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Do activity sensors identify behaviour changes in laying hens exposed to a vaccine challenge?

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Background

- Government veterinary officer in South Korea

  (Ministry of Agriculture, Food and Rural Affairs, APQA)

  - In charge of Animal Welfare Scheme
  - Inspector of animal welfare in livestock, transportation vehicle, slaughterhouse
- MSc Applied Animal Behaviour and Animal Welfare (2019)
- **Animal-based welfare assessment**

Background

- **Public concern & legislation**

- **Difficulties (1)**

- Development of improved housing system

Providing the possibilities of animals to express natural behaviours

➡ Move towards alternative house systems

- Large flocks with diverse structures

➡ Assess and monitor health and behaviour of individual animals ⬇

(Ben Sassi et al., 2016; Siegford et al., 2016)

Background

- **Difficulties (2)**

- Concealing signs of sickness
  (Siegford et al., 2016)
- Subtlety of behavioural changes at group level
  (Millman, 2007)
- Hiding in housing structure or flocks/herds
  (Siegford et al., 2016)
- Subjectivity & inaccuracy of human observation
  (González et al., 2008; Theurer et al., 2013)

Background

- **Early detection in changes behaviour and activity**
  - Improvement of welfare
- **Highly Pathogenic AI (H5N1)**
  - **131 million** poultry (2022)
    - Either culled or died
  - Mental illness (humans)
  - Deterioration of environment
- **Efficient and accurate monitoring** ➡ **Benefits !!**

- Early treatment, reduced mortality
- Reduced antibiotic use

(Milner et al., 1997; Wolfger et al., 2015; Neethirajan, 2020)

- Mental illness (humans)
- Deterioration of environment

For One Health !!

- Detection of early signs of disease, sickness

  ➡ Automated technology

Objectives

- **Detection of early signs of diseases or sickness**
  - Using behavioural changes identified via advanced technologies.
- Comparison
  - Clinical sign scoring
  - Observed changes in behaviour
  - Sensor data with others
- **Hypothesis**
  - When given a vaccine challenge, behaviour, clinical signs, activity: change
  - Sensor technology will identify the changes more accurately than human observation.

Method

- **Materials**
  - Animals (Hy-Line Brown)
    - 10 weeks of age (n= 29)
  - Husbandry
    - Light intensity (15-30 lux)
    - Period (06:00-20:00)

- **Pilot study**
  - Pilot study (n=8)
    - ND, ILT vaccine
    - Ocular only, ocular & nasal

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- Housing

Small room (40 m^2)

Research room (180 m^2)

- Vaccine type and application method

=> **Infectious Laryngotracheitis (ILT)** vaccine

- Ocular & nasal drop

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Method

- **Main study**
  - 5 replicated batches
    - 4 hens (25-35 weeks of age)
    - 12 day / batch

- **Sensors**
  - FitBark (10g)

    - 3-axis accelerometer
    - Movement, activity
  - TrackLab (26g)

    - UWB (Ultra-Wideband)
    - Movement, location

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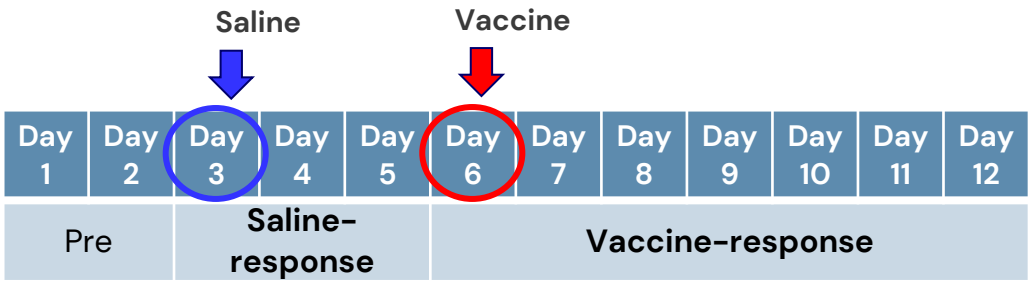
- Timetable



- Sensor attachment

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Method

- **Physiological factors**
  - Everyday (twice)
    - Respiratory rate (count/min)
    - Cloacal temperature (°C)
  - Day 1, 3, 6, 9, and 12
    - Weight, feed intake (kg)
- **Clinical signs**
  - Scale: 0 to 3
    - Abnormal breathing
    - Nasal and ocular discharge
    - Conjunctivitis
    - Depression

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- Example clinical sign score (conjunctivitis)

Scale	Description
0 (normal)	Normal conjunctiva
1 (mild)	Redness of conjunctiva (one or both eyes)
2 (moderate)	Moderate conjunctivitis with swelling of conjunctiva
3 (severe)	Severe conjunctivitis with swelling of conjunctiva, eyes shut

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Method

- **Behaviour/Location**
  - Video scanning (Geovision)
    - Every 15 min, 4 times/hour
    - 24 times/6hours/day
      - ex) 09:00-11:00, 13:00-15:00, 18:00-20:00
  - Measurements
    - Behaviour
      - Active and inactive
        - Inactive: stand, sit, nesting
    - Location
      - Feeder, drinker, perch, nestboxes

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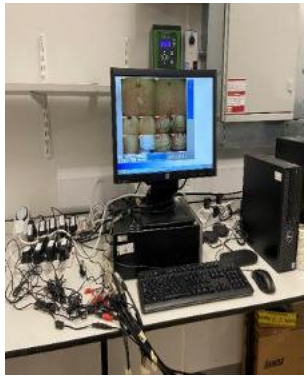
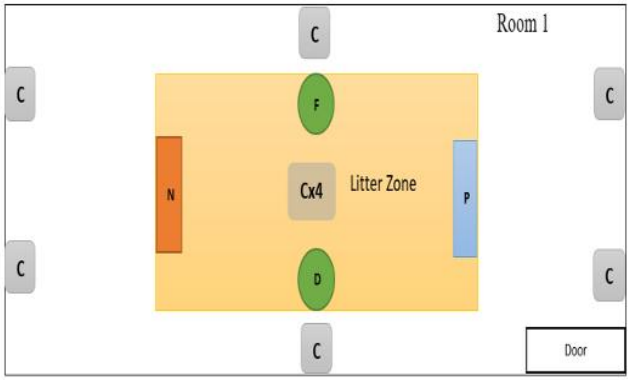
- Programme and cameras



Geovision



Floor plan

- Example of measurements

Behaviour	Definition
Stand	Hen is standing on the floor or the structure.
Sit	Hen is sitting on the floor or the structure.

Location	Definition
Feeder	Hen is standing within 1 bird length of the feeder.
drinker	Hen is standing within 1 bird length of the drinker.

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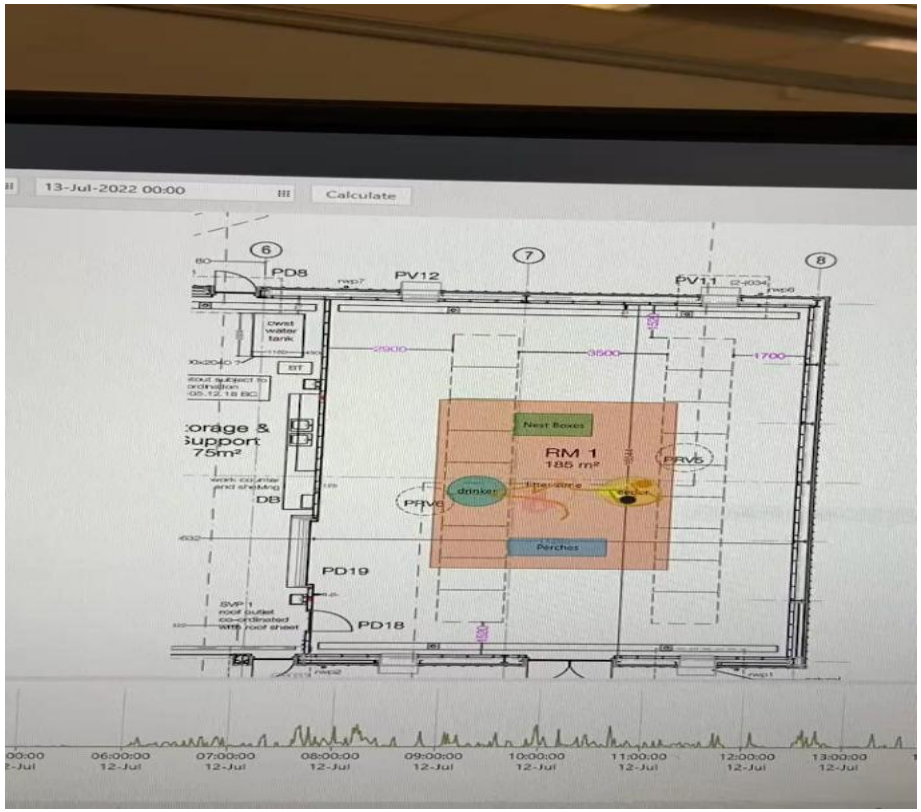
Method

- **Sensor data**
  - FitBark
    - Distance travelled
    - Activity level
  - TrackLab
    - Distance travelled
    - Location
- **Analysis**
  - RStudio
    - Linear mixed models (LMMs)
    - Fixed effects: day
    - Random effects: bird, batch

- Image of sensor data



TrackLab

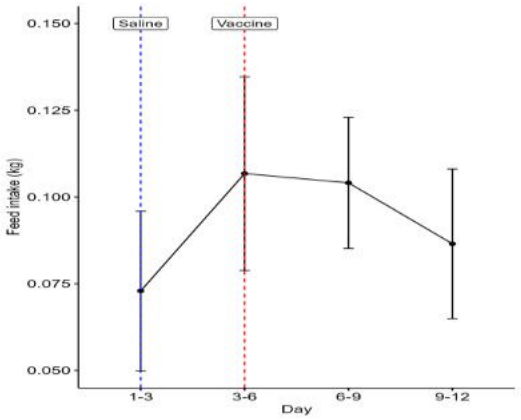
Results

- Physiological factors
- Clinical signs
- Behaviours
- Sensors
- Location

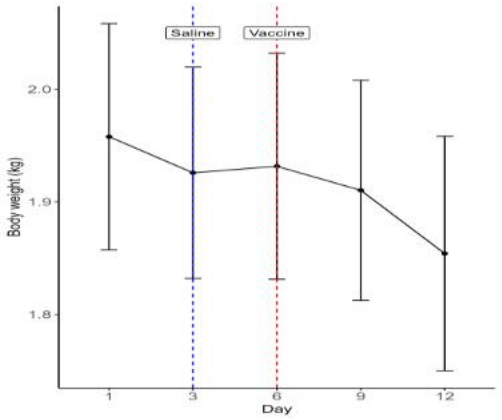
Results

- **Physiological factors**

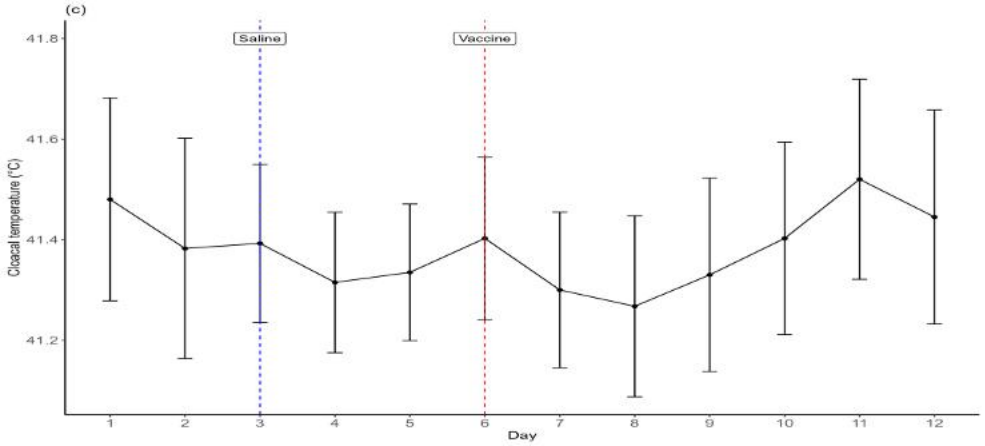
	F Statistic	p Value
Feed intake	4.28	0.031
Body weight	14.39	<0.001
Cloacal temperature	4.94	<0.001
Respiratory rate	1.46	0.179



Feed intake



Body weight

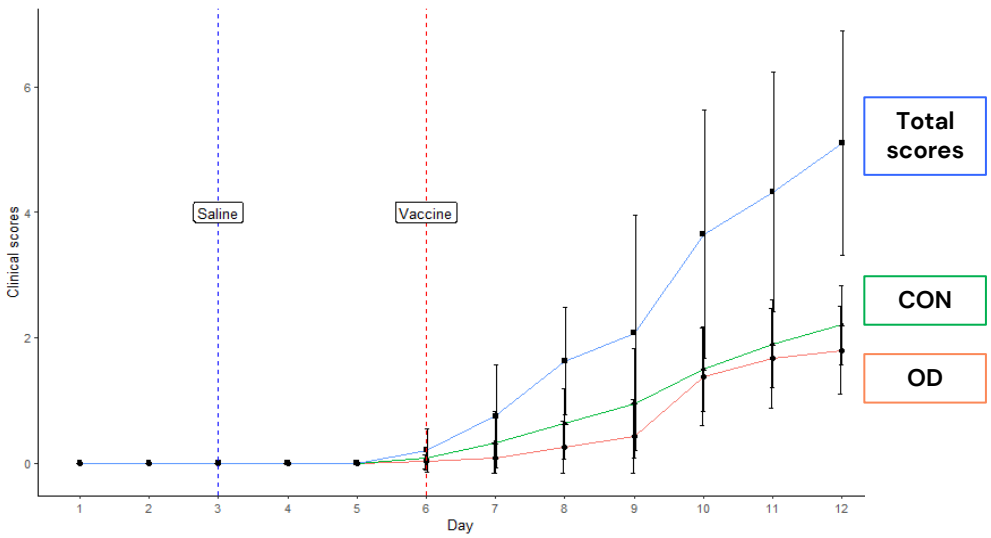


Cloacal temperature

Results

- **Clinical scores**

	F Statistic	p Value
Abnormal breathing (AB)	0.68	0.647
Ocular discharge (OD)	52.34	<0.001
Nasal discharge (ND)	0.49	0.785
Conjunctivitis (CON)	49.01	<0.001
Total scores (TS)	4.12	<0.001



Conjunctivitis

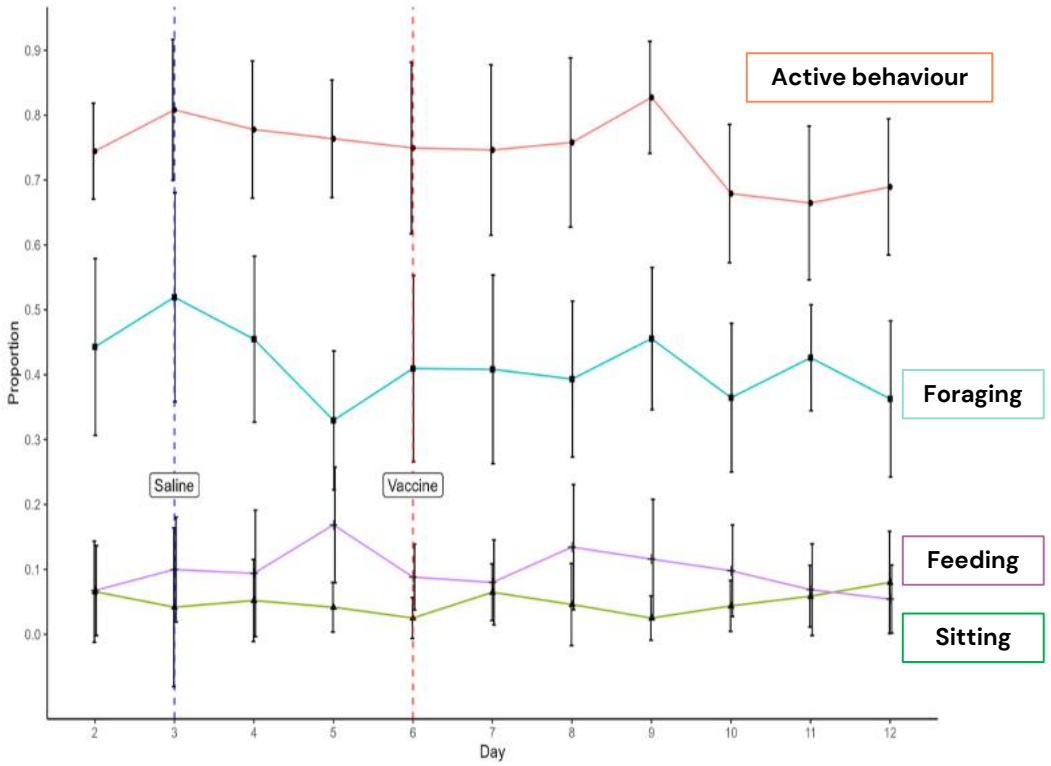
Ocular discharge

Results

- **Behaviour**

	F Statistic	p Value
Standing	1.91	0.070
Sitting	2.13	**0.044**
Walking	0.95	0.493
Foraging	2.21	**0.036**
Preening	1.41	0.210
Running	0.69	0.724
Drinking	0.56	0.833
Feeding	3.28	**0.004**
Pecking	0.85	0.584
Dustbathing	0.65	0.755
Nesting	0.75	0.674
Flapping	0.90	0.534
Active behaviours *	2.54	**0.018**

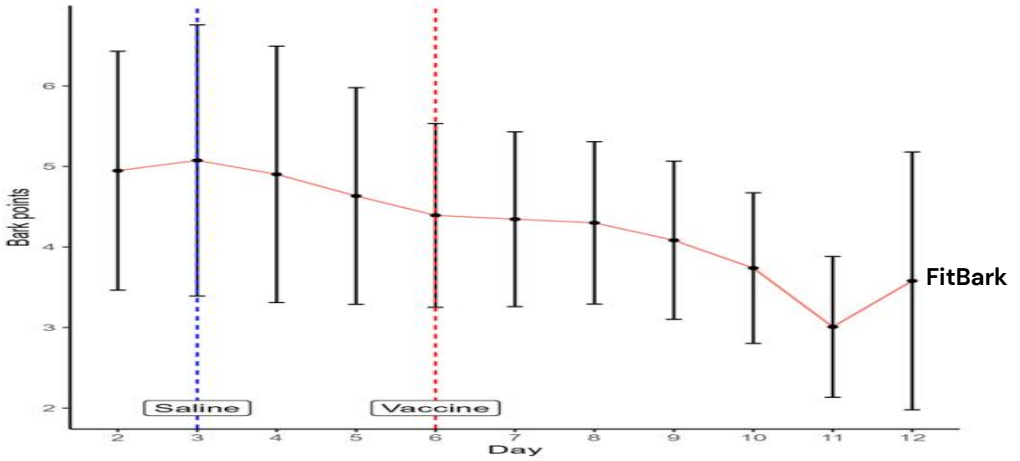
* Active behaviour: all behaviours except for standing, sitting, nesting



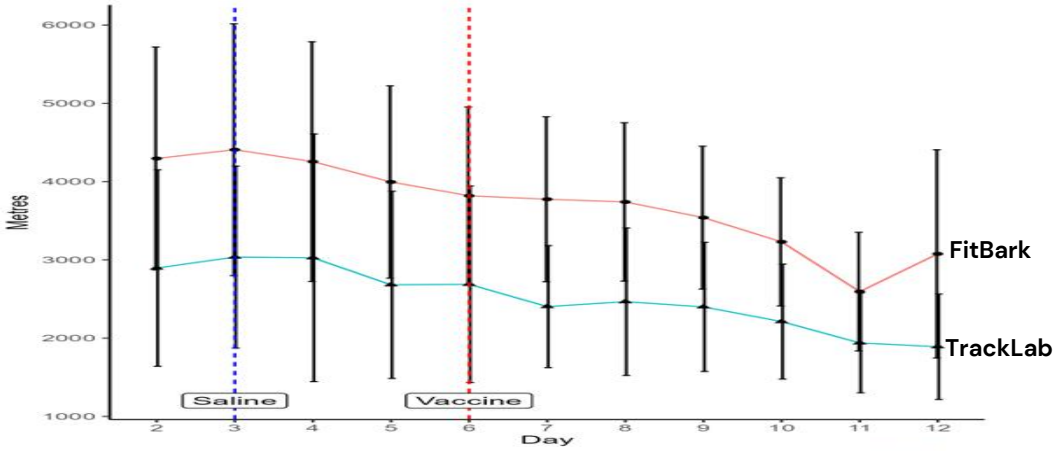
Results

- Sensors

	F Statistic	p Value
Activity level (FitBark)	7.87	< 0.001
Distance travelled (FitBark)	7.28	< 0.001
Distance travelled (TrackLab)	4.76	< 0.001



Activity level (FitBark)

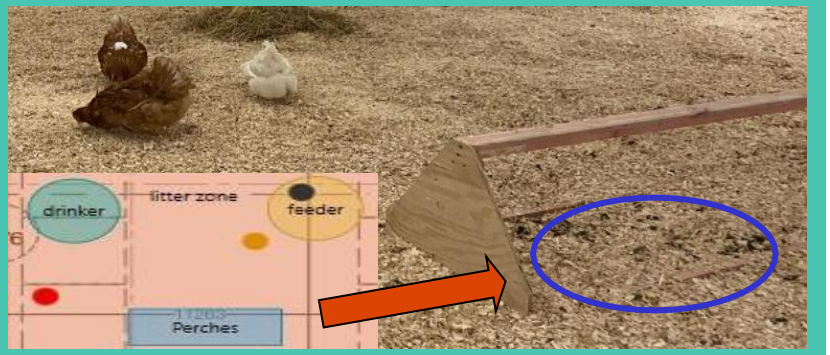


Distance travelled

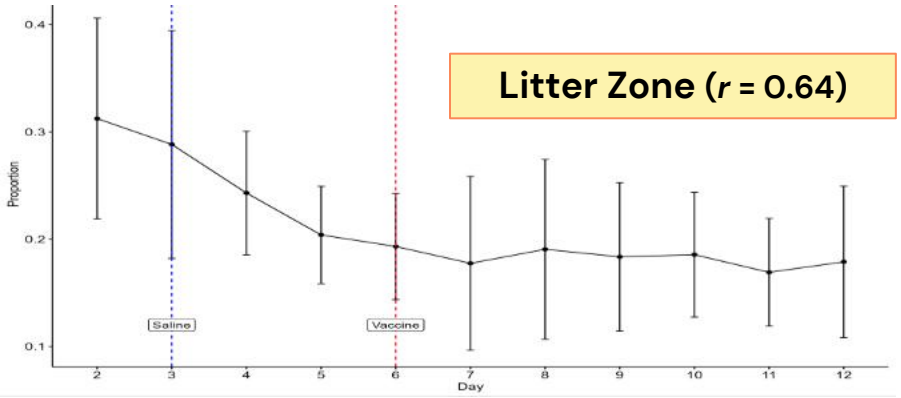
Results

- **Proportion (resource use)**

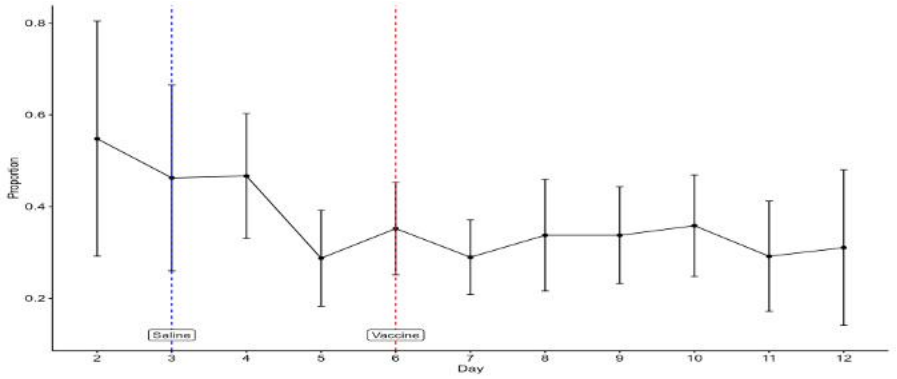
	TrackLab		Video	
	F Statistic	p Value	F Statistic	p Value
Inner zone	0.55	0.840	1.97	0.062
Litter zone	6.45	**<0.001**	2.71	**0.012**
Drinker	1.71	0.109	0.78	0.645
Feeder	0.82	0.609	1.47	0.185
Nest boxes	0.72	0.695	0.76	0.662
Perch	2.19	**0.037**		



Perch data: overestimation



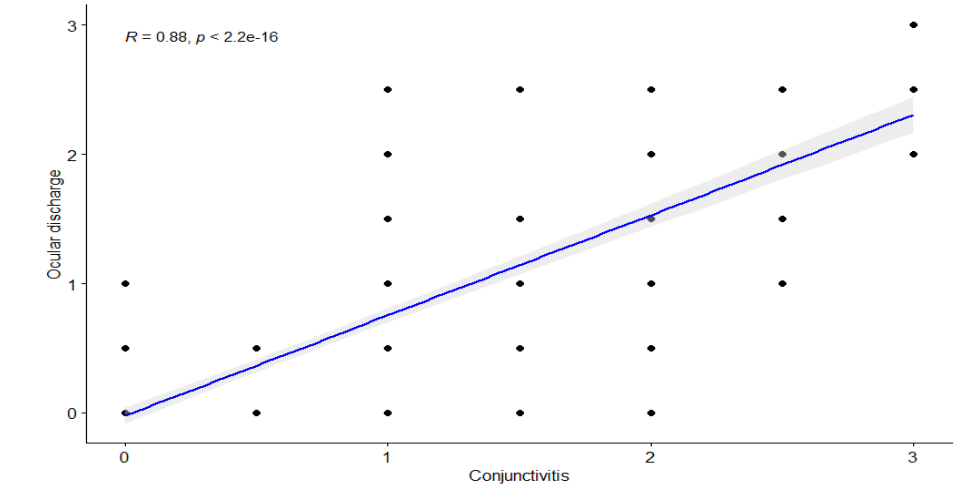
TrackLab

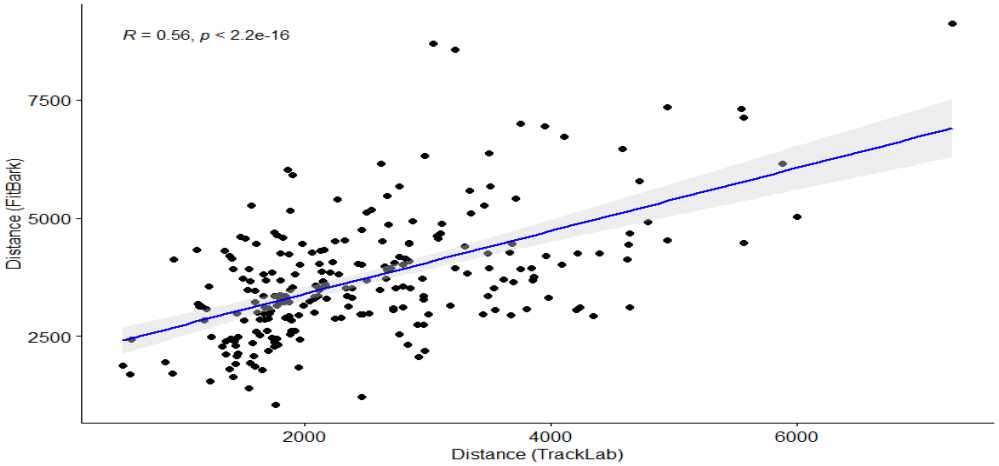


Video scanning

Results

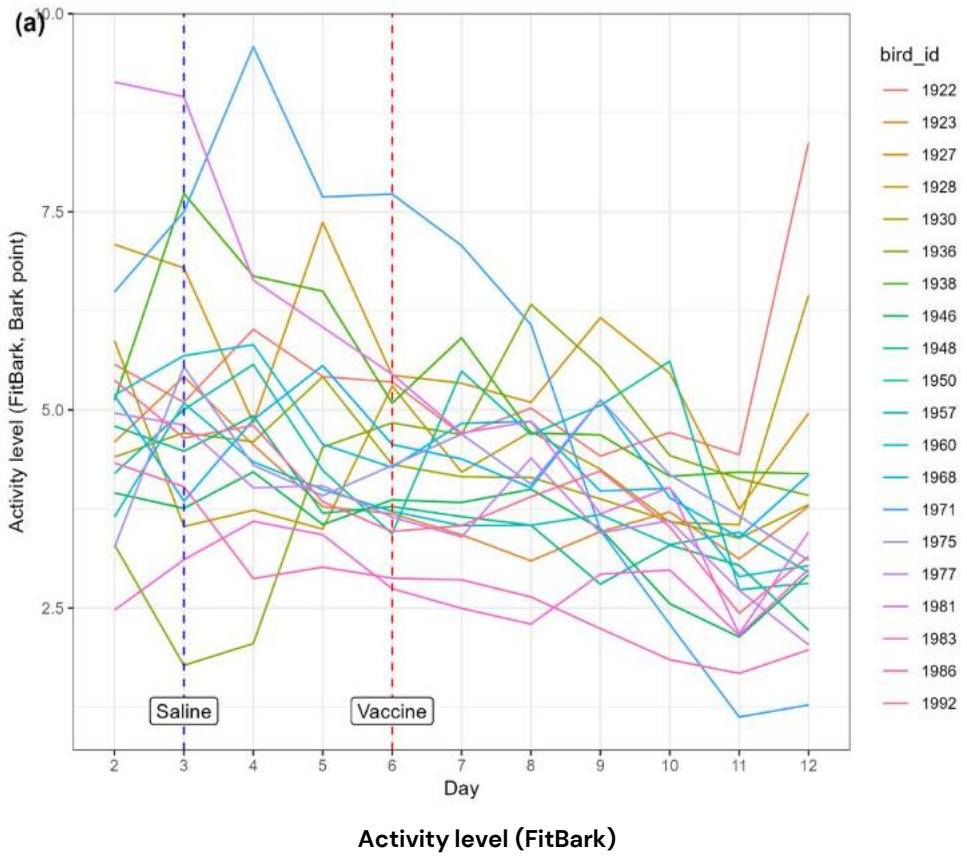
- **Correlation**
  - Clinical scoring
    - Conjunctivitis & ocular discharge (r = 0.88)
  - Sensors
    - Activity level & Distance travelled
      - FitBark (r = 0.98)
    - Distance travelled
      - FitBark & TrackLab (r = 0.56)
  - Behaviour
    - Activity & active beh (r = 0.46)
  - Total visit duration (Feeder)
    - Feeding location (r = 0.62)
    - Feed intake (r =0.67)





Discussion

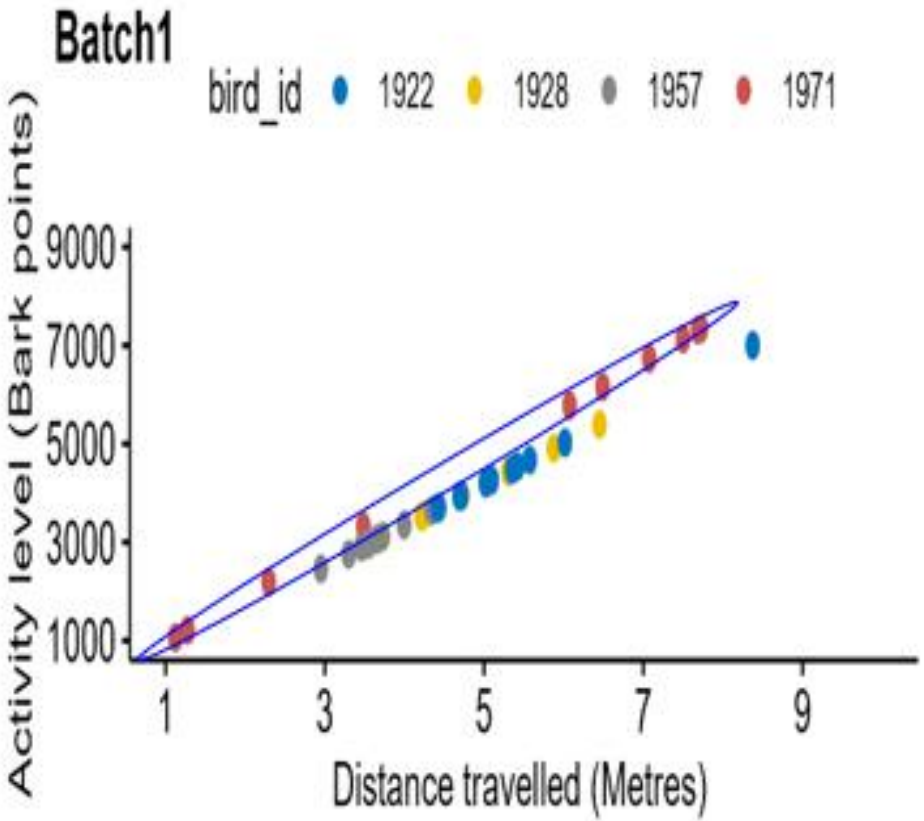
- **Individual differences**
  - Daily data values for each hen



Activity level (FitBark)

Discussion

- **Sensor differences**
  - (FitBark) Distance travelled and activity level per batch



Conclusion

- Vaccine challenge

- Some changes before vaccination

- Sensor vs human

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– Stimulate immune response

· Changes in behaviour and physiology without causing disease

➡ Animal welfare ⬆

– Time alone

· Longer acclimatization period

– Detect changes in activity

➡ Early detection..?

– Comparison human observation

➡ Reliable results..?

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Thank you!!

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Any questions?

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