GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN IN PUBLICA COMMODA SEIT 1737

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The confidence ratio: an approach to calculate the confidential learning of the virtual fencing system

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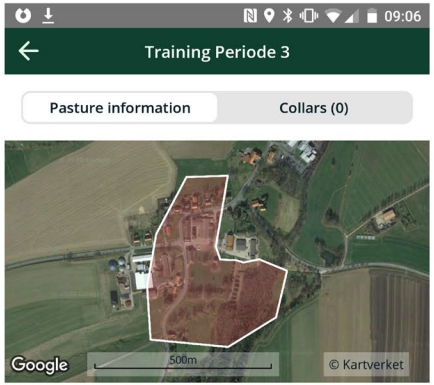
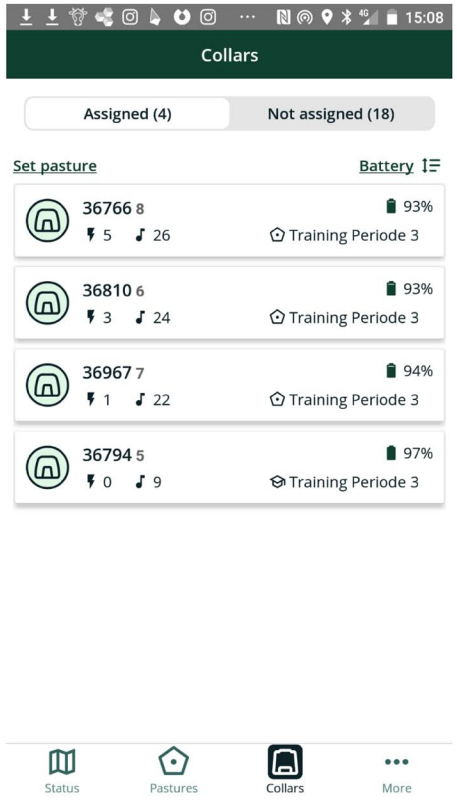

09:06
Training Periode 3
Pasture information
Collars (0)
Google
500m
© Kartverket
Name:
Training Periode 3
Area:
118318m²
Last updated:
2 months ago
Number of exclusion zones:
0
Edit pasture boundary
Delete pasture


15:08
Collars
Assigned (4)
Not assigned (18)
Set pasture
Battery
36766 8
93%
5
26
Training Periode 3
36810 6
93%
3
24
Training Periode 3
36967 7
94%
1
22
Training Periode 3
36794 5
97%
0
9
Training Periode 3
Status
Pastures
Collars
More


17:24
Status
Problem loading pasture
Google
100m
Status
Pastures
Collars
Move
More


18:16
Hauptversuch viel D
- Analysis
Today
Yesterday
Last week
Positions
Electrical pulses
Escapes
Google
100m
Status
Pastures
Collars
Move
More

Background

- Virtual fencing (**VF**)) has the potential to reduce labour (Stevens et al., 2021)
  - Facilitated fence shifting (Campbell et al., 2017)
  - Animal monitoring (Aquilani et al., 2022, Hamidi et al. 2023)

→ VF enables the management of areas that were previously unmanageable (Umstatter 2011)

Background

- A period of initial training is required (Verdon et. al. 2021; Hamidi et al. 2022; Animal Welfare Commitee, 2022)
- Prerequisite: learning to avoid the electric pulses (Lee et al. 2008) by responding to the acoustic signal (Confessore et al. 2021)
- Calculation of the ratio between acoustic signals and electric pulses
  (e.g. Eftang et a., 2022)

na = no of acustic signals

ne = no of electric signals

S = success, S = na – ne

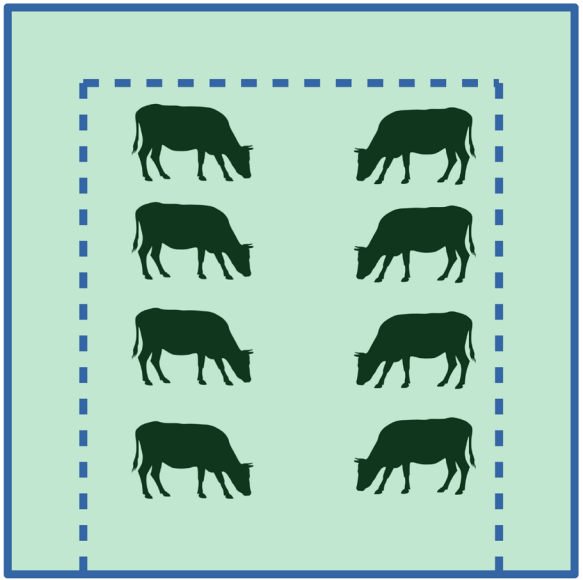
SR = success ratio, $SR = \frac{S}{na}$

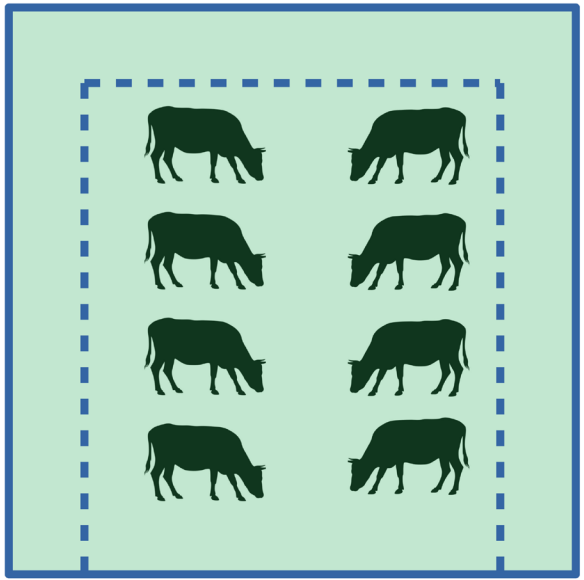
Material & Methods

- 12 day period
- 2 groups à 8 heifers
- 4 h per day

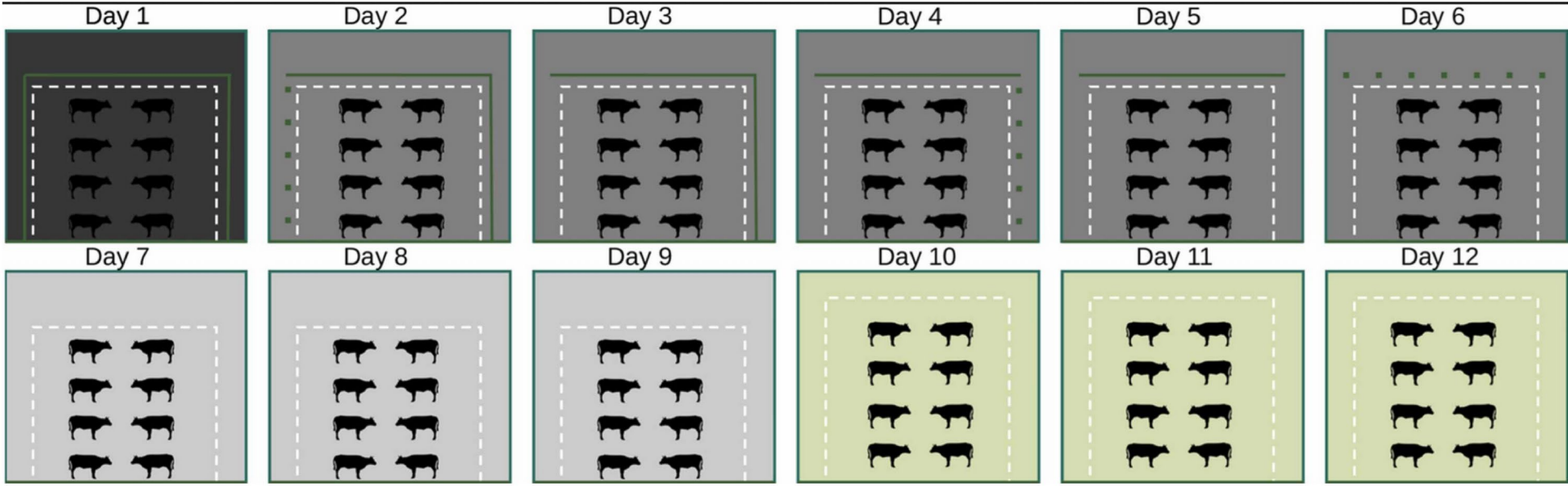
Virtual fence

Physical fence



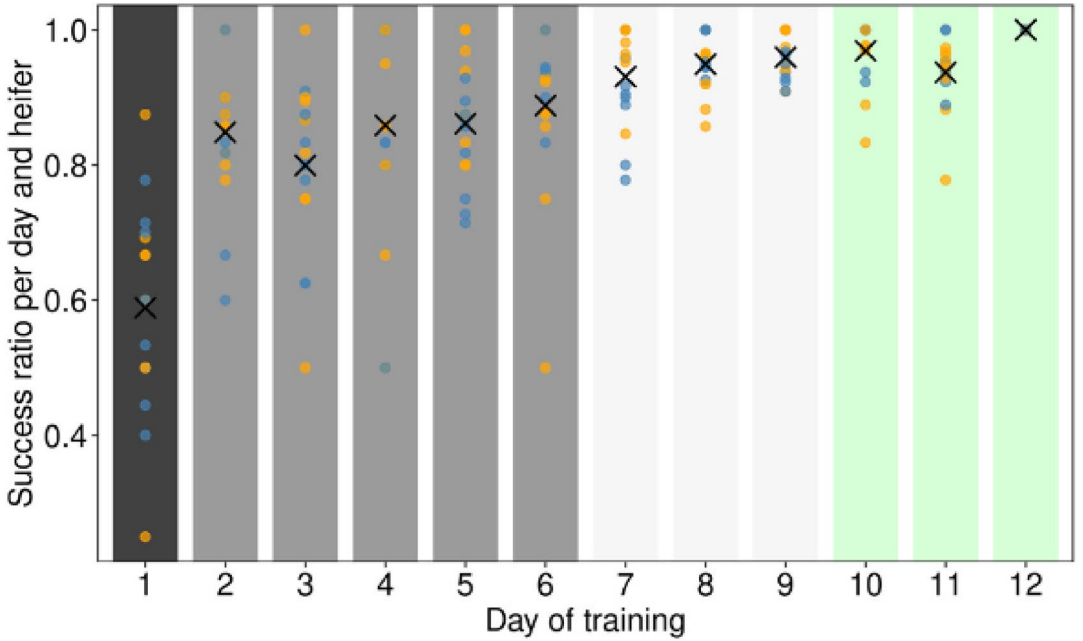


Material & Methods



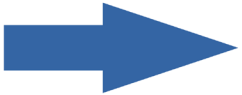
Success ratio (per day)	$0.59 \pm 0.03_{a}$	$0.85 \pm 0.01_{b}$	$0.95 \pm 0.02_{c}$	$0.97 \pm 0.02_{c}$

$P < 0.0001$



- Frequency of the animals' voluntary interactions with the VF is not considered in the success ratio.

- A high success ratio reveals either a high number or a low number of acoustic signals.



The success ratio for an animal receiving one or 14 acoustic signals without the subsequent electric pulse is both the maximum '1'.

- Teach mode
- Operating mode

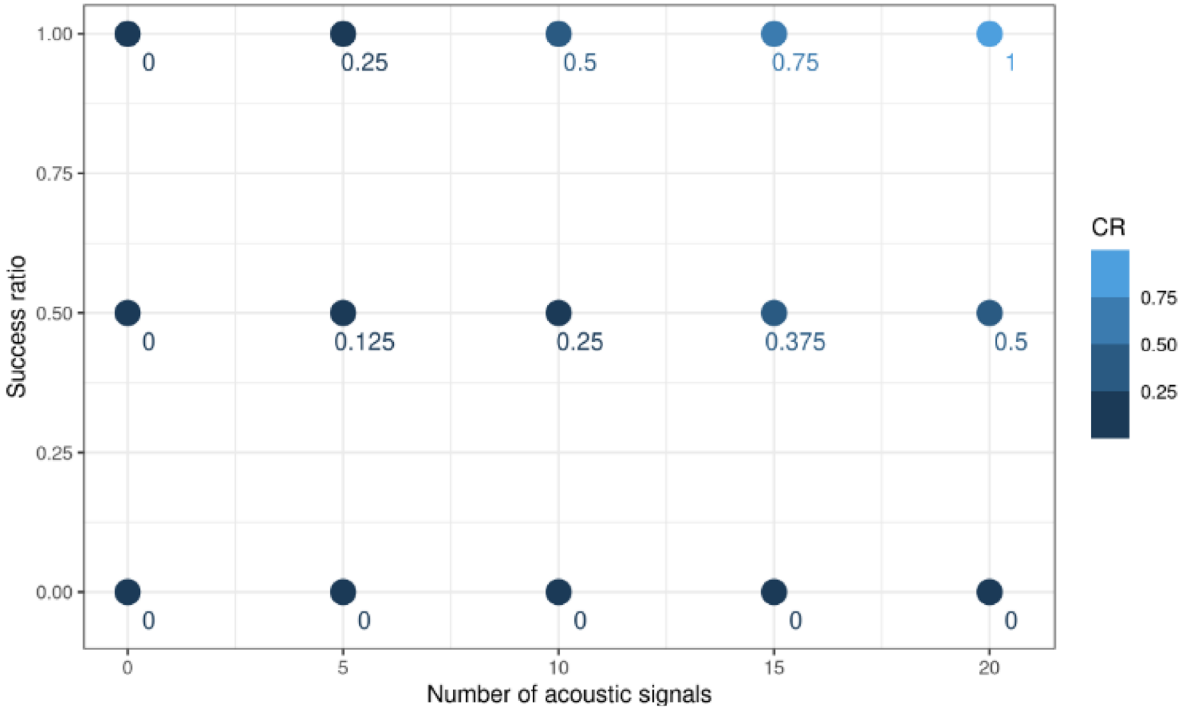
CR = confidence ratio, $CR = SR * \frac{St}{20}$

Confidence ratio (per day)	$0.20 \pm 0.08_{a}$	$0.34 \pm 0.05_{a}$	$0.67 \pm 0.06_{c}$	$0.51 \pm 0.06_{b}$

Two different types of learning can be separated:

(i) learning to avoid the electric pulse.

(ii) learning to interact with the acoustic signal.



Conclusion

Both types of learning need to be considered:

- Learning to avoid the electric pulse is necessary to ensure the functionality of the VF.
- Learning to interact with the acoustic signal is necessary for the animals' gaining confidence in their ability to manage their environement.

Applied Animal Behaviour Science
Volume 273, April 2024, 106220

Training cattle for virtual fencing: Different approaches to determine learning success

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Supplement

Reaction Score	Definition
1	Heifer continues to graze or walk slowly (< 3 steps) while turning around; away from the VF line; causing the signal to stop
2	Head shaking, walking (> 3 steps), jumping (only with front legs); away from the VF line; causing the signal to stop
3	Running (trot or canter); jumping; bucking away from the VF line, causing the signal to stop

Target variable	Phase 1	Phase 2	Phase 3	Phase 4
Reaction score 1 (counts per h)	$0.22 \pm 0.56_{a}$	$0.60 \pm 0.40_{a}$	$1.27 \pm 0.43_{ab}$	$1.72 \pm 0.43_{b}$
Reaction score 2 (counts per h)	$0.76 \pm 0.07_{b}$	$0.12 \pm 0.03_{a}$	$0.12 \pm 0.04_{a}$	$0.08 \pm 0.05_{a}$
Reaction score 3 (counts per h)	$0.28 \pm 0.04_{b}$	$0.03 \pm 0.02_{a}$	$0.04 \pm 0.02_{a}$	-