SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

The STSM applicant submits this report for approval to the STSM coordinator

Action number: CA 15134
STSM title: Assessment of animal-based welfare indicators in high and low feather pecking layer strains
STSM start and end date: 29/01/2018 to 05/03/2018
Grantee name: Dr. Mona Franziska Giersberg

1. PURPOSE OF THE STSM

Feather pecking and cannibalism causing severe damage and high mortality are major challenges and welfare issues in laying hen husbandry, particularly after the ban on beak trimming in many European countries. Besides direct behavioural observations, animal-based indicators, such as the assessment of plumage and integument condition, provide useful information about the occurrence of these behavioural disorders in a flock (Giersberg et al., 2017). Ideal animal-based welfare indicators should be reliable, feasible, and additionally less disruptive for the animals.

As a common model for studying the underlying principles of behavioural deviations in laying hens, birds from lines divergently selected on high (HFP) and low feather pecking (LFP) are compared to a randomly selected control line (CON) (Kjaer et al., 2001). Since these lines also show genetically related differences in their activity levels (Kjaer, 2009), “locomotion” may be a promising non-intrusive animal-based indicator. However, unlike plumage damage assessment or behavioural observation, locomotion activity is difficult to quantify manually, even in experimental situations. Therefore, special sensor-based technologies are needed, which measure the distances moved by the animals largely automatically.

One possibility is to use the ultra-wideband tracking system TrackLab (Noldus, Wageningen, The Netherlands). This system consists of beacons in a calibrated test-room, active tags attached to the animals and a software program. The tracking of the animals moving in the test-room is based on the beacons receiving data on “Time of Arrival” and “Angle of Arrival” of the tags attached to the animals. The recorded location data of the tags (x, y, z coordinates) are automatically processed by the software which calculates different activity parameters, for instance the distances moved by the animals.

Another option is video tracking which is based on automatic image analyses of video recordings from a top-view camera. A suitable program for this purpose is EthoVision (Noldus, Wageningen, The Netherlands) which is able to detect an animal in a video file, distinguish it from its background, and track its movements. The software offers a wide range of data acquiring settings that have to be adjusted manually.

In a former experiment, it was shown that a high similarity of the recorded distances by both systems was achieved when EthoVision data were acquired by settings which fitted the individual videos best (de Haas and Rodenburg, 2017). However, it would be less time-consuming and the possibility of manual errors would be reduced, if an EthoVision data acquiring setting could be identified that fitted all video recordings from one experiment, and strongly correlated with the TrackLab data.

Therefore, the aim of this STSM was to show systematically how different data corrections in TrackLab and different data acquiring settings in EthoVision affected the recorded distances moved by individual hens. In addition, a data acquiring setting which fitted all examined recordings should be identified in EthoVision by means of visual inspections. Eventually, the track lengths recorded by both systems should be compared and tested for correlations.

2. DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

2.1 Available dataset

A total of 132 individual hens from three lines (HFP, LFP and CON birds) were subjected to a 5 min open field test (according to Rodenburg et al., 2009) at the Carus research facility of the Animal Science Group of Wageningen University, The Netherlands. The equipment of the test-room allowed for recording the animals' activities both via ultra-wideband tracking (TrackLab) and video tracking (EthoVision). These data had been recorded in a previous experiment (de Haas and Rodenburg, 2017), and were already available for post-processing and further analyses during the STSM.

2.2. Analyses with TrackLab data

A sample of 17 TrackLab raw datasets (from 6 HFP, 6 LFP and 5 CON birds) was chosen to analyse the influence of different data correction settings on the recorded distances moved by the animals. The TrackLab-software offered three settings to rework the originally recorded track (Figure 1 a)), and to correct for possible overestimation of the distance moved. **"Outlier removal"** allowed for deleting data points which resulted from movements with unrealistic speed. Concerning laying hens, movements over 10 m/s^2 can be regarded as artefacts. **"Smoothing"** (Figure 1 b)) estimated the real value of the track points by means of the weighted last square values. Smoothing could be applied to varying extents, up to a maximum of 29 data points. **"Clipping zone"** (Figure 1 c)) made it possible to exclude certain areas of the test-room virtually. From previous studies it was known that an overestimation of the distances occurred particularly in the corners of the test-room, due to reflections of the signal. Therefore, it seemed reasonable to remove data points recorded near the corners.

The applied data correction settings in the present experiment were:

- outlier removal >10 m/s^2 (outl_re)
- medium track smoothing (smooth_15)
- maximum track smoothing (smooth_29)
- outlier removal >10 m/s^2 * medium track smoothing (outl_re*smooth_15)
- outlier removal >10 m/s^2 * maximum track smoothing (outl_re*smooth_29)
- clipping zone (zone)

The track lengths (in cm) resulting from these corrections were compared to the raw track lengths, and deviations were calculated (both in cm and %).

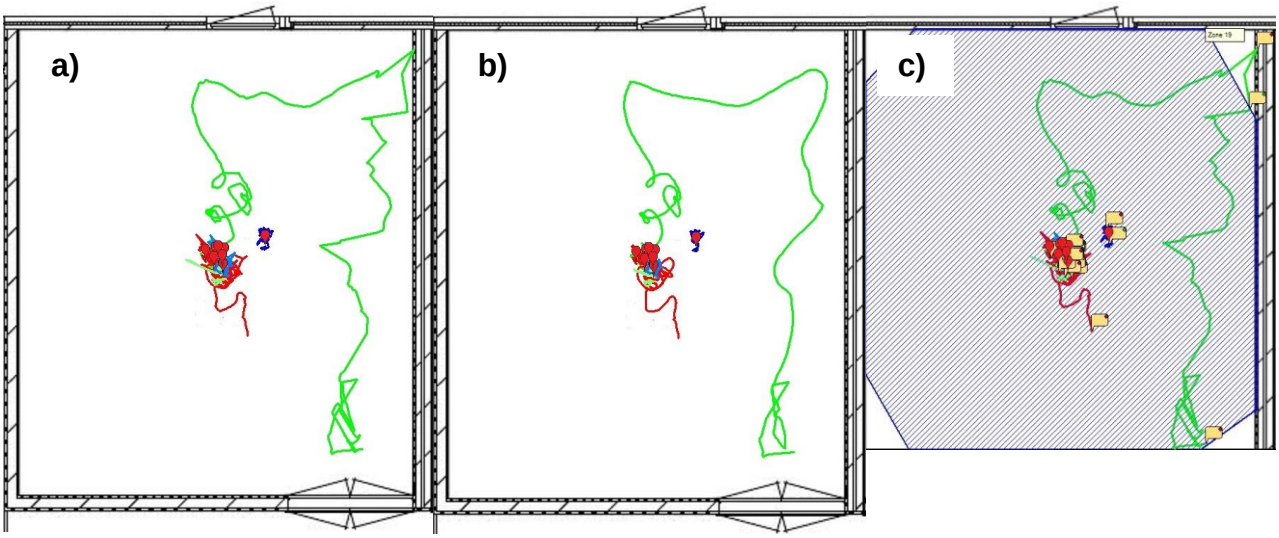

Fig. 1: Test-room shown by the TrackLab-software; the coloured lines represent the recorded distances moved by the animals; a) raw recordings; b) maximum smoothing (29) applied; c) clipping applied, only movements within the hatched area are recorded

2.3 Analyses with EthoVision

From 12 (3 HFP, 4 LFP and 5 CON birds) of the 17 TrackLab sessions, top-view video recordings were available, which were analysed with EthoVision. First, the test-room was calibrated using the same dimensions as in TrackLab (Figure 2 a)) Depending on different manually adjustable acquiring settings, the program identified the animal (Figure 2 b)) and recorded its distance moved (in cm) automatically, based on differences in contrast between the moving animal and the ground. The program allowed for visual inspection of incorrectly recorded movements during data acquisition.

The applied data acquiring settings in the present experiment were:

- for all trials: animal brighter than background; minimum distance moved: 15 cm; sampling rate: 1.99/s; subject size: 80-500 pixel
- static subtraction, brightness threshold: 15, video pixel smoothing (vps): low (StatSub_15_l)
- dynamic subtraction, brightness threshold: 15, vps: low (DynSub_15_l)
- dynamic subtraction, brightness threshold: 20, vps: low (DynSub_20_l)
- dynamic subtraction, brightness threshold: 25, vps: low (DynSub_25_l)
- dynamic subtraction, brightness threshold: 20, vps: high (DynSub_20_h)
- dynamic subtraction, brightness threshold: 20, vps: none (DynSub_20_n)
- dynamic subtraction, brightness threshold: 20, vps: medium (DynSub_20_m)
- dynamic subtraction, brightness threshold: 20, vps: high, sampling rate: 4.26 (DynSub_20_h_sr)

The track lengths (in cm) resulting from these settings were compared to the track lengths acquired with the setting that fitted best due to visual inspection. Deviations were calculated (both in cm and %).

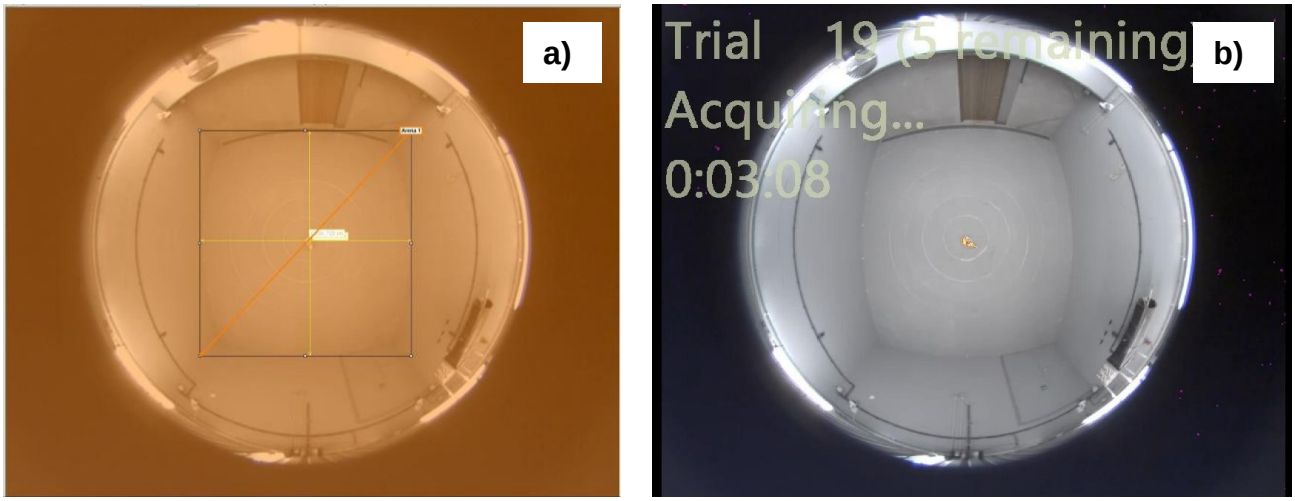

Fig. 2: a) test-room calibration in EthoVision; b) automatic video analysis; the yellow spot in the centre represents the animal identified by EthoVision

2.4 Correlations between TrackLab and EthoVision data

To get a first impression of the agreement between the distances measured by TrackLab and EthoVision, the results of both programs were correlated. The track lengths acquired with the EthoVision setting that fitted best due to the visual inspection were therefore regarded as the gold standard, and compared to the track lengths obtained by different correction settings in TrackLab.

3. DESCRIPTION OF THE MAIN RESULTS OBTAINED

3.1 Analyses with TrackLab data

The raw distances moved by individual hens from the different lines during the 5 min open field test are presented in Table 1. Additionally, the deviations resulting from the applied data correction settings were reported. It was shown that all corrections shortened the original recorded track lengths to varying extents. In particular, the correction “smoothing” altered the raw distance moved by up to 98.6% (CON, animal no. 1, smooth_15). Since only two hens moved outside the selected zone, interactions of this correction with other settings were not considered further.

Tab. 1: TrackLab recordings: raw distances moved (cm) by individuals of three laying hen lines (HFP, LFP, CON), and deviations resulting from the application of six different data correction settings (in cm and %)

Line	No	Raw dist. mov.	Deviation of track length (cm and %) in relation to raw distance moved when applying different data correction settings											
			outl_re		smooth_ 15		smooth_ 29		outl_re* smooth_15		outl_re* smooth_29		zone	
		cm	cm	%	cm	%	cm	%	cm	%	cm	%	cm	%
HFP	1	433	-4	0.9	-250	60.0	-304	70.2	-241	55.8	-302	69.8	-*	-
	2	515	-1	0.2	-242	47.3	-341	66.7	-243	47.6	-343	66.9	-	-
	3	894	-2	0.2	-256	28.7	-389	43.5	-255	28.5	-390	43.7	-	-
	4	905	-2	0.2	-399	44.1	-544	60.1	-399	44.1	-546	60.3	-	-
	5	1027	-1	0.1	-462	44.9	-710	69.1	-461	44.8	-710	69.1	-	-
	6	2090	-11	0.5	-457	21.9	-677	32.4	-466	22.3	-684	32.7	-	-
LFP	1	130	-1	0.4	-125	96.1	-125	95.9	-125	96.4	-122	93.2	-	-
	2	807	±0	0.0	-385	47.7	-517	64.1	-385	47.7	-517	64.0	-	-
	3	907	-3	0.3	-270	29.7	-430	47.3	-273	30.0	-427	47.1	-	-
	4	1248	-8	0.7	-316	25.3	-446	35.8	-313	25.1	-446	37.7	-8	0.7
	5	2771	-136	4.9	-617	22.3	-772	27.9	-665	24.0	-813	29.4	-88	3.2
	6	5143	-5	0.1	-3253	63.1	-4140	80.3	-3257	63.2	-4145	80.4	-	-
CON	1	178	±0	0.0	-175	98.6	-172	96.9	-175	98.2	-172	96.8	-	-
	2	521	-2	0.4	-191	36.7	-307	58.9	-192	36.8	-308	59.2	-	-
	3	541	-3	0.5	-117	21.7	-155	28.6	-120	22.2	-158	29.2	-	-
	4	703	-2	0.2	-362	51.5	-516	73.4	-363	51.7	-517	73.5	-	-
	5	712	-5	0.7	-267	37.6	-352	49.5	-267	37.5	-360	50.5	-	-

*- animals moved within the zone
Deviations of >50% from the raw distance moved are highlighted in red

3.2 Analyses with EthoVision

The acquiring setting which fitted all analysed videos best, due to the visual inspection, was “DynSub_20_l”. Therefore, the track lengths recorded using the other acquiring settings were related to “DynSub_20_l” (Table 2). Depending on the applied setting, the recorded track lengths were longer or shorter compared to the results obtained by using “DynSub_20_l”. In contrast, the distance moved by hen CON no. 2 was 59.3% longer when analysed with “StatSub_15_l” compared to “DynSub_20_l”. Since a higher sampling rate (DynSub_20_h_sr) did not influence the recorded distance moved these results were discarded from further analyses.

Tab.2: EthoVision recordings: distances moved (cm) by individual of three laying hen lines (HFP, LFP, CON) acquired by the best fitting setting (DynSub_20_l), and deviations resulting from the application of six other data acquiring settings (in cm and %)

Line	No	Dist. mov. DynSub_ 20_l	Deviation of track length (cm and %) in relation to "DynSub_20_l"-setting when applying different data acquiring settings											
			StatSub_ 15_l		DynSub_ 15_l		DynSub_ 25_l		DynSub_ 20_h		DynSub_ 20_n		DynSub_ 20_m	
		cm	cm	%	cm	%	cm	%	cm	%	cm	%	cm	%
HFP	1	46	-46	100.0	-46	100.0	-46	100.0	-46	100.0	-46	100.0	-0	±0
	3	362	+85	23.5	+23	6.4	-97	26.7	+4	1.1	-15	4.2	+17	4.7
	6	1282	+810	63.2	+11	0.8	-93	7.2	+9	0.7	+3	0.2	-11	0.8
LFP	1	0	±0	0.0	±0	0.0	±0	0.0	±0	0.0	±0	0.0	±0	0.0
	2	178	+83	46.8	-8	4.5	-50	28.3	+80	45.0	-4	2.0	-2	0.9
	3	663	+12	1.8	+13	2.0	+21	3.2	+57	8.6	-15	2.3	+10	1.5
	4	970	+22	2.2	+21	2.1	+11	1.2	-2	0.2	+5	0.5	+38	3.9
CON	1	0	±0	0.0	±0	0.0	±0	0.0	±0	0.0	±0	0.0	±0	0.0
	2	141	+84	59.3	+83	58.8	-63	44.5	+87	61.5	+31	21.8	-60	42.7
	3	341	-97	28.5	-97	28.5	-67	19.8	±0	0.0	+4	1.2	-34	10.0
	4	522	+55	10.4	+53	10.2	-38	7.3	+134	25.6	-5	0.9	-33	6.3
	5	771	+81	10.5	+78	10.1	±0	0.0	+25	3.3	-29	3.8	-55	7.1

Deviations of >50% from the "DynSub_20_l"-setting are highlighted in red

3.3 Correlations between TrackLab and EthoVision data

The correlation coefficients for track lengths comparisons between TrackLab and EthoVision data are presented in Table 3. There were strong positive correlations between the distances moved recorded via the best fitting EthoVision setting (DynSub_20_l) and data obtained by TrackLab without (raw distances moved) and with different correction settings. The best correlations were achieved when maximum track smoothing was applied to the TrackLab data (smooth_29; τ_b=0.84). In contrast, outlier removal and its interactions had hardly any effects on track lengths, and thus on the correlations, which is in line with the descriptive presentations (Table 1). However, these calculations must be interpreted with caution as only a small sample size of track lengths was analysed (12 tracks from 12 individual hens).Nevertheless, it becomes clear that the distances detected by both programs correspond well, and that this agreement can be increased by applying certain corrections in TrackLab.

Tab. 3: *Kendall's τ_b for correlations between distances moved detected via the best fitting EthoVision setting (DynSub_20_l) and different TrackLab settings*

Distances moved recorded via **EthoVision**	Distances moved recorded via **TrackLab**					
	raw dist. mov.	outl_re	smooth_ 15	smooth_ 29	outl_re* smooth_15	outl_re* smooth_29
DynSub_20_l	0.72	0.72	0.81	0.84	0.75	0.84

3.4 General conclusions

- **TrackLab:** The recorded distances moved by individual laying hens in an open field situation varied considerably depending on the applied data correction settings. All correction settings and their interactions shortened the original track (raw distance moved).
- **EthoVision:** Similar to TrackLab, the recorded distances moved depended on the applied data acquiring settings. Different acquiring settings shortened or stretched the distances moved to various extents. It was possible to visually identify one data acquiring setting that fitted all analysed tracks (n=12) best.
- In general, the distances moved recorded by the two programs showed good agreement. This agreement could be increased particularly when applying the maximum track smoothing correction in TrackLab.

4. FUTURE COLLABORATIONS

It is planned to transfer the automatic tracking techniques described here to different contexts in a joint EU project with further collaborators. The objective will be to compare traditional methods for assessing animal-based indicators (scoring welfare and health traits manually) with automatic sensor-based methods (such as TrackLab and EthoVision). It will also be investigated whether and to which extent these methods are able to track animals in larger groups and in field situations.

5. REFERENCES

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