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High and low feather pecking selection lines of laying hens differ in response to a judgment bias test

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ABSTRACT

Feather pecking represents a serious problem in the poultry industry that can negatively affect production as well as the welfare of laying hens. Although feather pecking has been studied from many different angles, there are only a few studies of the relationship between feather pecking and cognition. This study aims to compare the cognitive performance of hens from the high feather pecking (HFP) and the low feather pecking (LFP) lines in a visual discrimination (Go/No-Go) task and to study their decision making under ambiguity using the judgment bias test.

Twenty HFP and 20 LFP hens were trained in a visual discrimination task to approach a coloured feeder (white for half of the hens and black for the other half) containing a reward (one mealworm) and to refrain from approaching a feeder with a different colour (colour opposite to positive, *i.e.* black or white) to avoid punishment (water spraying). During the subsequent judgment bias tests hens were tested in the presence of the positive, negative or ambiguous stimulus (grey coloured feeder), always one type of stimulus at a time. The latencies to reach each of the stimuli were recorded. At the end of the visual discrimination training phase, 36 out of 40 hens successfully discriminated the positive and the negative coloured feeder. There was a slower association of the coloured feeder with the reward in the HFP line and HFP hens did not suppress the response to the negative stimulus as effective as HFP hens, which could be a sign of their high motor impulsiveness. However, in the judgment bias test HFP hens approached the ambiguous feeder significantly faster than LFP hens (HFP 13.59 $\pm$ 1.11 s, LFP 16.68 $\pm$ 1.10 s, $P < 0.05$), that can be interpreted as evidence that hens from the HFP line are more optimistic, *i.e.* that they are in a more positive affective state. The high motor impulsiveness of HFP hens provides another possible explanation for their response to the ambiguous stimulus. However, higher motor activity of the HFP line did not affect the results of the judgment bias test. Furthermore, there were no significant differences in plasma corticosterone levels between the lines, suggesting that differences in stress levels might not explain the results of the judgment bias test.

1. Introduction

Feather pecking (FP) in laying hens represents one of the major welfare issues facing the poultry industry. FP is a form of maladaptive behaviour involving pecking at and pulling out feathers of conspecifics (Savory, 1995; Rodenburg et al., 2013). It leads to feather loss resulting in denuded areas and in extreme cases to cannibalism and increased mortality. Apart from the economic consequences, FP and cannibalism are indicators of poor welfare (Bessei, 2018). Lines obtained by divergent selection of laying hens for the propensity to feather peck (high and low FP lines, HFP and LFP) provide a unique opportunity to study FP and its underlying mechanisms (Kjaer et al., 2001). The difference in severe feather pecking between the lines is more consistent than the differences in gentle feather pecking (van der Eijk et al., 2018). Gentle feather pecking seems to be more susceptible to environmental factors, such as light intensity (Kjaer and Vestergaard, 1999) and is more common,

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especially during early life (Rodenburg et al., 2004).

Although it is not clear whether stress causes FP or vice versa, these phenomena seem to be interconnected (Buitenhuis et al., 2004; de Haas et al., 2013). While according to Kjaer and Guemené (2009) the FP selection lines did not differ in their basal levels of corticosterone (CORT), or in their maximal adrenal capacity assessed by injecting ACTH, the levels of CORT after handling and restraint were higher in HFP than in LFP birds. On the other hand van der Eijk et al. (2019) did not find any differences between the FP selection lines in CORT levels after manual restraint. Although fearfulness can be challenging to measure, data from several avian species indicate that CORT responses and fear behaviour responses are linked (Janczak et al., 2006; Cockrem, 2007). While some authors reported lower fearfulness in HFP hens as compared to LFP hens (de Haas et al., 2010; van der Eijk et al., 2018), others have not found such differences (Rodenburg et al., 2010). Thus, even though the results concerning differences in stress and fearfulness between lines selected for FP are contradictory, it would be interesting to know whether these lines differ in their response to uncertainty in a judgment bias test. Animals in relatively worse conditions, assumed to generate more negative affect, show more 'pessimistic' judgments of ambiguity than those in relatively better conditions (Lagisz et al., 2020). Both unpredictable mild stress in laying hens (Zidar et al., 2018), as well as the experimental elevation of CORT levels in broiler chickens (Iyasere et al., 2017) induce pessimistic judgment bias. Pessimistic judgment bias was also found in starlings expressing stereotyped behaviour (Brilot et al., 2010). According to some authors, FP has also been described as, under certain circumstances, a form of stereotyped behaviour (Bilčík and Keeling, 1999; Kjaer et al., 2004; Rodenburg et al., 2004) which applies mainly to gentle feather pecking (Rodenburg et al., 2004). However, Kjaer et al. (2015) based on perseveration in a guessing task did not prove impaired response inhibition in the HFP line, and thus questioned the classification of FP as a stereotypy. FP is a very persistent and goal-directed behaviour with clear impulsive compulsive characteristics (van Hierden et al., 2004; van Zeeland et al., 2009; Brunberg et al., 2011; Kops et al., 2013). Heinsius et al. (2020) measured the ability of birds genetically and phenotypically selected for FP activity to inhibit a prepotent motor response. Their results did not prove a lack of behavioural inhibition in hens from the HFP line in comparison with control in a Go/No-Go task.

Since FP is considered as an indicator of negative welfare, we tested the hypothesis that the higher incidence of FP in the HFP line causes pessimistic cognitive bias as compared to the LFP line. Moreover, we used the advantage of the Go/No-Go training preceding the judgment bias test to address the hypothesis formulated by Heinsius et al. (2020) assuming that impulsive animals are unable to accurately execute inhibitory control and therefore predicting higher motor impulsivity in the HFP hens.

2. Material and methods

2.1. Animals, housing and management

Forty White Leghorn laying hens, 20 from the HFP and 20 from the LFP line (Kjaer et al., 2001) were 30 weeks old at the beginning of the experiment. Tested animals were randomly selected from five HFP and five LFP pens. Due to mortality, the group size in pens varied from four to 10 hens. All hens were individually marked with a neck tag (Roxan) with a unique number and numbered plastic backpacks.

All pens (floor area 2 m^2 per pen) were located in the same room. The floor was covered with wood shavings. Each of pens contained an elevated platform, one nest box separated from the rest of the pen by a plastic curtain, a feeder and approximately five nipple drinkers. Food and water were provided *ad libitum*. Animals were kept under the 15 L: 9D h light-dark cycle at the time of testing.

2.2. Testing arena

The custom-made plywood arena (Fig. 1) consisted of the start box (25 cm × 60 cm × 100 cm - W × D × H) separated by a guillotine door from the testing area (120 cm × 200 cm × 100 cm - W × D × H). The guillotine door was manually operated by one observer standing next to the start box. The arena was originally designed for a two-choice (left-right) test (Hernandez et al., 2015; de Haas et al., 2017). However, to avoid the strong side preference problems of this approach (de Haas et al., 2017), we decided for a straight alley test based on colour discrimination. The stimuli, feeders of three colours (white, black, grey; on a given trial only a single colour was presented), were placed in the centre of the hind wall and were surrounded by a rectangle (40 cm × 50 cm) marked on the floor with adhesive tape. The feeders (15 cm × 10 cm × 9 cm - W × D × H) were painted metal boxes with an open-top side (Fig. 1). Approach latencies, measured from the moment the guillotine door opened until the hen crossed the decision line surrounding the feeder, were recorded by the observer standing next to the start box using a stopwatch. A circular hole (5 cm in diameter) was drilled in the

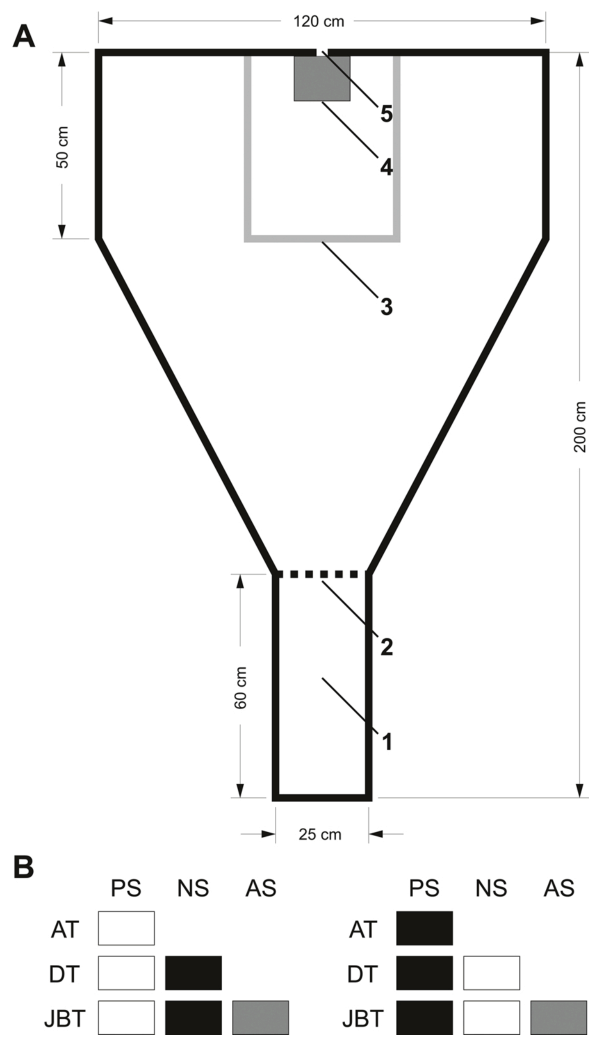

Fig. 1. A The judgment bias test arena. Arena consisted of the start box (1) separated by a guillotine door (2), the feeder (4) close to the opposite wall surrounded by the decision line (3) and the hole (5) over the feeder used for the punishment delivery (water spraying). **B** The stimuli during the association training (AT), visual discrimination training (DT) and judgment bias testing (JBT) were set for the half of the animals as follows: the white feeder as a positive stimulus (PS), the black feeder as a negative stimulus (NS) and the grey feeder as an ambiguous stimulus (AS)(left panel). For the other half of the animals, the feeder colours were used in the opposite manner (right panel).

middle of the hind wall, 30 cm above the floor. This hole allowed the second observer to punish the bird in case of an incorrect response (water spray). The second observer was situated behind the arena and monitored the hens' response using a video image from the camera mounted on the top of the hind wall.

2.3. Behavioural tests

Animals were subjected to 'pretraining', during which they were habituated to the testing arena. During the habituation, hens could move freely in the testing arena for 5 min and were provided with three mealworms, used as a reward in the following tasks, on the floor of the testing arena.

2.3.1. Association training

In the first phase of the training, hens were trained to associate the positive colour of the feeder with the reward (one mealworm). Before opening the guillotine door one mealworm was placed inside the feeder close to its front wall to make sure that hens could not see the reward before making their choice. The latency to approach the feeder was measured as the time elapsed from the door opening until the hen crossed the decision line with both feet. In case that the animal did not approach the feeder within the 30 s period, it was gently returned to the start box. In that case, the maximum latency (30 s) was assigned for the trial, and the procedure was repeated. Each animal was subjected to eight trials per session. For 10 HFP hens and 10 LFP hens, the white feeder represented the positive stimulus (PS), while for the other 10 HFP hens and 10 LFP hens it was the black feeder. Each hen was subjected to one session of 8 trials per day with only the PS present. To reach the training criterion each hen was required to approach at least 75 % of presented PS (trials) on three consecutive days (sessions). Hens were subjected to 4 association training sessions in total.

2.3.2. Visual discrimination training (Go/No-Go task)

After the establishment of an association between the PS and reward, hens were trained on the visual discrimination task. For those HFP and LFP hens trained previously to associate the white feeder (PS) with the reward (mealworm), the black feeder was introduced as the negative stimulus (NS), approach to which was punished (water spraying). For the other half of HFP and LFP hens trained to associate the black feeder with the reward (PS), the white feeder was introduced as the NS. Within each session, animals were exposed to four PS and four NS in random order. The maximum latency within each trial was 30 s. Each hen was subjected to one training session of 8 trials per day. The discrimination criterion was to approach more than 75 % of PS and less than 25 % of NS within one session on three consecutive days. After reaching this criterion hens proceeded to the next stage, the judgment bias test. Hens were subjected to 10 Go/No-Go sessions in total.

2.3.3. Judgment bias test

In the judgment bias test, in addition to the PS and NS already familiar to hens from the previous visual discrimination task, the new ambiguous stimulus (AS), a feeder with the intermediate colour (grey), was introduced. The four PS, four NS and two AS per session were presented in random order. The maximum latency to approach the presented stimulus was again 30 s. Approaching the PS was rewarded, approaching the NS was punished, and approaching the AS was neither rewarded nor punished. Latency measurement was the same as in the case of the visual discrimination task. The optimistic-like responses were indicated by a shorter latency to approach the AS and on the contrary, the pessimistic-like responses were indicated by a longer latency to approach the AS. Hens were subjected to 3 judgment bias tests (sessions).

2.4. Activity in the home pen

General activity of hens in home pens (i. e. pens where animals were kept during the entire experiment) was coded from video recordings. The camera located above the door of each home pen provided a view of the whole pen including litter area, feeder, drinker, elevated platform, but excluding the nest box. The behaviour of hens was recorded during three consecutive weeks (27, 28 and 29 weeks of age) during weekends, one hour in the morning (10:00 h – 11:00 h) and one hour in the afternoon (14:00 h – 15:00 h).

Scan sampling was used to obtain individual time budgets. Only two categories of behaviour were classified - locomotor activity (animals moving from one place to another including walking, running, jumping or flying), and resting behaviour (sitting calmly in the home pen with head hidden under the wing or with closed or open eyes without performing any other activity). Behaviour was recorded every 10 min and the proportions of time spent in these behaviours were calculated from the data (the number of scans engaged in each behaviour divided by the total number of scans).

2.5. Plasma corticosterone

Blood samples (3 mL) were taken from the wing vein 10 min after the 5-minute long manual restraint at the age of 25 weeks (see van der Eijk et al. (2019) for the method). CORT analysis was carried out at the Adaptation Physiology Group, WUR, Wageningen.

Blood samples were centrifuged at 21 °C for six minutes at 2095 x g to obtain plasma and stored at −20 °C until the analyses. The concentration of CORT was estimated in 300 μl of plasma using the radioimmunoassay kit (MP Biomedicals, LLC, Orangeburg, USA), as described by Buyse et al. (1987).

2.6. Data analysis

All analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Statistical analyses of behavioural latencies data from the association training, visual discrimination training and judgment bias tests were performed using survival analysis (Budaev, 1997; Jahn-Eimermacher et al., 2011; Gygax, 2014), because of a high incidence of the right-censored data (censored observations were trials in which hens did not approach the feeder before the fixed end of observation at 30 s). Latencies to approach positive stimulus across all sessions of association training were analysed using the SAS procedure LIFETEST. Line (HFP *vs.* LFP) was specified in the STRATA statement, and the session was included as a covariate in the TEST statement. The same approach was used for the analysis of latencies to approach positive and negative stimuli (each stimulus separately) in visual discrimination training, and positive, negative and ambiguous stimuli in judgment bias tests.

The activity and resting in the home pen data were analysed using the procedure GLIMMIX. The fixed factors were line (HFP, LFP), test week (27, 28 and 29) and time of day (morning, afternoon). The Tukey-Kramer adjustment was applied for the post-hoc analyses.

CORT levels were log-transformed to obtain a normal distribution and a comparison between lines (HFP, LFP) was made using the TTEST procedure in SAS.

2.7. Ethical approval

The experiment was approved by the Central Authority for Scientific Procedures on Animals according to Dutch law (N^{o}: AVD104002015150).

3. Results

3.1. Behavioural tests

3.1.1. Association training

The LFP hens approached the PS faster than the HFP hens (Table 1), as shown by the survival analysis of the latencies data from 4 association training sessions (log-rank = 27.71, $P < 0.001$, Fig. 2). There was a significant effect of the session on the latency to approach the PS (log-rank = 87.45, $P < 0.001$), reflecting decreasing latencies with four progressing sessions of association training.

3.1.2. Visual discrimination training (Go/No-Go task)

The approach latencies to the PS during the visual discrimination training (Go/No-Go task) did not differ between the lines (pooled data from 10 discrimination training sessions; log-rank = 0.84, n.s.; Table 1, Fig. 3 top). There was a significant effect of the session on the latencies to approach the PS (log-rank = 201.9, $P < 0.001$), revealing decreasing latencies to approach PS with progressing sessions. The HFP hens approached the NS during the discrimination training faster than the LFP hens (Table 1), as indicated by the Kaplan-Meier plot of the latencies (log-rank = 44.27, $P < 0.001$, Fig. 3 bottom). There was a significant effect of the session on the latency to approach the NS (log-rank = 240.8, $P < 0.001$), indicating increasing latencies to approach NS with progressing sessions of discrimination training. At the end of the discrimination training phase, 36 out of 40 hens reached the discrimination criterion and proceeded to the next stage or tests, the judgment bias test.

3.1.3. Judgment bias test

The latencies to approach the PS during the judgment bias tests did not differ between the lines (pooled data from 3 sessions; log-rank = 0.59, n.s.; Table 1, Fig. 4 top). The hens from the HFP line approached the AS (log-rank = 4.49, $P < 0.05$; Table 1, Fig. 4 middle), and the NS (log-rank = 11.32, $P < 0.001$; Table 1, Fig. 4 bottom) with the shorter latencies than the LFP line hens. There was not a significant effect of the session on the latencies to approach the AS (log-rank = 0.35, n.s.).

3.2. Activity in the home pen

There was a significant effect of line on proportion of time spent by locomotor activity in the home pen ($F_{1, 204} = 15.58$, $P < 0.001$), with the HFP line being more active (HFP 0.21 ± 0.03, LFP = 0.09 ± 0.02) (Fig. 5). Time of day effect was also significant ($F_{1, 204} = 4.01$, $P < 0.05$) with higher activity in the morning as compared with the afternoon activity. There was no significant effect of the testing week or interactions between the factors. The only significant factor affecting proportion of time spent resting was line ($F_{1,204} = 31.52$, $P < 0.001$) with the LFP (0.25 ± 0.04) line resting more than the HFP line (0.05 ± 0.02) (Fig. 5). However, the mean proportion of time spent by locomotor activity in all observed periods did not correlate with the mean approach latencies to any of the stimuli, *i.e.* the activity levels did not affect the performance in the judgment bias test.

Table 1
Latency to approach stimuli during the association training, visual discrimination training and judgment bias tests by hens from the high feather pecking (HFP) and the low feather pecking (LFP) line. Data represent mean ± SEM. PS – positive stimulus, AS – ambiguous stimulus, NS – negative stimulus.

		Latency (s)		Chi-square for the log-rank test	P
		HFP	LFP		
Association training	PS	10.50 ± 0.38	7.76 ± 0.21	27.71	<0.001
Discrimination training	PS	5.46 ± 0.18	5.53 ± 0.17	0.84	ns
	NS	23.76 ± 0.38	26.53 ± 0.27	44.27	<0.001
Judgment bias test	PS	3.18 ± 0.09	3.08 ± 0.09	0.59	ns
	AS	13.59 ± 1.11	16.68 ± 1.10	4.49	<0.05
	NS	28.06 ± 0.40	29.35 ± 0.22	11.32	<0.001

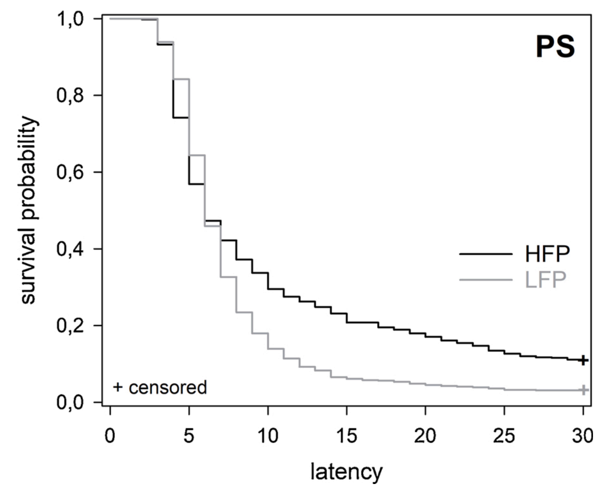

Fig. 2. Kaplan–Meier plots of the latencies to approach the positive stimulus (PS) by HFP and LFP hens during association training. The plot contains pooled latency data from the 4 sessions. Every time a hen approached the stimulus (coloured feeder) the proportion of trials in which hens failed to approach the stimulus on the Y-axis drops. The effect of the line was significant (log-rank test $P < 0.001$).

3.3. Plasma corticosterone

The analysis of blood samples did not reveal any effect of line on plasma CORT (HFP = 3.59 ± 0.33 ng/mL, LFP = 3.80 ± 0.43 ng/mL).

4. Discussion

The main objective of this study was to test the hypothesis that the higher incidence of FP in the HFP line (see Supplementary data) causes pessimistic cognitive bias as compared to the LFP line. Unexpectedly, our results showed that HFP hens had shorter latencies to approach the ambiguous stimulus (probe) than LFP hens that could be interpreted as a sign of an optimistic bias. Nevertheless, the faster approach to the AS can be also interpreted as a result of the higher impulsivity of the HFP hens. This is in agreement with our second finding, showing that HFP hens were more impulsive in their responses, as indicated by the shorter latencies to approach to the NS in the Go/No-Go task as well as in the judgment bias test, although this response was punished. Yet, the performance in the judgment bias test was not affected by the higher motor activity of the HFP line.

Our knowledge of the relationship between feather pecking and cognitive abilities of laying hens is very limited. An interesting hypothesis linking cognitive performance and feather pecking was formulated recently by Heinsius et al. (2020). They tested whether the HFP line exhibits higher motor impulsivity since according to some authors SFP is a very persistent behaviour with impulsive compulsive characteristics (van Hierden et al., 2004; Brunberg et al., 2011; Kops et al., 2013). Heinsius et al. (2020) used the Go/No-Go task to measure the ability of birds genetically and phenotypically selected for FP activity to inhibit a prepotent motor response. Nevertheless, they did not prove the higher motor impulsivity of HFP hens as compared to control hens. Both were similarly able to inhibit pecking behaviour towards a visual cue in the operant chamber. The motor impulsivity was measured as the number of pre-cue responses (pecks) and the percentage of pecks

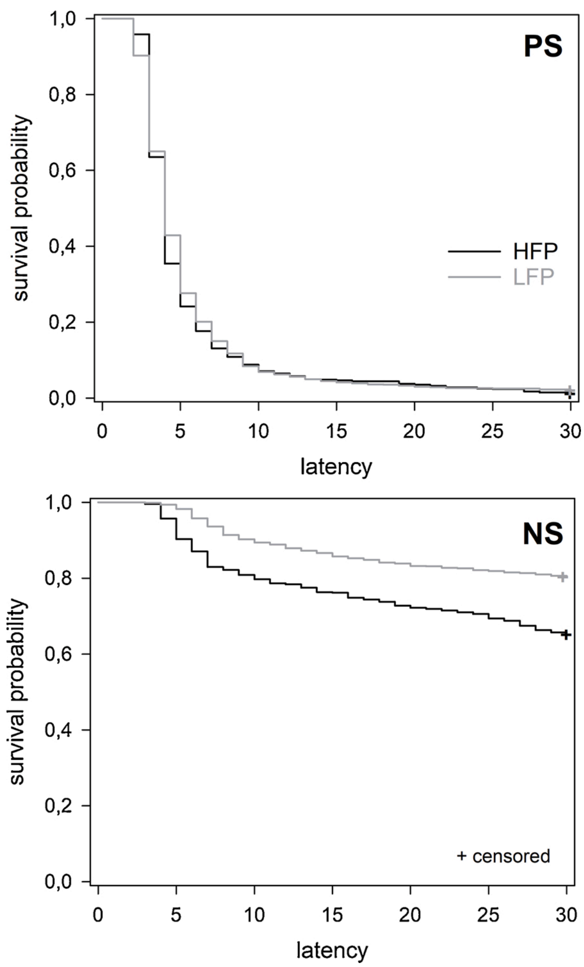

Fig. 3. Kaplan–Meier plots of the latencies to approach the positive stimulus (PS) and the negative stimulus (NS) by HFP and LFP hens during visual discrimination training (Go/No-Go task). The plots contain pooled latency data from the 10 sessions. Every time a hen approached the stimulus (coloured feeder) the proportion of trials in which hens failed to approach the stimulus on the Y-axis drops. The effect of the line on the latencies to approach the PS was not significant, while to approach the NS it was significant (log-rank test $P < 0.001$).

in response to the No-Go cue. On the other side, our visual discrimination (Go/No-Go) data seem to support their hypothesis that HFP hens exhibit higher motor impulsivity. The LFP hens more affectively inhibited the response to punished negative stimulus in both discrimination training and judgment bias test than HFP hens.

de Haas et al. (2010) observed in both FP lines that if the birds had a choice between four different food items offered to them (food-pellets, feathers, grass, and mealworms hidden in wood-shavings) they showed a strong preference for mealworms and spent most of the time actively foraging worms. Whereas both lines found mealworms reinforcing, HFP birds ate worms faster and tended to have more worm-eating bouts than LFP birds. This strong food motivation could also be responsible for the tendency of HFP hens to approach the NS in our study, even though such an approach was punished.

Several authors interpreted the behavioural differences between the HFP and LFP line in terms of the coping style paradigm (Koolhaas et al., 1999; Sih et al., 2004; Koolhaas et al., 2010). Although it was not carried out at lines selected directly for FP, these works connected higher performance of FP with proactive coping style while birds with lower performance of FP have a reactive coping style (Korte et al., 1997; Rodenburg et al., 2004). Reactive copers are more flexible in their behaviour and react strongly to environmental stimuli. In contrast, the

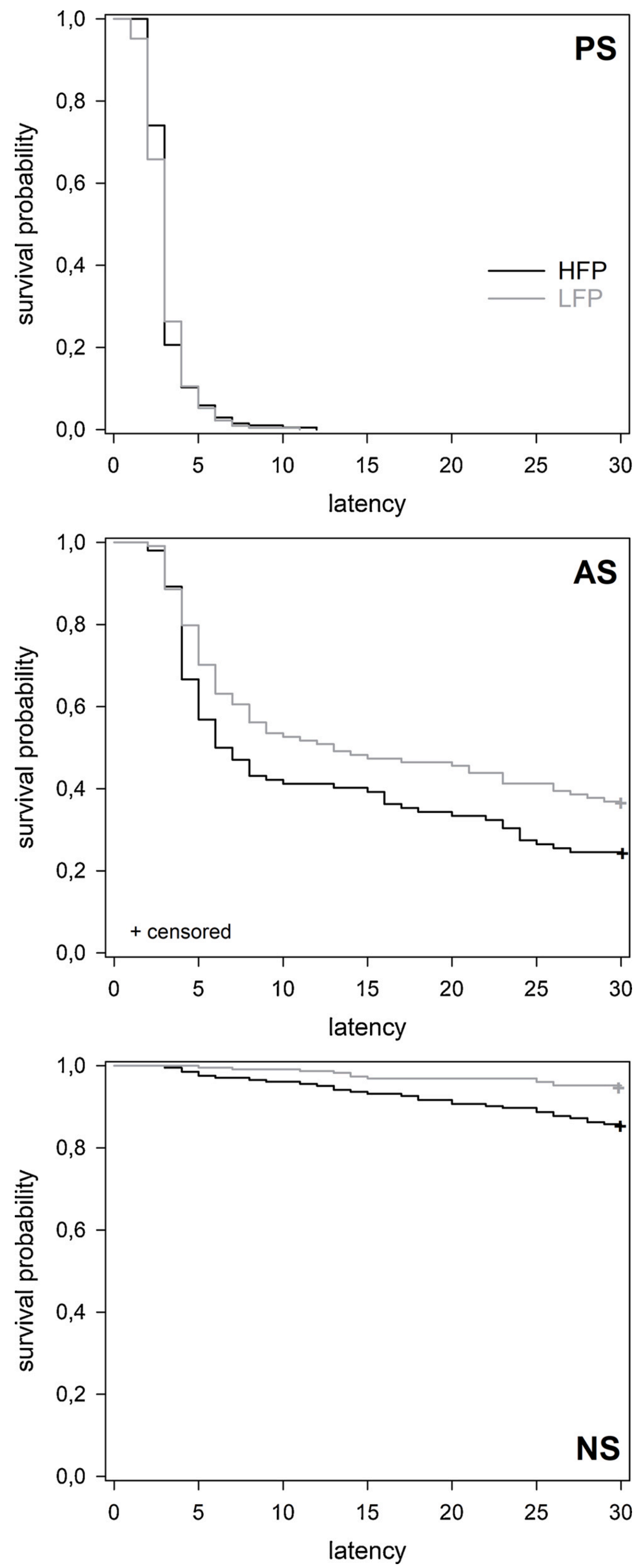

Fig. 4. Kaplan–Meier plots of the latencies to approach the positive stimulus (PS), the ambiguous stimulus (AS) and the negative stimulus (NS) by HFP and LFP hens during the judgment bias tests. The plots contain pooled latency data from the 3 sessions. Every time a hen approached the stimulus (coloured feeder) the proportion of trials in which hens failed to approach the stimulus on the Y-axis drops. The latencies to approach the PS did not differ between lines, while there was a significant effect of line on latencies to approach the AS (log-rank test $P < 0.05$), as well as the NS (log-rank test $P < 0.001$).

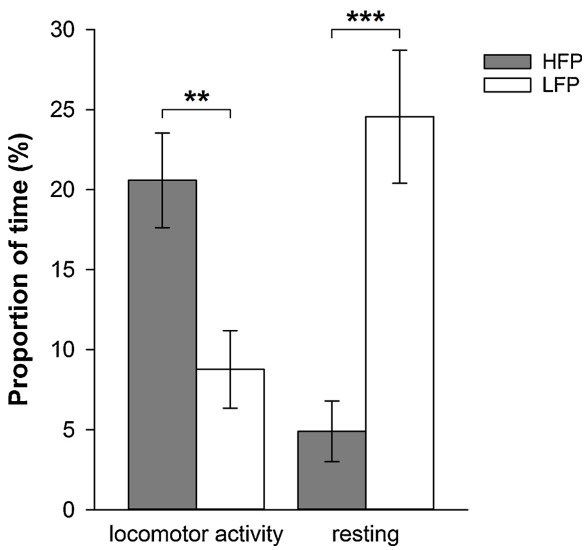

Fig. 5. Mean proportion of time spent by high feather pecking (HFP) and low feather pecking (LFP) line hens by locomotor activity and resting in the home pen as measured on three consecutive weeks (27, 28 and 29 weeks of age), one hour in the morning (10:00 h – 11:00 h) and one hour in the afternoon (14:00 h – 15:00 h). Data represent mean ± SEM.

behaviour of proactive copers is less guided by environmental stimuli and more by internal mechanisms, thus they are less flexible in coping with changes in their environment and easily form routines (Koolhaas et al., 1999; van Hierden et al., 2002). Coping styles or variation in personality are also related to variation in cognition (Sih and Del Giudice, 2012). These hypotheses are based on a connection between fast-slow behavioural types (*e.g.* boldness, aggressiveness, exploration tendency) and cognitive speed *vs*. accuracy trade-offs, ecologically important aspects of decision-making including impulsivity, risk sensitivity and choosiness.

de Haas et al. (2017) showed that the personality traits of laying hens are related to their cognitive performance. In a two-choice association task (left-right choice based on visual cues in the arena identical to that used in this paper), hens which showed a passive personality type were better at learning compared to hens which showed a more proactive personality type. So, if we accept that the HFP line represents a proactive and the LFP line a reactive coping style, de Haas et al. (2017) results agree with our results showing better cognitive performance in LFP hens. In support of this statement is also the fact that out of 40 hens involved in our experiment only four did not pass the criterion of successful visual discrimination training and were not included in the subsequent judgment bias tests. Out of those four hens, one was from the LFP line while the remaining three were from the HFP line. According to Sih and Del Giudice (2012), proactive behavioural types are associated not only with impulsiveness (speed over accuracy) but also with persistence. When deciding when to quit an option, proactive animals are relatively insensitive to change (ignore the losses), and instead, follow set routines sometimes long after an option is no longer rewarding. Our results suggest such persistence in the HFP hens showing slower learning to avoid punishment associated with the NS during the visual discrimination training.

Using the judgment bias tests we found that HFP hens showed positive bias in response to the probe (the ambiguous colour cue) as indicated by shorter latency to approach this cue. This could be interpreted as a result of a more positive affective states or optimistic judgment bias in HFP hens as compared to LFP hens. The link between positive affect, well-being and proactive coping has also been shown in humans (Greenglass and Fiksenbaum, 2009). At first sight surprising more positive affective states in the HFP hens indicating their higher welfare status correspond also with the lower fearfulness in this line as compared with the LFP line observed by several authors (Bögelein et al., 2014; Kops et al., 2017; van der Eijk et al., 2018).

We did not find any differences in plasma CORT between the lines divergently selected for FP behaviour. That is in agreement with the results of van der Eijk et al. (2019), who did not find any differences between the FP lines in CORT levels after manual restraint. However, Kjaer and Guémené (2009) found that the CORT reactivity of HFP birds to handling and restraint was higher than the reactivity of LFP birds. Using two commercial lines of laying hens differing in their propensity to FP it was shown that plasma CORT levels in low feather peckers were significantly higher during both resting conditions and restraint as compared to high feather peckers (Korte et al., 1997; van Hierden et al., 2002). Such higher CORT in the low FP hens taken together with the ‘pessimistic’ judgment bias observed in chickens treated with CORT (Iyasere et al., 2017) could be a possible explanation of the pessimistic bias in LFP birds observed here.

Another possible explanation of the cognitive bias reported in this paper can be the already mentioned persistence associated with a proactive coping style which can be manifested by insensitivity to change. This persistence can be responsible not only for the continued approach towards the NS, ignoring punishment in the visual discrimination task, but also their positively biased response to an ambiguous cue in the judgment bias tests. According to Sih and Del Giudice (2012), proactive individuals are more likely to be a victim of a cognitive bias due to over-persistence, a tendency to stick with an option even after it is no longer optimal. Such proactive persistence through a string of losses is not necessarily maladaptive. If the signals from the environment are noisy or if the environment changes frequently, a few losses are not good indicators of future losses. Then ‘over-persistence’ in the short-term can be adaptive in the long-term (Sih and Del Giudice, 2012).

Our result proved the hens from the HFP line spent a larger proportion of time by locomotor activity than hens from the LFP line. Higher general activity of HFP hens is well documented in the literature (Kjaer, 2009; de Haas et al., 2010). HFP animals also show higher explorative pecking in a new environment (de Haas et al., 2010). There is a question whether the higher motor activity of HFP birds could affect their performance in the judgment bias test. To exclude the option that the judgment bias was affected by the activity levels, Harding et al. (2004) compared activity levels of the treatment groups of rats using in hole-board test and found no differences. Mendl et al. (2009) further developed this idea and suggested that the general activity effects would likely consistently influence response to all stimuli that require active behaviour, not only responses to ambiguous probe stimulus. In our experiment, the proportion of time spent by motor activity did not correlate with the latencies to approach the PS, NS or AS.

5. Conclusions

The present study aimed to compare the cognitive performance of laying hens from lines selected for a high (HFP) or a low (LFP) feather pecking propensity. We found that the hens from the LFP line showed a faster association between the feeder colour and the reward. They also mastered the visual discrimination task quicker. The shorter latencies to approach the negative colour feeder by HFP hens in comparison with LFP hens during visual discrimination training judgment bias test could reflect higher impulsivity of HFP hens. The shorter latency to approach ambiguous feeder (3 s) can be interpreted as positive cognitive bias, proving the link between positive affect, well-being and proactive coping style. Another possible interpretation is motor impulsivity or over-persistence in responses that fits also with the results of the Go/No Go tests. We showed that HFP hens spent a higher proportion of time in the home pen by the locomotor activity and a lower proportion of time by resting than LFP hens. However, activity levels did not correlate with the latencies of responses to any of the stimuli in the judgment bias test and plasma CORT levels were similar for HFP and LFP hens, suggesting activity and stress levels might not explain differences in judgment bias.

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.applanim.2021.105305.

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