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Analysis of Behavioural Profile of Hens with the Use of Computer Software

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ABSTRACT

The aim of the study was to evaluate the emotional reactivity of hens with the use of physical parameters such as movement velocity and position of the selected parts of the body analysed by computer software - Tracker®. 200 Rhode Island White hens kept individually in a laying hen breeding farm were used in the study. The analysis of hens behaviour was performed with the use of Novel Object Test. Afterwards the video clips were analysed to determine behavioural reactivity with the use of Tracker® software by analysis of two control points: the upper part of the head and the peak of the tail. The results suggest that it is possible to use Tracker® software for evaluation of hens behavioural profile and this sort of analysis enables to classify hens to the groups of timid or curious/courageous birds based on the parameters of movement velocity of the upper part of the head and the peak of the tail and on the basis of the ratio between the position of the head and the tail.

INTRODUCTION

Questions and uncertainties related to avian behaviour have been raised by a number of authors (Kjaer *et al.*, 2001; Rodenburg *et al.*, 2004; Uitdehaag *et al.*, 2006, 2008a,b; de Haas *et al.*, 2013). Since consumers are interested in poultry farming conditions and methods of animal production, there is a need to search for helpful solutions in maintaining bird welfare. Improvement of keeping conditions is not the only effective method to provide welfare and decrease the level of stress in birds. Genetic selection and changing of behaviour on the additive level are very useful tools (Mench, 1992; Craig & Swanson, 1994; Jones, 1996) which allow to adapt bird temperament to farming conditions by lowering excessive timidity and aggressiveness and thereby maintain low level of animal stress (Jones, 1996). Genetic selection may be used on the basis of reliable identification of hens temperament and appropriate classification of emotional profile. A number of studies with the use of behavioural assays have been performed to evaluate emotional reactivity in birds (Rozempolska-Rucinska *et al.*, 2017; Forkman *et al.*, 2007; Uitdehaag *et al.*, 2008b; Jones, 1996). However, the main difficulty with this method is a lack of unbiased assays. Behavioural responses of birds are complex and reactions indicating conflict of motivation may be observed. Therefore, assessment of emotions experienced by an animal may be subjective and ambiguous (Rozempolska-Rucinska *et al.*, 2017) and it is necessary to find tools by which behavioural profile of hens could objectively be defined and thereby the reliability of assessment of behaviour for breeding values would be improved.

The aim of the study was to determine emotional reactivity of hens based on measurements of physical parameters such as movement velocity and positional change of selected parts of hens body with the use of computer software, Tracker®.

MATERIAL AND METHODS

200 Rhode Island White hens kept in a system of individual cages in laying hen breeding farm were used in the study. Birds selected for the study were at the same age and NOT test was performed on the same day for each individual animal. Behavioural analysis of the hens was performed with the use of Novel Object Test (NOT), according to the method described by Forkman *et al.*, (2007) and Uitdehaag *et al.* (2008b).

The reason for choosing this test was that it reflects everyday situations that birds cope with, such as reading with a laser scanner. Therefore, it should precisely characterize reactions of hens in the inbreeding. The object used in the test was a glittering pencil moved 1 cm inside the front wall of the cage and left immobilized for 30 seconds. The test was performed on one of four cages so that birds kept in adjacent cages have no possibility of seeing the object.

Hens behaviour was video recorded with the use of a movie camera Sony HDR – CX41OVE mounted on a stand of the constant height and distance from the front of a cage. Movement of all individual birds was recorded for 30 seconds. Afterwards, the video clips were analysed for bird behavioural reactivity. On the basis of our previous studies (Rozempolska-Rucinska *et al.*, 2017) all hens were classified according to their behaviour, to the one of 6 groups: escape (34 individuals)–birds with sudden movements, attempting to go outside the cage; avoidance (35 individuals)–birds moving away from the object but without sudden movements; avoidance-approach (35 individuals)–birds with alternate reactions: approach and moving away from the object; observation (44 individuals)–birds standing in one position with minor head or torso movements, observing the object and not approaching nor distinctly moving away from the object; approach (23 individuals)–approaching to the object, heading towards the object and observing it; pecking (29 individuals)–approaching to the object with one or multiple pecking on the object. Detailed information on the test performance and classification of laying hens to a specified group was given by Rozempolska *et al.*, 2017a, 2017b.

The next step was the analysis of behavioural reactions with the use of Java-based free software, Tracker 4.95® (Brown, 2012) for motion analysis allowing determination of multiple movement parameters. Each video clip was analysed with a frame-by-frame method with step size of 20 frames which refers to an interval of 0.8 second. Position of two body control points: the upper part of the head (h) and the upper part of the tail (t) were recorded (Fig. 1). The position of the control points was defined in centimeters in the cage front plane. The position value of the point determined the vertical deviation of this point from the center line of the frame (cage) - line 0. These control points were selected as representatives due to their good visibility in each frame and replicability of selection. 37 positions of the head and tail for each bird could be determined. Before measurements calibration was done according to the cage width = 27 centimetres. As a consequence every 0.8 seconds of the point of each film is defined by:

1. vh - movement velocity of the head (centimetres per second);
2. vt - movement speed of the tail (centimetres per second);
3. yh - vertical position of the upper part of the head in regard to the central line of the cage (centimetres);
4. yt - vertical position of the upper part of the tail in regard to the central line of the cage (centimetres);
5. y-posit = yh – yt - ratio between vertical position of the head and the upper part of the tail – values below zero indicated that the position of the head was below the upper part of the tail, values above zero indicated that the head was higher than the upper part of the tail (centimetres);
6. y-ht = (yh+25cm)+(yt+25cm) - the sum of vertical positions of the head and the upper part of the tail in regard to the bottom line of the cage.

Statistical differences were estimated with the use of ANOVA with fixed terms with the least square method (GLM procedure). In the mathematical model a fixed influence of bird behavioural reaction determined in NOT was included. The preliminary analysis did not show significant influence of other behavioural factors on bird behaviour such as floor of the battery, light, bird age, therefore these factors were omitted in the final model.

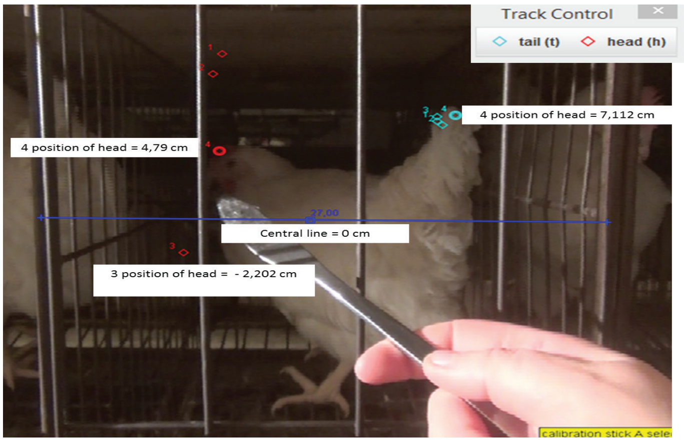

Figure 1 – Exemplary location of the analyzed control points in Tracker 4.95® software

RESULTS AND DISCUSSION

When analysing positions of the control points according to the defined hen's behavioural reaction, an interesting phenomenon was observed that the birds showed the lowest position of the head and the upper part of the tail during the escape attempt (Table 1). However, the level of reaction was not statistically different from those characteristic to pecking or approaching. This is a result of the fact that a new object stimulating the reaction was situated at the central point of the cage, that is for y-g and y-o in position 0. In consequence, birds lowered their head to that level in order to peck or observe it. The position of the head and the upper part of the tail determined at the measured behavioural reaction suggests that during escape reactions hens lower their heads. However, this kind of reaction may also be observed during the approach to the object which indicates that the bird may move its head mainly in vertical position for better recognition of the object. The highest position of the head and the upper part of the tail was observed during two reactions: avoidance and observation. These values are significantly different from those characteristic for the position during escape reaction. However, no differences in position were found in comparison to the other reactions.

Table 1 – Position of the measured parts of hen's body in regard to behavioural reactions of birds

Behavioural reaction	Position of the head		Position of the upper part of the tail		Head-tailposition ratio		Simultaneous position of the head and the tail	
	Lsm	se	lsm	Se	lsm	se	lsm	se
Escape	4.51^{a}	0.67	5.37^{a}	0.78	-0.86^{ac}	0.64	59.89^{a}	1.31
Avoidance	6.71^{bc}	0.66	5.71^{a}	0.77	1.06^{b}	0.63	62.49	1.29
Avoidance-approach	6.97^{bc}	0.66	8.77^{b}	0.77	-1.80^{a}	0.63	65.75^{b}	1.29
Observation	8.14^{b}	0.59	6.82	0.68	1.32^{bc}	0.56	64.97^{b}	1.15
Approach	5.47^{ac}	1.13	6.28	1.31	-0.80	1.08	61.76	2.20
Pecking	6.27^{ac}	0.73	6.02^{a}	0.84	0.24^{bc}	0.69	62.30	1.42

a,b - ls means within a column with no common superscripts differ significantly at $p<0.05$.

lsm - Least-Squares Means; se – standard error

The movement speed of the control points was the second analysed parameter (Table 2). An assumption was made that the higher speed of the control points the more sudden bird reactions associated with emotions such as fear or panic should be observed. Unfortunately, no unequivocal relations between the velocity of the control points movement and bird behavioural reaction were found. Although the highest movement velocity of the head was observed in birds showing escape reaction, it did not differ from pecking or approach reactions which are based on completely different emotions. Shaking or flicking with the head are characteristic reactions to all emotional profiles of birds being in a new situation, (Nicol *et al.*, 2011) however this kind of behaviour in animals facing more unfavourable environmental conditions is usually more intensive and long-lasting. It is possible that longer time of observations would enable us to find differences of movement speed of the head between birds from the groups: escaping, pecking, and approaching. Different results were obtained for movement velocity of the upper part of the tail. The highest value of this endpoint was noted for escaping birds and it was significantly different when compared to those obtained for reactions of avoidance-approach, observation, approach and pecking.

The obtained results do not provide the answer to the question, to which type of behavioural reaction birds (shown in Table 1) may be classified on the basis of the measured parameters. In other words, it is not possible to define behavioural reactions and related emotions on the basis of the position and movement velocity of the head and the upper part of the head when assuming that behavioural reactions of animals provide indirect information on emotions they experience (Desire *et al.*, 2002; Marino, 2017).

Table 2 – The movement speed of hen's body in regard to behavioural reactions of birds

Behavioural reaction	The movement speed of the head		The movement speed of the tail	
	lsm	se	lsm	se
Escape	3.39^{ac}	0.29	1.69^{a}	0.12
Avoidance	2.20^{b}	0.29	1.14	0.12
Avoidance-approach	3.73^{c}	0.29	1.46^{b}	0.12
Observation	2.10^{b}	0.26	1.01^{c}	0.11
Approach	2.96	0.50	1.21^{bc}	0.21
Pecking	2.54^{ba}	0.32	0.93^{c}	0.13

a,b - ls means within a column with no common superscripts differ significantly at $p<0.05$

lsm - Least-Squares Means; se – standard error

On the other hand, it is possible to evaluate bird behavioural profile (Table 3). Regarding that statistically significant differences of the results were found, the birds were classified into two behavioural profiles according to Rozempolska-Rucinska *et al.* (2017a, 2017b). Hens manifesting reactions such as escape, avoidance, avoidance-approach were defined as timid birds, on the other hand, the profile of curious/courageous hens included birds that were observing, approaching and pecking the object. In this case an assumption was made that behavioural reactions are indirect indication about emotions that the animals experience (Desire *et al.*, 2002). The results suggest that classification to one of the two groups of birds: timid or curious/courageous animals may be based on the three behavioural parameters.

There is a number of reports on behavioural aspects of domestic chicken such as cognition, emotion and sociality (Marino, 2017). Some authors indicated that that birds manifesting reactions linked with fear, that is escape, avoidance, avoidance-approach (Rozempolska-Rucinska *et al.*, 2017a,b) move their heads and the upper part of the tail significantly faster in comparison to birds showing reactions of curiosity and courage. A number of reports on bird welfare suggest that intensive head shaking is a good marker indicating frustration or response to distressing stimuli (Duncan, 1970; Hughes, 1983; Dunnington & Siegel, 1986; Nicol *et al.*, 2009 and 2011). However, Nicol *et al.* (2011) showed that this type of behaviour is observed in all birds that face new stressful situations and it increases in unfavourable environmental conditions. This was confirmed in the present study. It is also noteworthy that the head is significantly lowered in regard to the upper part of the tail, when a bird manifests reactions associated with fear which is opposite to reactions from the 'curious/courageous' behavioural profile. In this case the head is positioned higher than the upper part of the tail. No differences between hen profiles for the rest of the markers (positions and simultaneous positions of the measured points) were found.

Table 3 – Position and movement velocity of the control points in regard to the bird's behavioural profile

Measuredparameter	Behavioural profile			
	timid		curious/courageous	
	Lsm	se	lsm	se
Headposition	6.10	0.40	7.13	0.44
Movement speed of the head	3.11^{A}	0.18	2.37^{B}	0.20
Position of the upper part of the head	6.64	0.46	6.48	0.51
Movement speed of the upper part of the tail	1.43^{A}	0.07	1.02^{B}	0.08
Head-tailposition ratio	-0.53^{a}	0.38	0.65^{b}	0.42
Simultaneous position of the head and tail	62.74	0.77	63.61	0.85

ls means within a row with no common superscripts differ significantly at $p<0.05$ (a,b) and at $p<0.01$ (A,B)

lsm - Least-Squares Means; se – standard error

It seems that classification of hens to one of these two profiles is adequate for an effective selection towards the reduction of fear (Rozempolska-Rucinska *et al.*, 2017a,b). Performance of NOT assay followed by the analysis of movement speed of the control points such as the upper part of the head and the tail would allow to make an objective assessment of the behavioural profile and emotionality of birds. However, the appropriate classification of hens as timid or curious/courageous is a difficult task. Our earlier study in which 13000 birds were tested with NOT assay (Rozempolska-Rucinska *et al.*, 2017a,b) indicated that assessment of hen reaction may be ambiguous and may require replaying of the movie clips for several times to classify bird behaviour. Determination of bird reactions based on of the position in which control points and measuring their movement velocity is a type of unbiased assessment and may increase work effectiveness (necessary for a greater number of birds). These are the most valuable features of this type of assessment in terms of reliability of behavioural markers as a breeding value.

CONCLUSIONS

In summary, chicken behaviour has been a subject of a number of studies in the past decade, however there is a lack of new methodological approaches that would quantify this biomarker. Our study showed that Tracker® may be successfully used for precise assessment of hen's behavioural profile. This software was previously introduced to biological analysis of invertebrate behaviour by Bownik & Stępniewska (2015), however our team used it for the first time for the analysis of bird movement behaviour. Although it is not possible to determine precisely the type of avian reaction by determination of the movement, speed and position of the head and the upper part of the tail, this type of analysis allows determination of the behavioural profile. Regarding the movement velocity of the control points such as the upper part of the head and tail or position ratio between the head and the upper part of the tail it is possible to classify birds to the group of timid or curious/courageous animals. Our results suggest that this type of behavioural assessment is an adequate method of an effective selection towards the reduction of reactivity in hens, which would enable to reduce incidence of stress-induced, undesirable phenomena as pterophagy and cannibalism.

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DECLARATION OF INTEREST

There is no conflict of interest with other works.

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