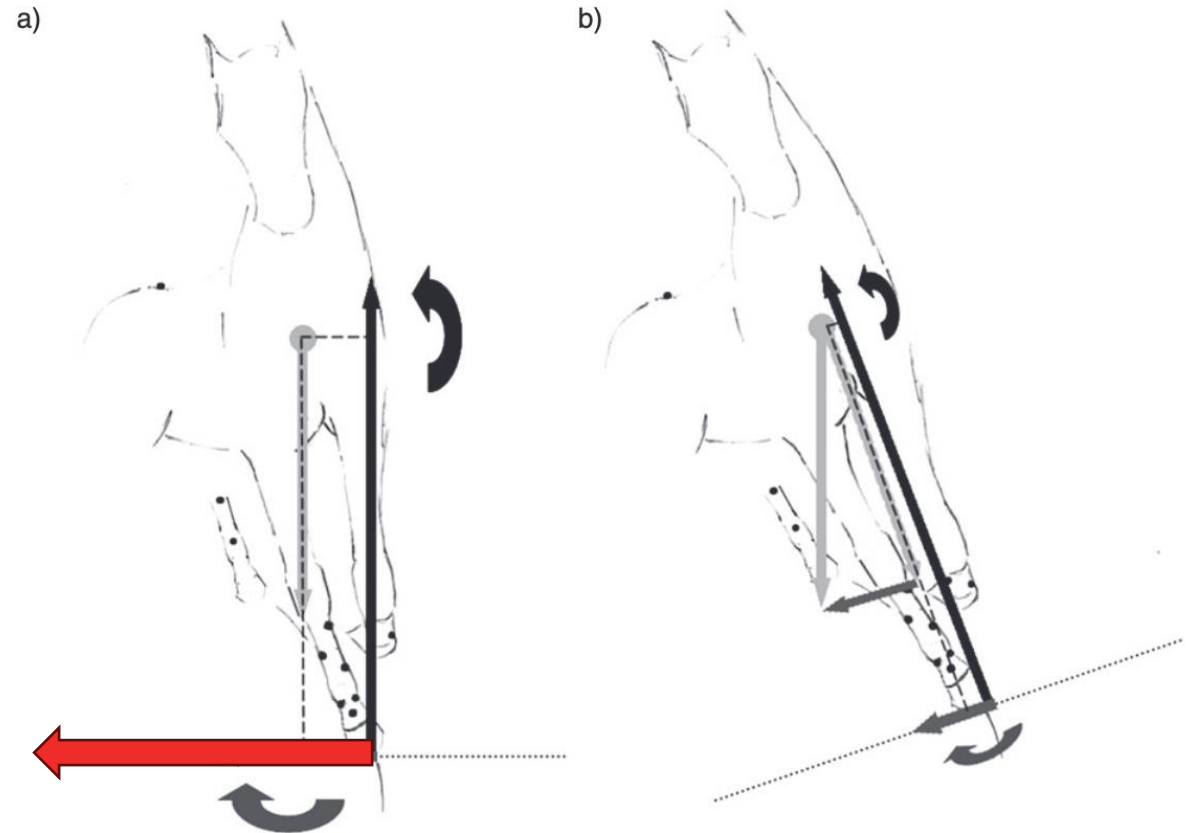
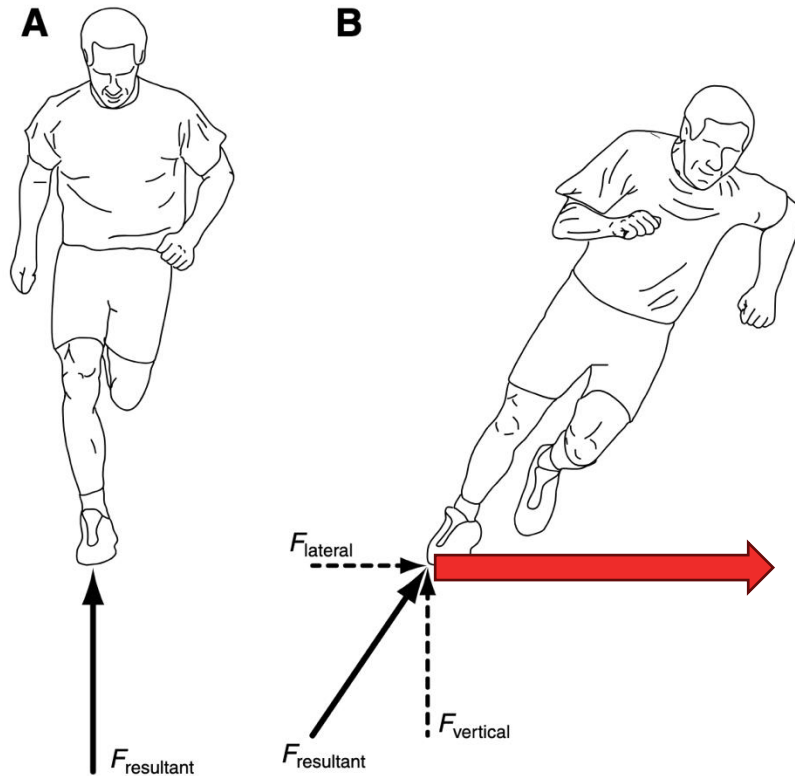
Clockwise

- UK
- Australia
- Japan
- Hong Kong



Curve negotiation

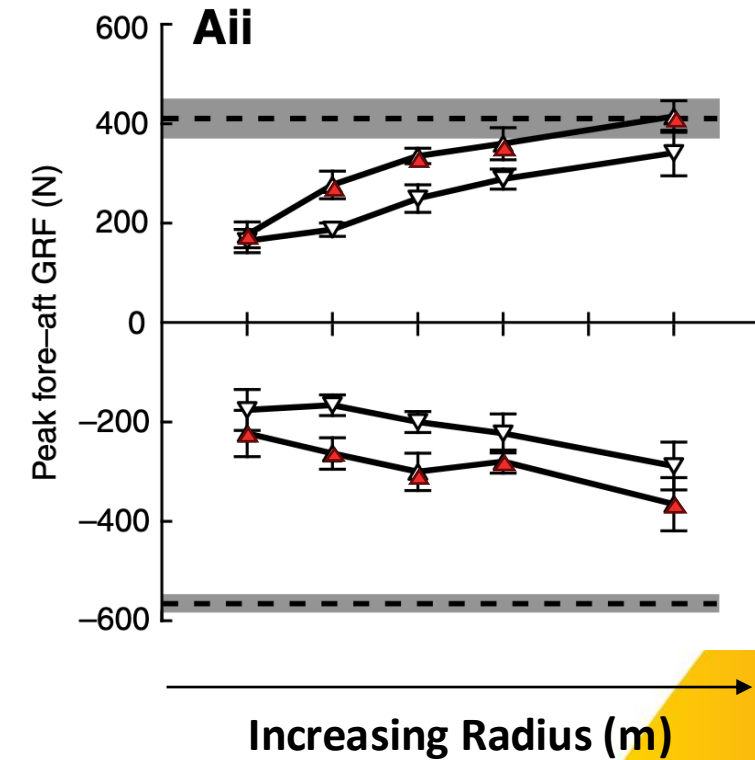
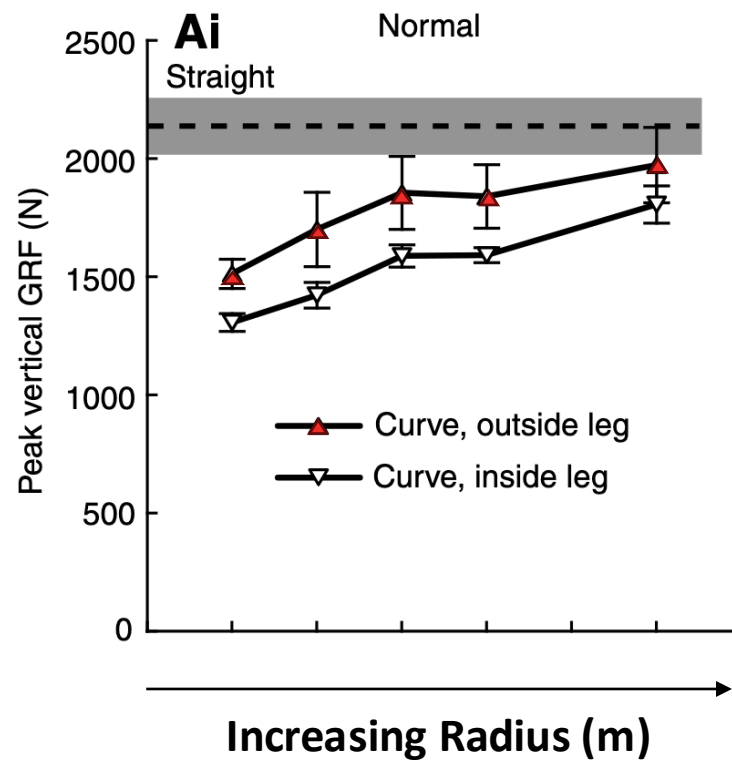
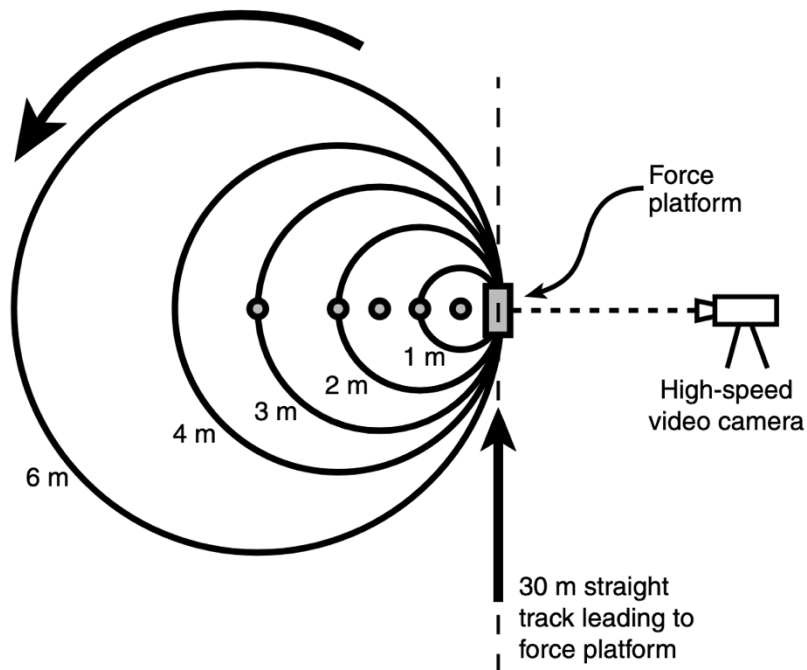
- Centripetal force (inwardly directed GRF) is generated at the ground by the human or horse pushing outwards



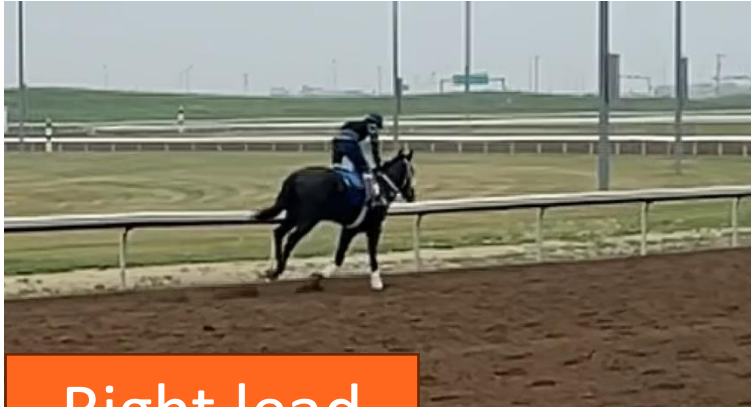


Inside vs. Outside Leg in Human Sprinting

- Outside leg ▲, higher:
 - Peak vGRF
 - Braking force
 - Propulsive force



What happens at the bend?



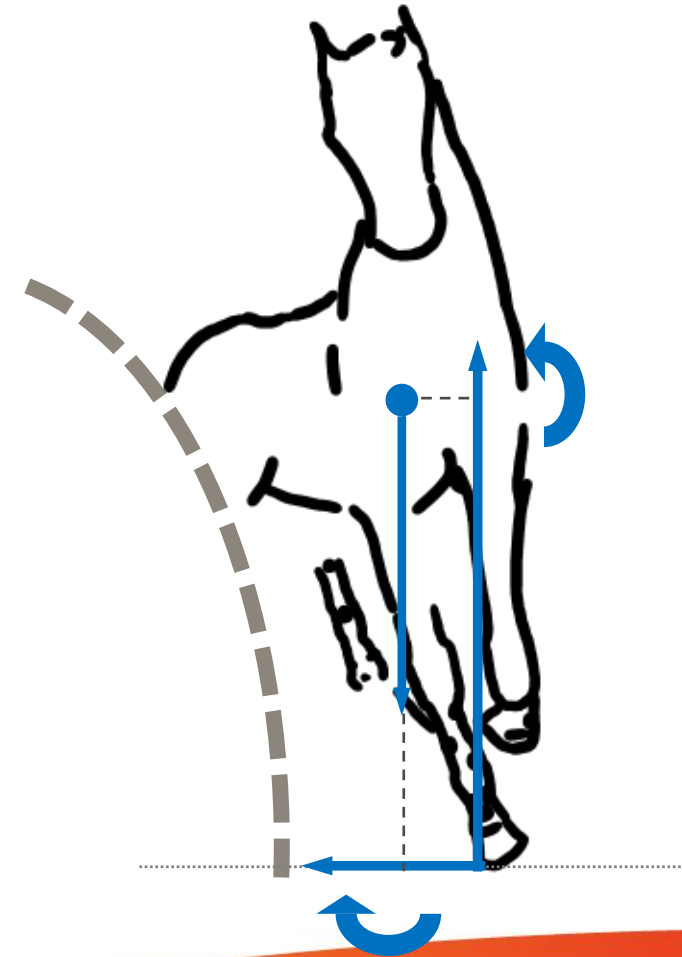
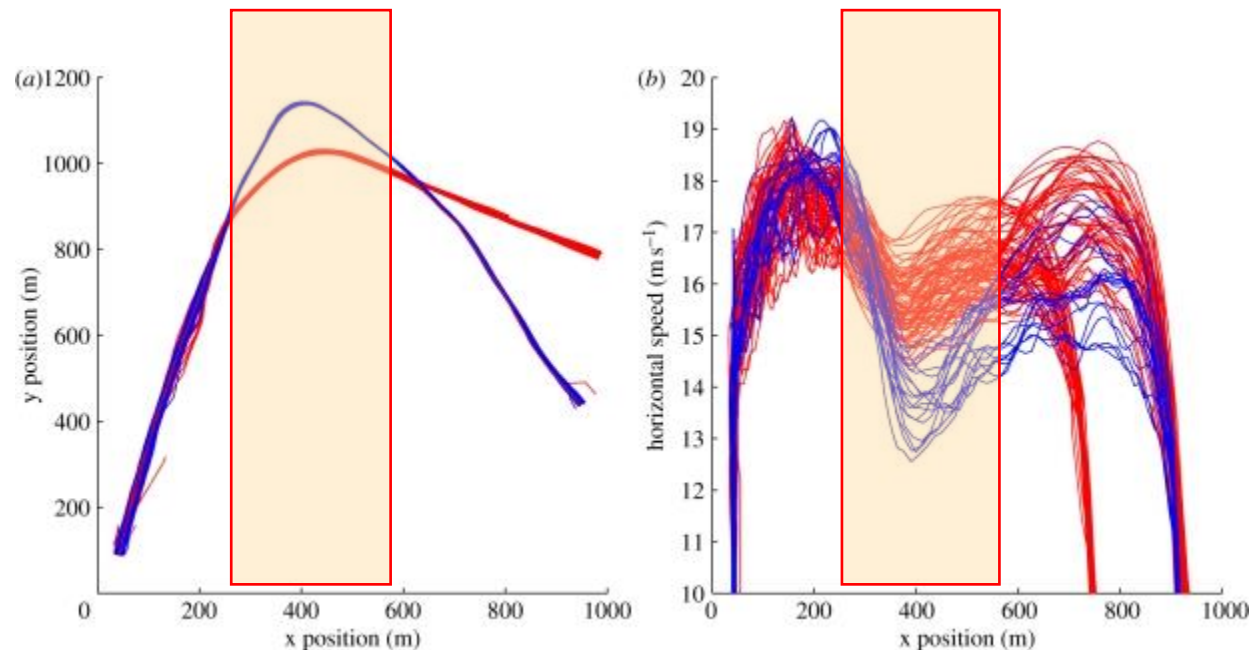
Right lead



Left lead

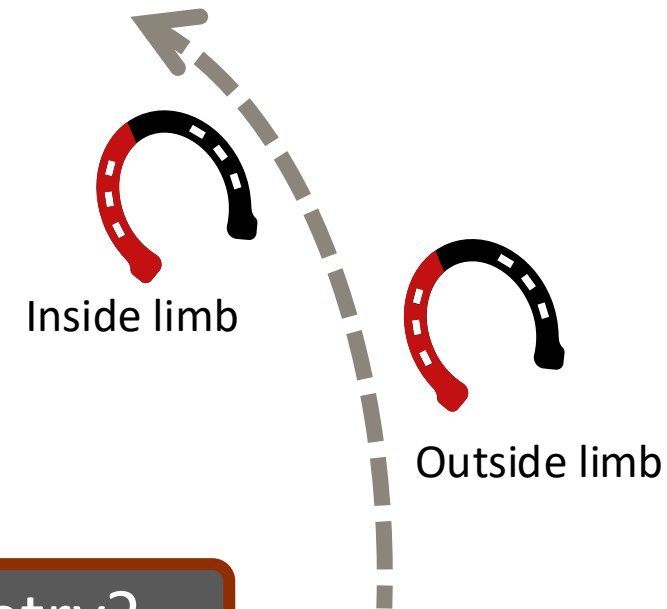
What happens at the bend?

- Lead change at gallop
- Slowed down¹
- Body lean towards the centre²



What happens at the bend?

- Lead change at canter/gallop
- Slowed down¹
- Body lean towards the centre²
- At canter, the inside leg has a:
 - Shorter stride length²
 - Longer duty factor^{2,3}
 - Lower peak vertical force³
 - Lateral aspect compressed³

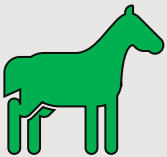


Potential Medium- or Long-Term Asymmetry?

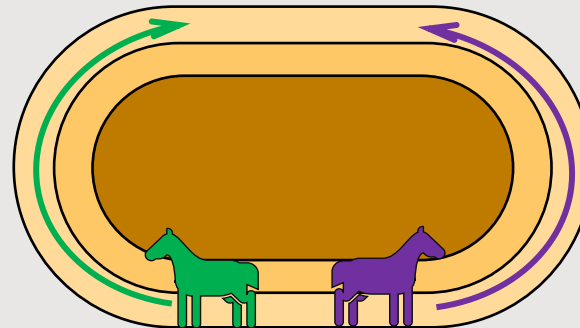
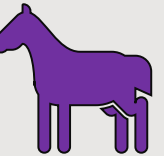
Potential Medium- or Long-Term Asymmetry?

- Training and racing predominantly in one direction
- Gait asymmetries¹

Clockwise (Hong Kong)

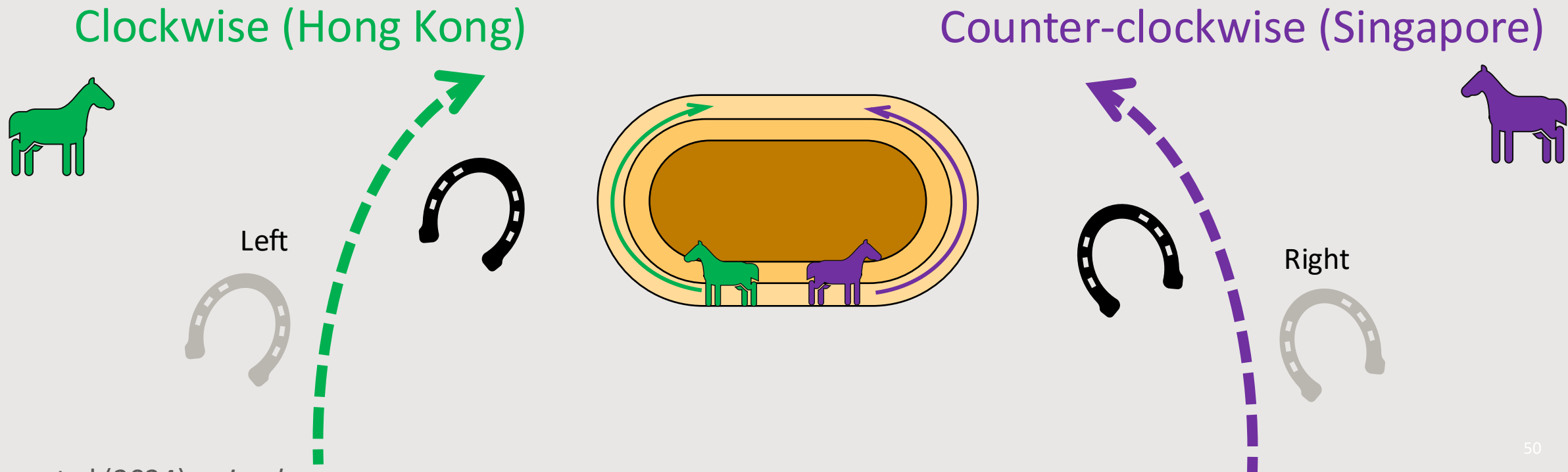


Counter-clockwise (Singapore)



Potential Medium- or Long-Term Asymmetry?

- Training and racing predominantly in one direction
- Gait asymmetries¹ - reduced outside fore- and hindlimb loading



Potential Medium- or Long-Term Asymmetry?

- Training and racing predominantly in one direction
- Gait asymmetries¹
 - Reduced outside fore- and hindlimb loading
- Hoof shape asymmetries?
 - Adaptive to loading²
 - Hoof width
 - Narrower hoof, ↑ movement asymmetry³



Training/racing direction and hoof asymmetry

Hoof Asymmetry

- 186 thoroughbreds (Geldings: 184, 98.9%)
- Training at the Hong Kong Jockey Club (6+ months)
- Clockwise training and racing
- 15.3 – 16.2 hands tall (155 – 165cm)
- Shod in all four limbs (aluminum shoes)
- No clinical lameness reported (6+ months)

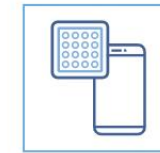


The Hong Kong Jockey Club
RIDING HIGH TOGETHER



Hoof Asymmetry

- End of shoeing cycle
- Shoe removed
- Solar (solear view)
- EponaCam
 - Left and Right
 - Fore and Hind



Horse Hoof Measurement Products

EPONACAM

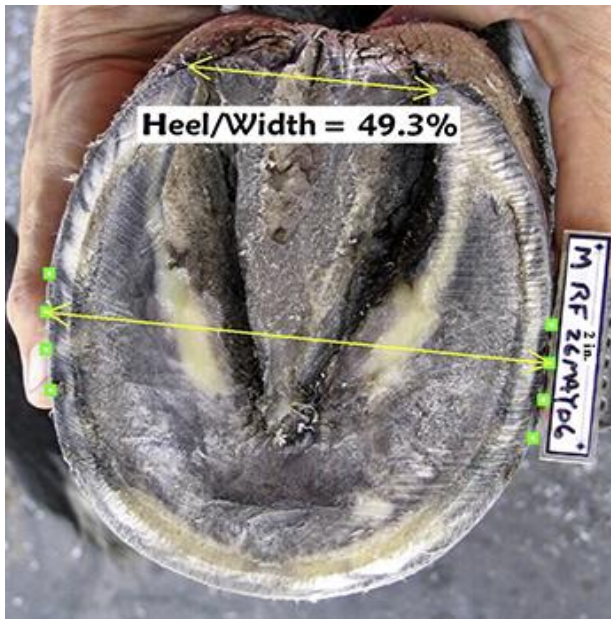
EponaCam is an App along with a hardware cradle that converts any smart phone into a 'Hoof Camera'.

[Additional Product Details](#)



Hoof Asymmetry

- Metron Hoof with AI (Intellect Module)
- Calibration with finger-clip (inches into pixels)



Horse Hoof Measurement Products

METRON HOOF

Metron-Hoof is an image-based system using photographs and radiographs to keep track of the horse's hoof. (It is a subset of the full veterinary product, Metron-DVM.)

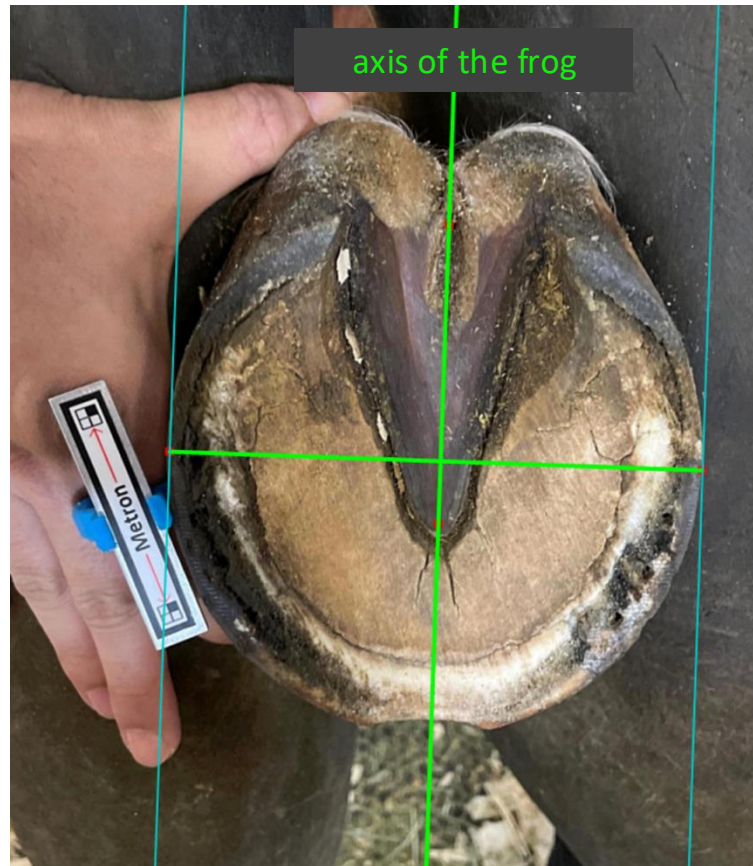
Additional Product Details



Hoof Asymmetry



calibration



auto-labeling



widest part of hoof

Hoof symmetry

- Paired *t*-tests (Left vs. Right)

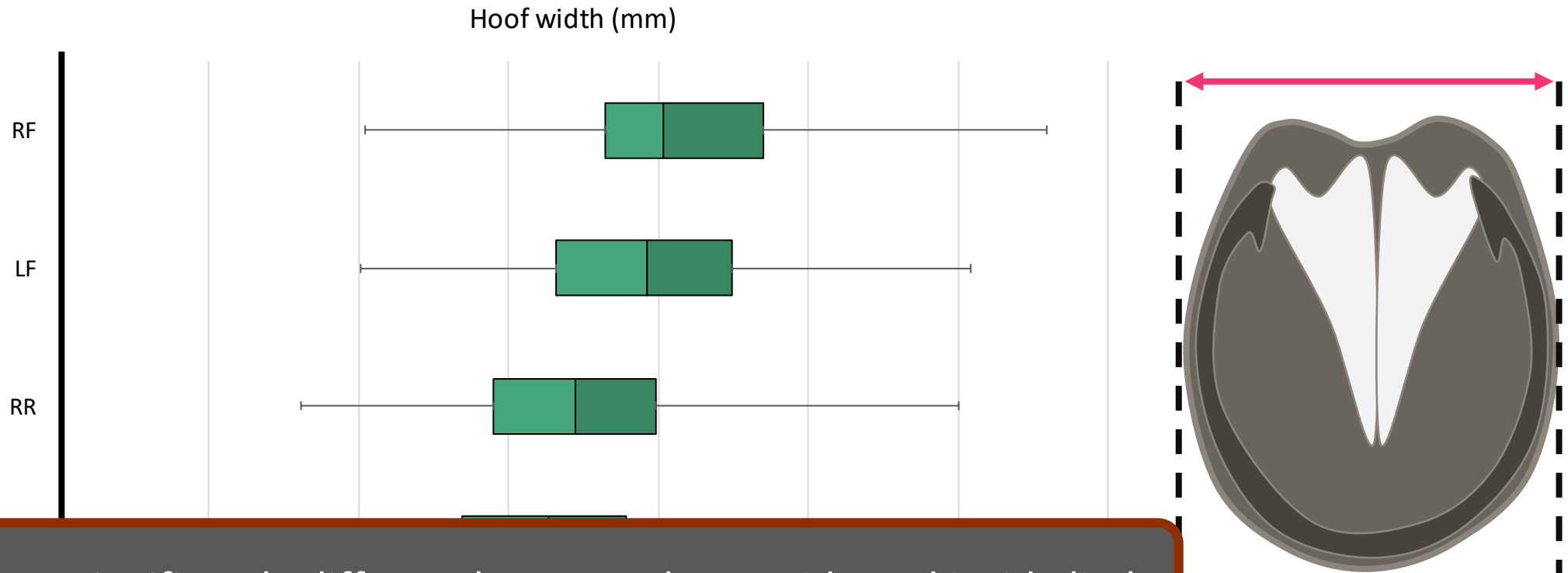
	Left (Outside; mm)	Right (Inside; mm)	Δ (mm)	<i>P</i> -value
Forelimb	139.1 $\pm$ 8.4	141.5 $\pm$ 8.2	2.4 $\pm$ 7.6	<0.01
Hindlimb	132.6 $\pm$ 7.2	134.7 $\pm$ 8.1	2.1 $\pm$ 6.7	<0.01



Hoof width was significantly different between the outside and inside limb.

Thoroughbreds predominantly training and racing clockwise have wider inside hooves.

Hoof Asymmetry

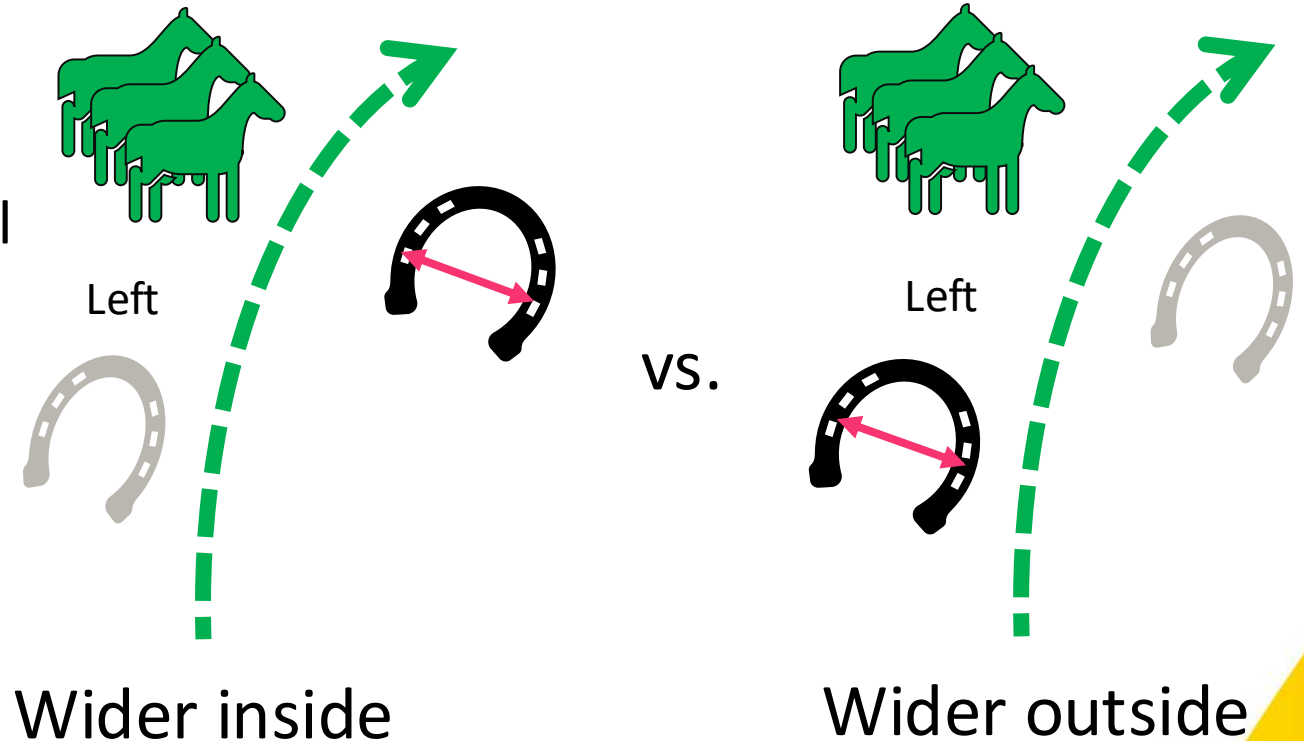
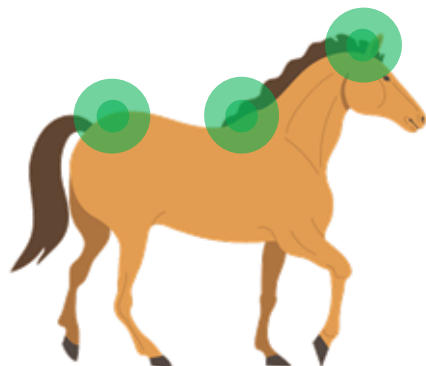


Hoof width was significantly different between the outside and inside limb.

Thoroughbreds predominantly training and racing clockwise have wider inside hooves.

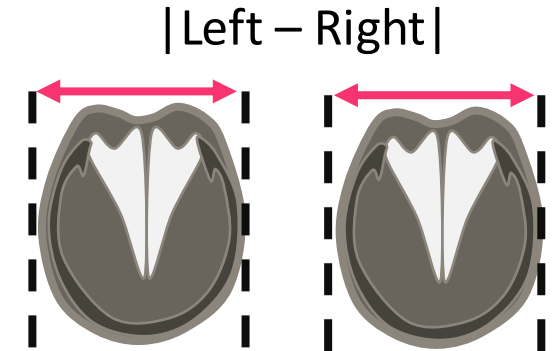
Movement Asymmetry

- Movement asymmetry between groups
- Hypotheses:
 - Asymmetrical forelimbs
→ Movement asymmetry in Poll and Withers
 - Asymmetrical hindlimbs
→ Movement asymmetry in Pelvis



Movement Asymmetry

- Absolute difference between left and right (n=186)
 - Forelimb: 5.3 mm
 - Hindlimb: 4.2 mm

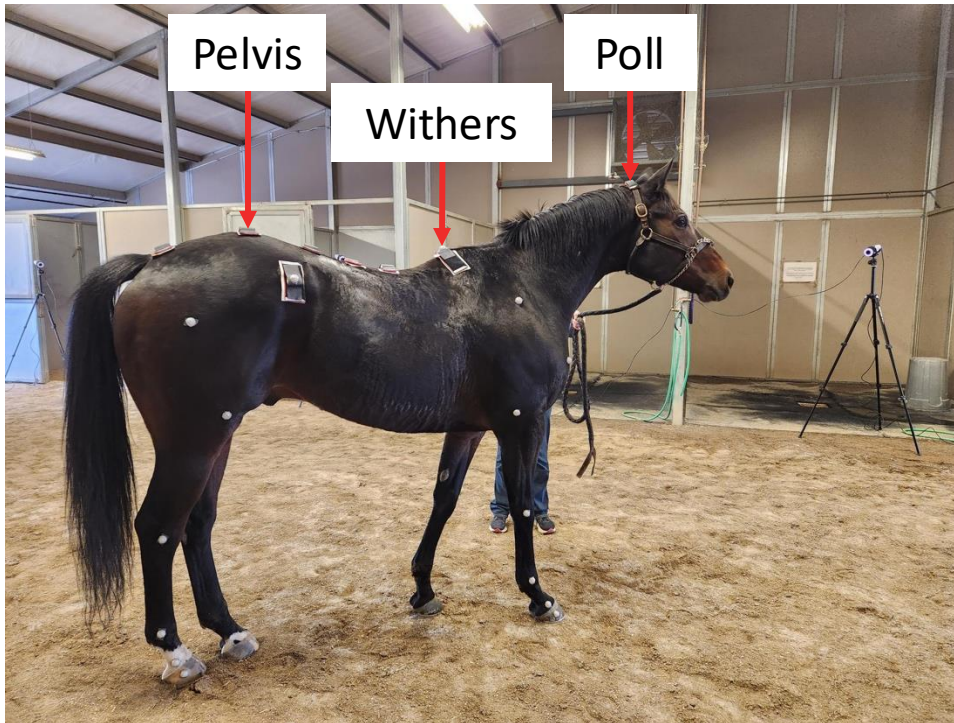


	Wider right (Inside)	Wider left (Outside)	No left-right asymmetry
Forelimb	65 (34.9%)	27 (14.5%)	94 (50.5%)
Hindlimb	63 (33.9%)	28 (15.1%)	95 (51.1%)

Movement Asymmetry

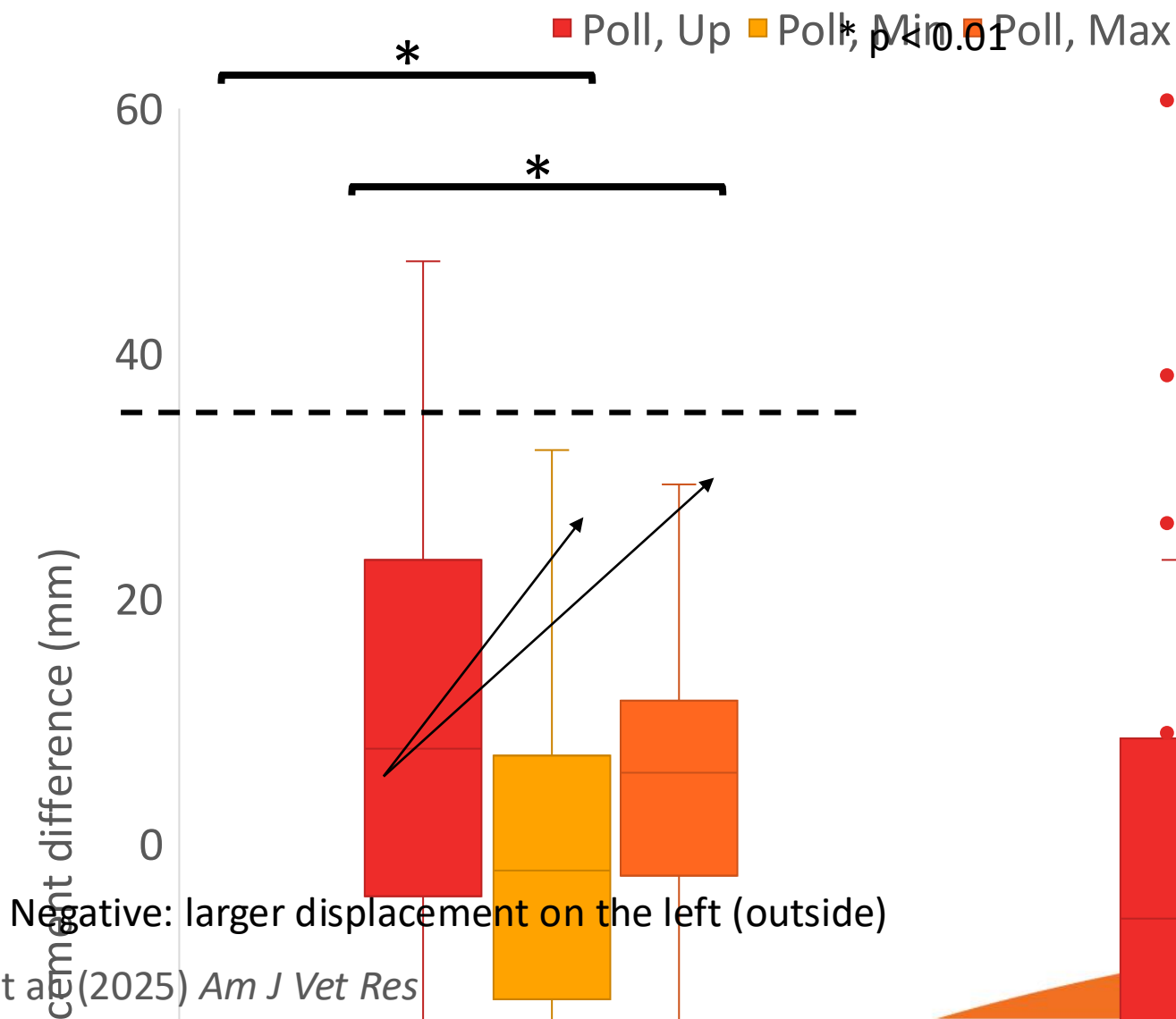


- Xsens DOT Inertial Measurement Units (IMUs)
- Placed along the midline at 3 anatomical positions
- Tri-axial acceleration and angular velocity recorded at 60 Hz



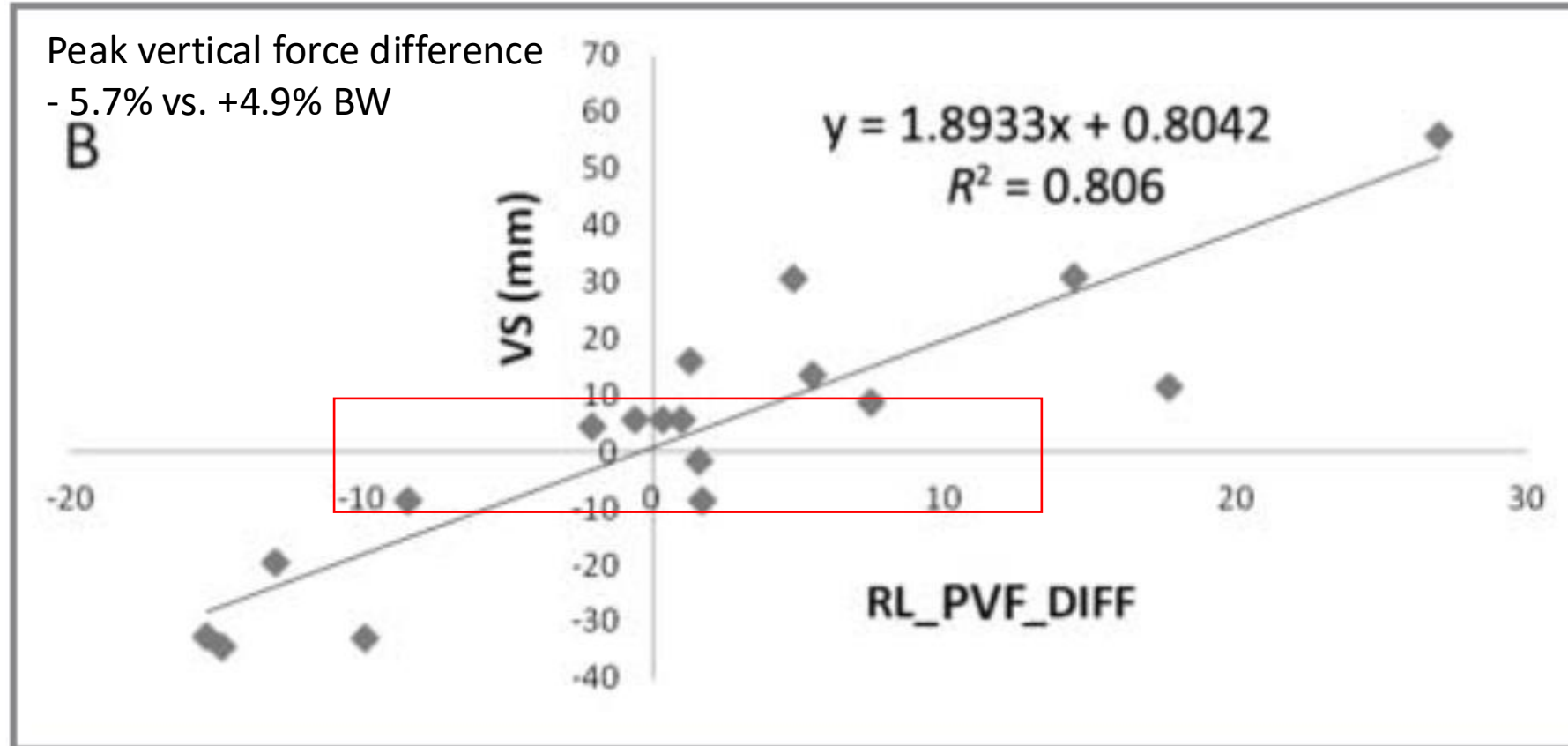
- Straight line in-hand trotting
- Firm and level surface
- 15 – 30 strides

Movement Asymmetry



- Significant differences in UpDiff & MaxDiff
 - Poll
 - Withers
- Larger push-off and vertical displacement at the poll (wider side)
- Higher vertical position of the poll reached after pushing-off with wider side
- No significant difference between groups in minDiff or Pelvis

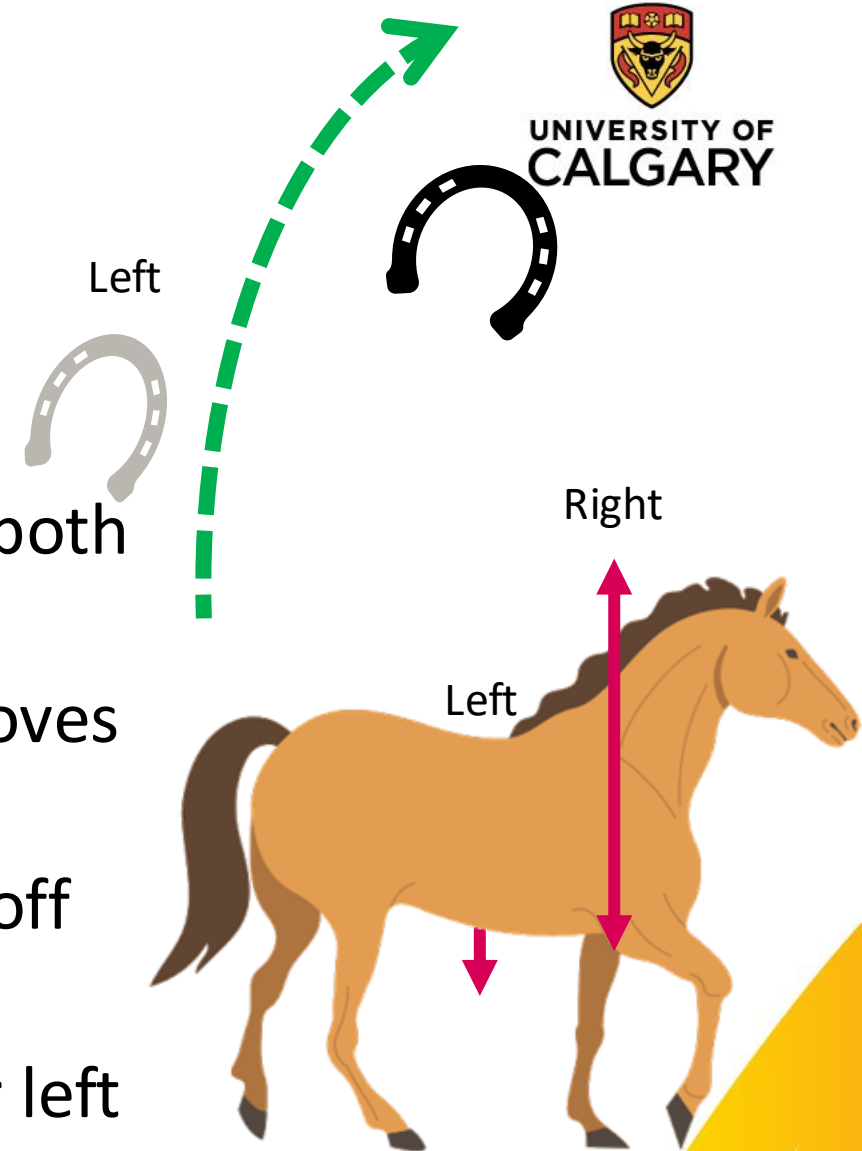
Push-off Force Asymmetry



When trotted in a straight line, push-off force is higher on the side with the wider hoof.

Conclusion

- Racing thoroughbreds predominantly training and racing clockwise shows left-right hoof asymmetry
- Hooves were found to be wider on the right side, both fore- and hindlimbs
- More horses have wider right hooves than left hooves
- Horses with wider right fore-hooves shows larger vertical displacement during and after right push-off
- No significant difference was found in the pelvis vertical displacement in horses with wider right or left hind-hooves



Implications

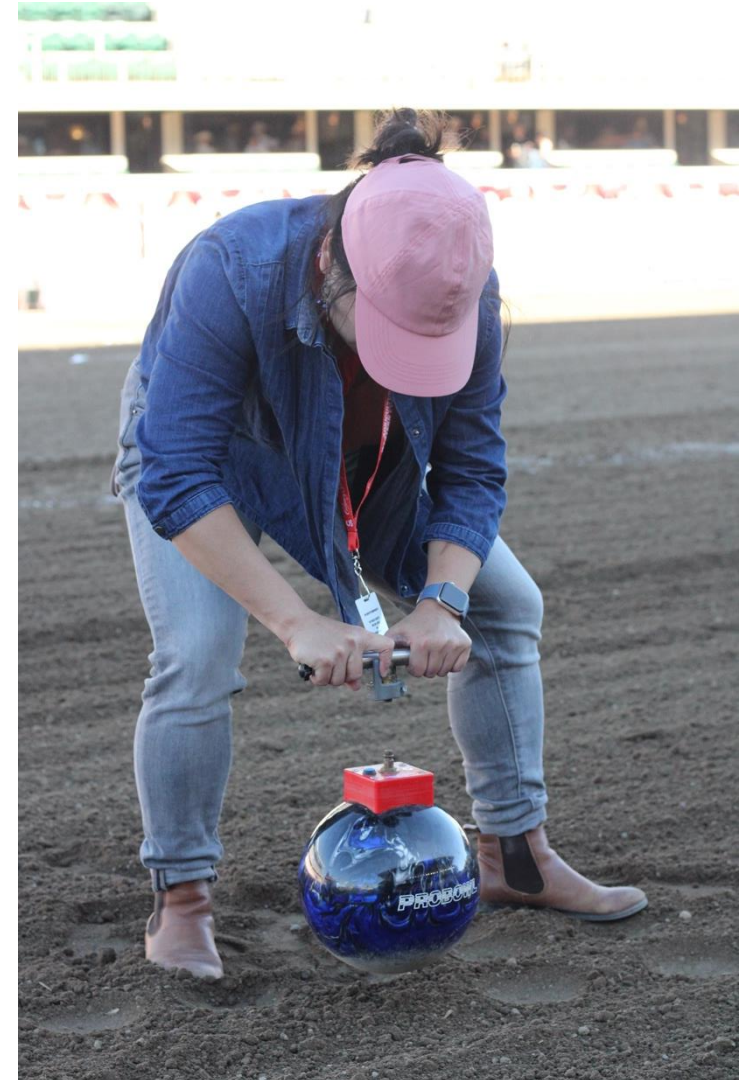
- Evidence for farriery interventions – trimming and shoeing
- Monitor changes in hoof width
- Target balance force production between limbs
- Reference for lameness assessments
 - Lameness: abnormal stance or gait



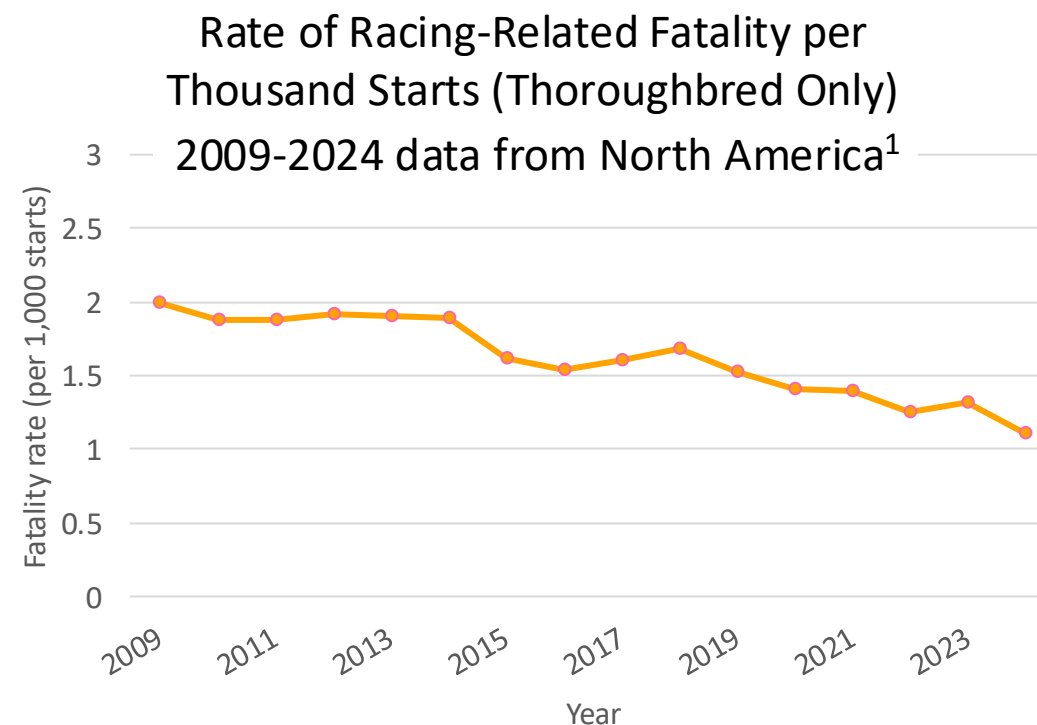


Lecture Outline

1. Horse Gait and Rider Biomechanics
2. Movement Asymmetry in Horses
3. Research Example: Racing on a Bend
4. Stride Parameters and Injury Prediction

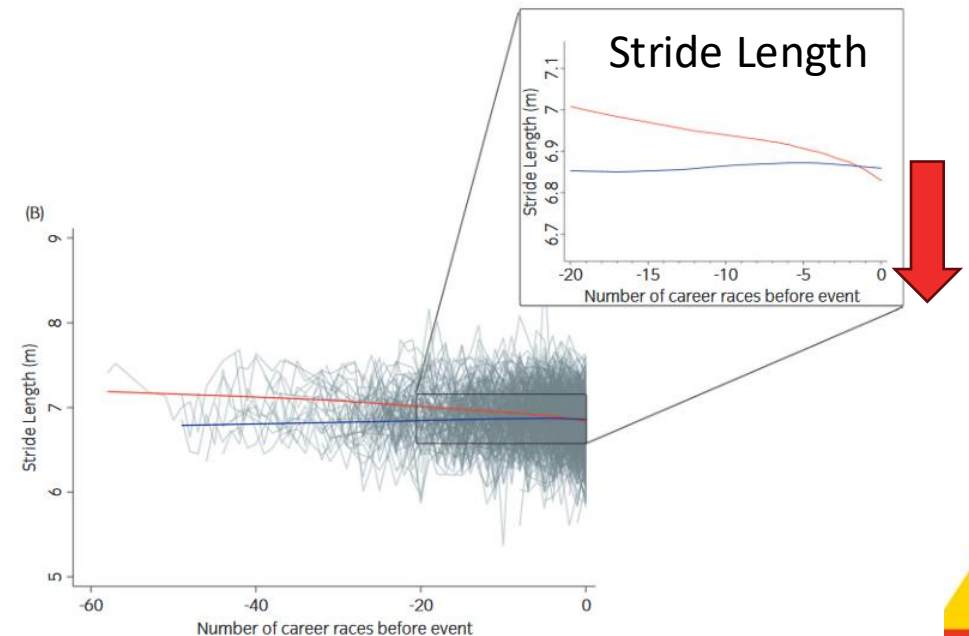
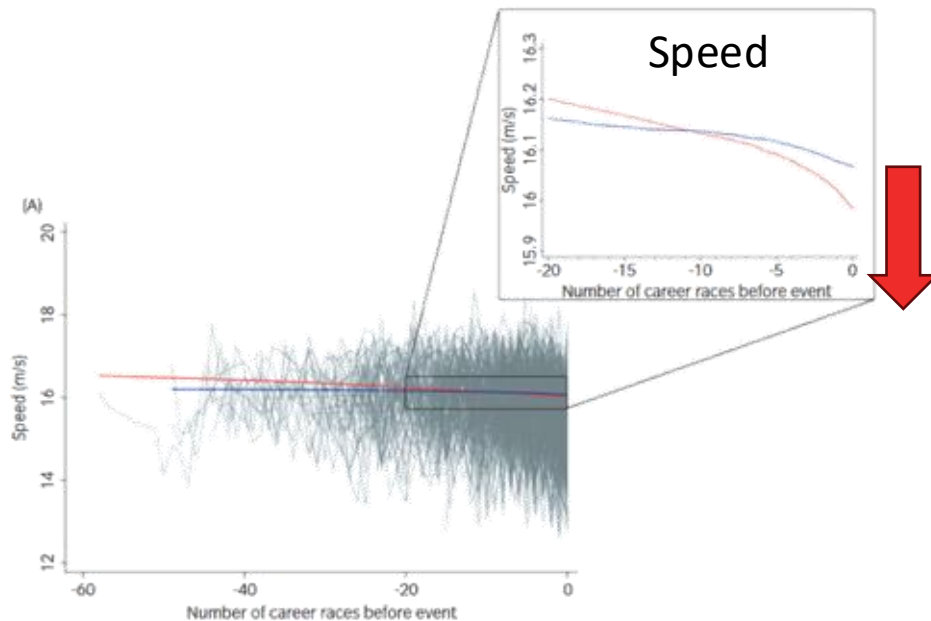


Catastrophic Musculoskeletal Injuries in Racehorses



Predicting the Risk of MSI in Racehorses

- Risk of MSI increased by
 - 1.18x per 0.1 m/s decrease in speed
 - 1.11x per 10 cm decrease in stride length



Control

Injured

Building a Database

- Flat racing in Alberta
 - Thoroughbreds
 - Standardbreds
 - Quarter horses
- Chuckwagon racing

Thoroughbred racing



Chuckwagon racing



Standardbred racing with a sulky



Stride Parameters

High sampling frequency
(10 - 25 Hz) GPS/GNSS data loggers



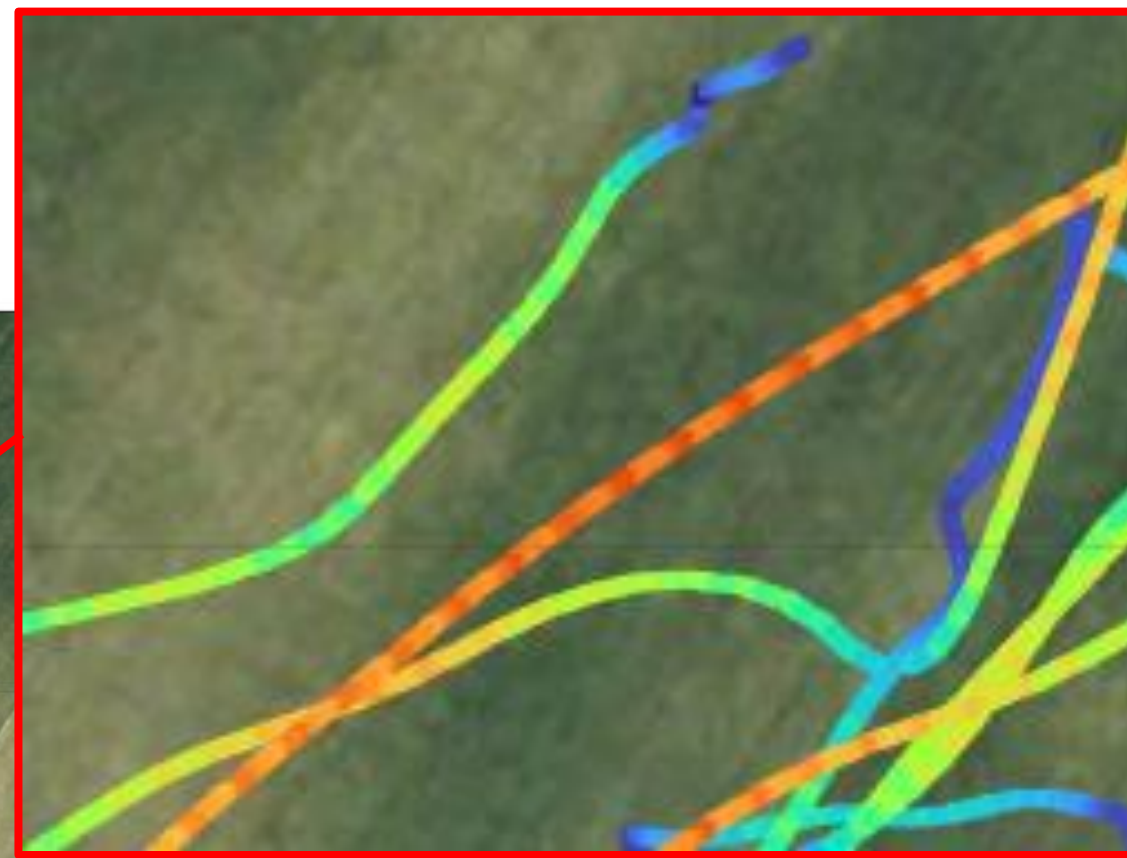
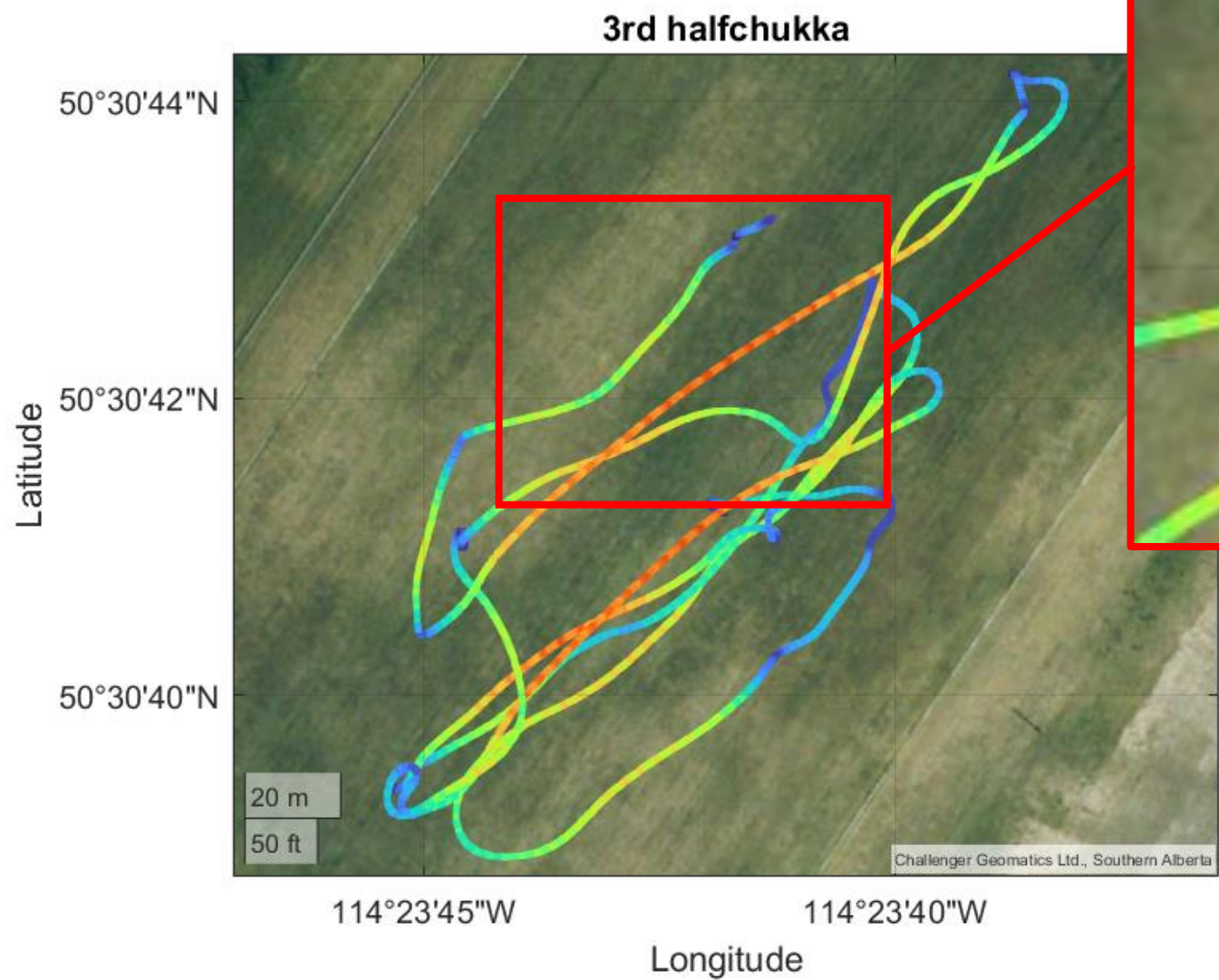
Sensor placed in the middle pocket of racing cloth



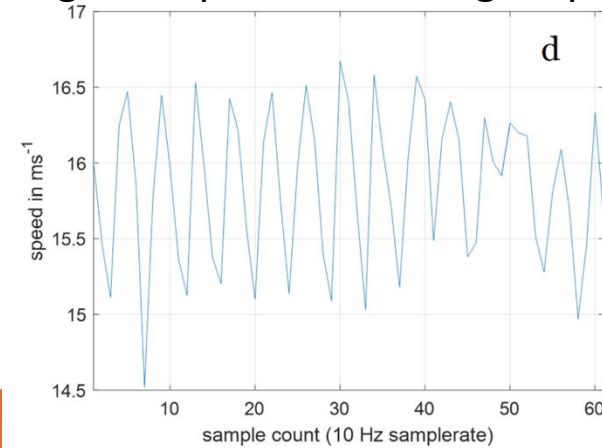
Sensor(s) placed in the 'backpack' of the harness



Stride Parameters

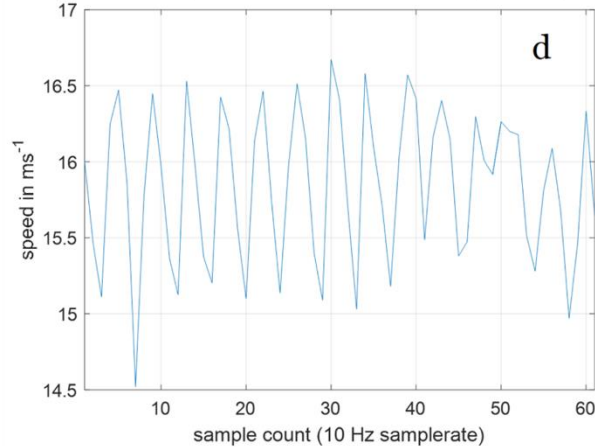


Changes in speed within a galloping stride

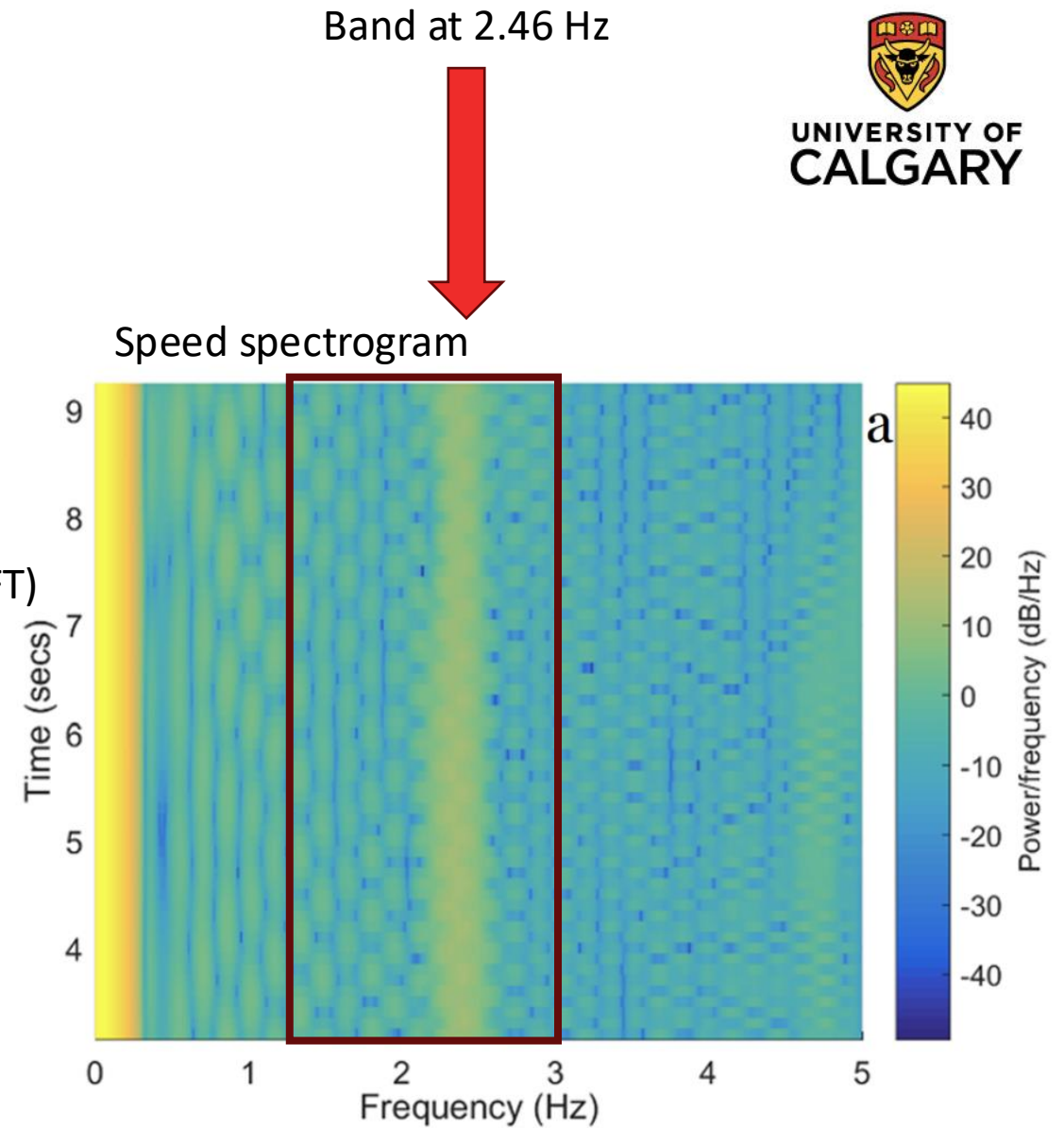


Stride Parameters

Changes in speed within a galloping stride



fast Fourier transformation (FFT)



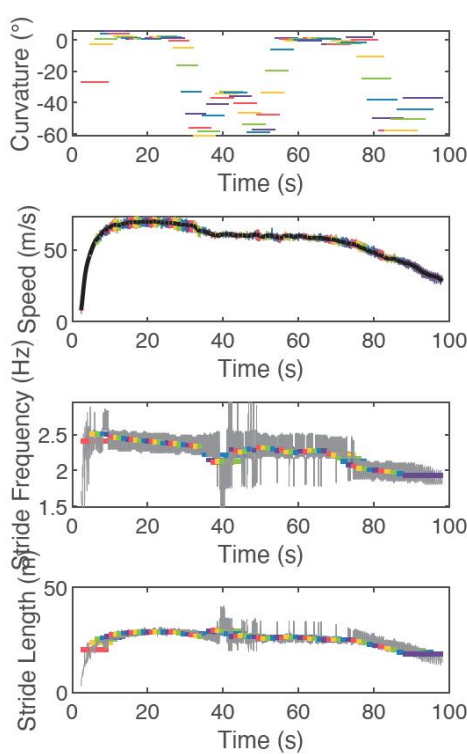
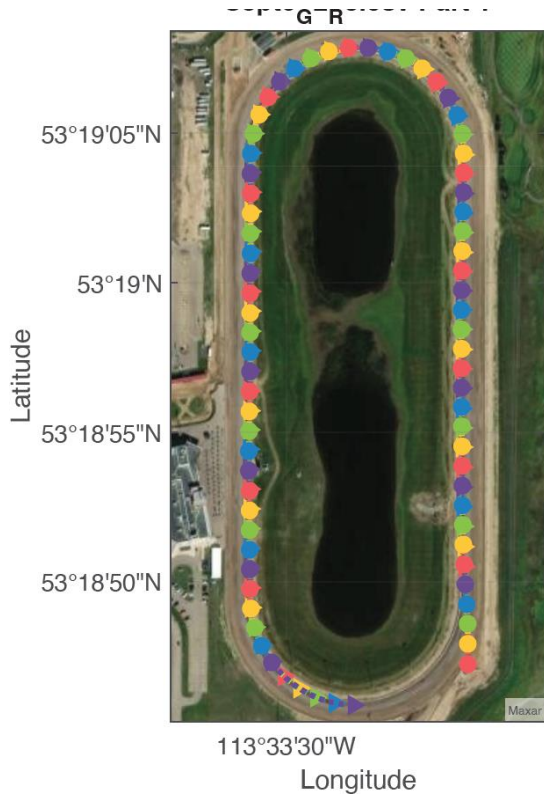
Stride Parameters

Stride parameters

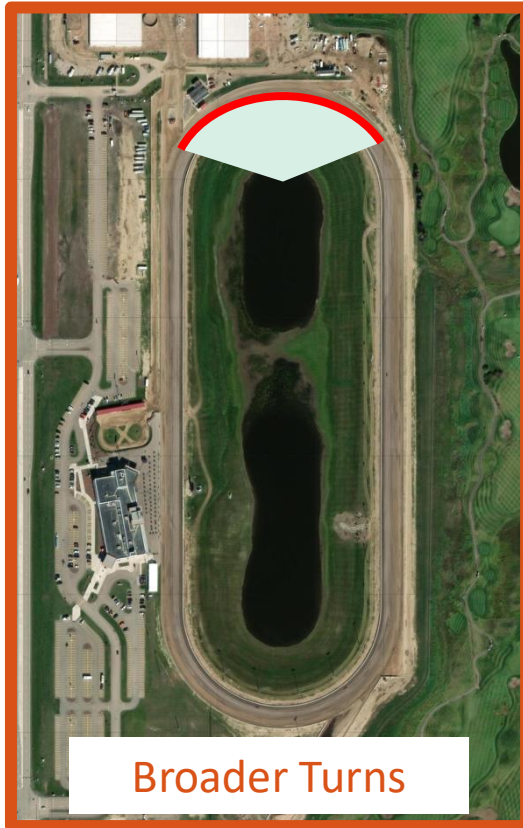
Speed (m/s)	- Directly obtained from the GPS-logger - Recorded as positional changes over time
-------------	---

Stride Frequency (Hz)	Identified from periodic fluctuations in GPS speed
-----------------------	--

Stride Length (m)	$\text{Stride length} = \frac{\text{Speed}}{\text{Stride Frequency}}$
-------------------	---



Stride parameters over different track geometries



Century Mile Racetrack

- Full Mile Track (1.6 km)
- Radius of 112 m

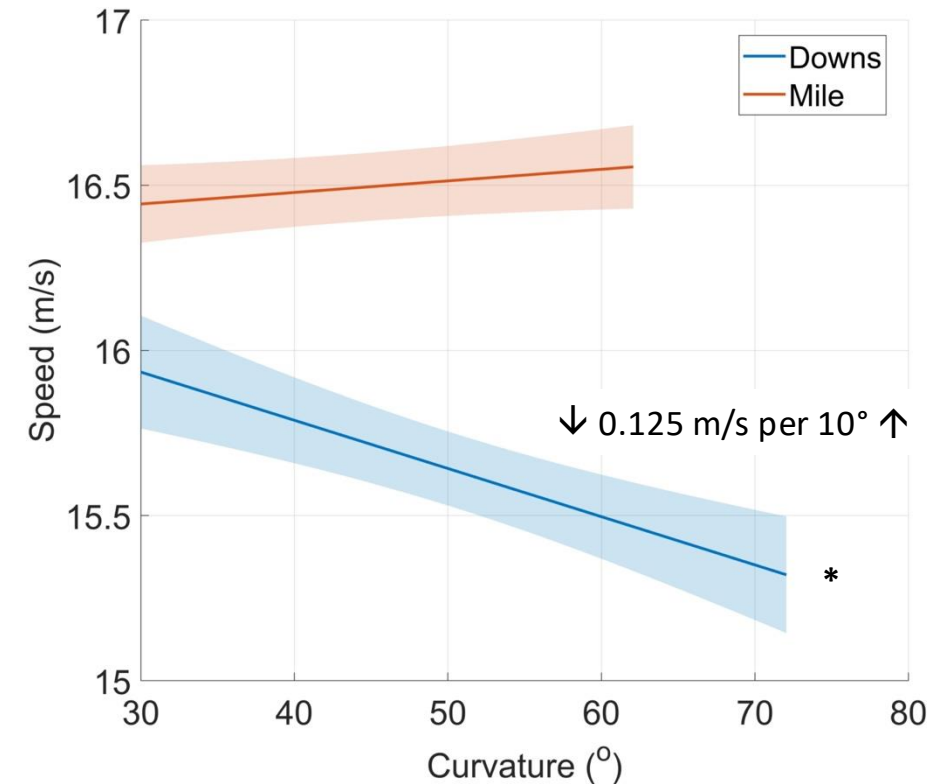
Century Downs Racetrack

- 11/16th of a Mile (1.1 km)
- Radius of 90 m



Stride Parameters over Different Track Geometries

- Century racetracks
 - Downs (90 m): speed ↓ when curvature ↑
 - Mile (112 m): not slowing down at turns
- Might explain the difference in pattern of limb injuries when running on tracks of different radii¹
 - Fore vs. hind
 - Left vs. right



Closer to the apex →

Stride Parameters over Different Track Geometries

- Pattern of limb injuries¹
 - Large radii (over 129 m): ↑risk of right (outside) hindlimb fracture
 - Tight turns (50 – 126 m): ↑risk of right forelimb fracture
- Large radius turns
 - Horses maintain **higher speeds**
 - **↑ peak vertical force & impulse** in both hindlimbs²
 - Trailing hindlimb provides more propulsive force²
- Tighter turns
 - Outside forelimb bears **↑ centripetal, propulsive and vertical forces**³
 - Partly offset by slower speed
 - Lowest overall injuries risk¹

Other Factors Affecting Stride Parameters

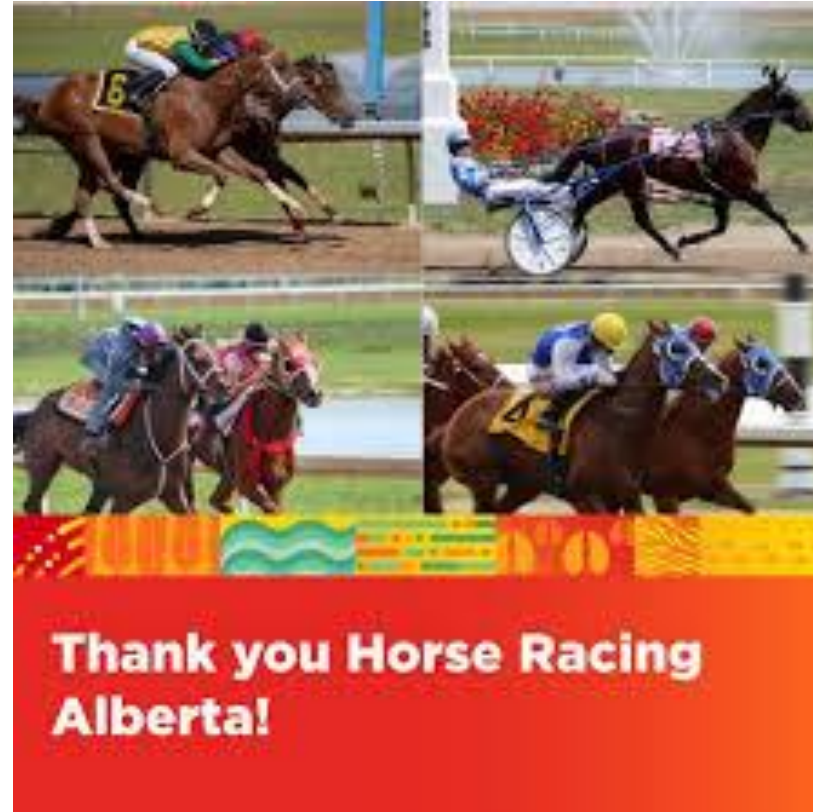
- Position in a chuckwagon outfit¹
 - Wheelers vs. Leaders
 - Left vs. Right
- Surface properties
 - Impact acceleration
 - Penetration depth
 - Moisture
 - Surface stiffness



Racehorse injury prevention



Interested in Joining the Dark Side? 🤡



Email: zoe.chan1@ucalgary.ca

Acknowledgements

- UCalgary Equine Biomechanics Team
- Funding & Support
 - Century Racetracks
 - Horse Racing Alberta
 - Morris Horse Foundation
 - Hong Kong Jockey Club
 - McCaig Institute for Bone and Joint Health
- My quadruped, Tux

