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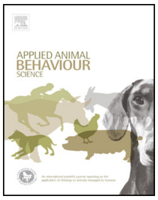

Nest choice in laying hens: Effects of nest partitions and social status

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ABSTRACT

Nest choice in loose-housed laying hens is influenced by nest characteristics, position and social factors. We examined the relative preference of laying hens for two group-nests differing in the presence or absence of a partition in the middle of the nest and whether this was influenced by social status. We hypothesized that hens would prefer the partitioned nest as it provides more enclosure, and that social status would affect nest choice.

Relative preference for the nests was assessed in a free choice preference test conducted in two consecutive trials each with eight groups of 20 hens from 18 to 31 weeks of age. The hens were individually marked and had access to two commercial group-nests (49 × 114 cm), one of which contained an internal wooden partition (30 × 10 cm) which divided the nest in two halves. At 28 weeks of age, the position of the nests was switched. The number of eggs laid was recorded daily. On one day each at 24 and 28 weeks of age (after the nest switch) video recordings were made of the first 5 h of daylight. From these videos we recorded the number of nest visits per egg per nest and the number of nest visits for individual hens. On one day each at 24 and 27 weeks of age we also recorded videos from within the nests to assess individual nest choice for egg-laying. In addition, we recorded aggressive interactions between individual hens during the first hour of light on one day each at 18, 24 and 27 weeks of age to establish social status.

We found a relative preference for the partition nest with a greater proportion of eggs laid in these nests as well as fewer nest visits per egg. The hens were also consistent in their egg-laying location over the two days of observation. After the nest switch, however, the hens did not switch egg laying location and the number of visits per egg no longer differed between nests suggesting that the preference for the partitioned nest was only important at the beginning of lay. In addition, although social rank had no impact on preference of nest type, lower ranking hens performed more nest visits and laid their eggs slightly later on the second observation day (week 27 of age) compared with higher ranking hens. Therefore, the use of partitions could improve the attractiveness of group-nests.

1. Introduction

Non-cage systems for laying hens utilize the motivation of hens to lay their eggs in an enclosed area in order to allow automatic egg collection. To ensure a working system, attractive nests must be provided to avoid floor eggs and to improve animal welfare by allowing hens to perform highly motivated pre-laying behaviour (Cooper and Appleby, 1995; Duncan and Kite, 1989; Kruschwitz et al., 2008a). The attractiveness of a nest is influenced by various factors including physical characteristics such as amount of enclosure and floor type (Duncan and Kite, 1989; Kruschwitz et al., 2008b; Stämpfli et al., 2011), position (Huber-Eicher, 2004; Lentfer et al., 2011; Riber and Nielsen, 2013) and presence of other hens (Riber, 2010, 2012). Individual hen factors such as hormonal status, age, and social rank are likely to play a role as well.

In response to the current industry trend of increasing the area of group-nests due to economic reasons, we compared two group-nests differing in size (0.43 m^2 vs. 0.86 m^2) in a previous study and found that hens laid more eggs and performed fewer nest visits per egg in the smaller nests (Ringgenberg et al., 2014a). When comparing the number of visits per egg per nest in a preference test, the nest with the fewest visits per egg is considered to be more attractive

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as more of its visits result in egg-laying. Although small group-nests are attractive to hens, in large aviaries such nests may be associated with an increased risk of overcrowding in preferred locations like the ends of nest rows (Clausen and Riber, 2012; Lentfer et al., 2013; Niebuhr, 2007; Riber and Nielsen, 2013). An alternative to smaller nests would be to partition larger nests internally into smaller areas, thereby increasing nest attractiveness without promoting overcrowding.

The use of partitions in nests has not been investigated before but Duncan (1978) reported that feral hens had their nest sites well concealed, mostly utilizing a vegetative cover. Knowing that hens are highly motivated to lay their eggs in an enclosed area (Appleby and McRae, 1986; Zupan et al., 2008), we hypothesized that a central partition in a large nest would increase nest attractiveness.

Pre-laying behaviour and nest site selection are also affected by social factors, including the presence of hens (Riber, 2012), the identity of those hens (Ringgenberg et al., 2014a), and their relative social status (Freire et al., 1998). There are however conflicting results on whether social status affects nest site choice; i.e. whether higher ranking hens have preferential access to the most attractive nesting locations (Freire et al., 1998; Rietveld-Piepers et al., 1985). Social status affects priority access to other resources such as feed (Banks et al., 1979; Collias and Collias, 1967) and space (Keeling and Duncan, 1989; Odén et al., 2004) and we hypothesized that if there was a preferred nest, social status would affect nest choice.

We used a free choice preference test to assess relative preference among two group-nests, differing only in the presence or absence of a partition, and to examine the pre-laying behaviour of hens kept in small groups. Furthermore, we explored the social status of the hens, using David's score (David, 1987), in terms of nest choice and timing of egg-laying. We expected hens to show a relative preference for nests offering a greater degree of enclosure and some structural complexity, i.e., the partitioned nest. We also expected that hens with a higher social rank would lay more eggs in the preferred nests and would perform fewer nest visits than subordinate hens.

2. Materials and methods

2.1. Animals, housing and treatments

The Cantonal Veterinary Office approved this experiment (Bern, Switzerland, Approval BE27/13) and we followed the ethical guidelines of the International Society of Applied Ethology. The experiment was conducted over two consecutive trials, the first conducted from May to August 2013 and the second from September to December 2013. For each trial, 160 LSL non beak-trimmed laying hens were reared in one group with ad libitum access to water, feed, perches and sawdust bedding from 0 to 17 weeks of age. At 18 weeks of age, the birds were moved into the experimental barn and randomly assigned to eight pens in groups of 20 animals. The hens were individually marked with numbered PVC plates (8 × 6 cm) mounted on the back of the hens with two straps that went under the wings (as in Harlander Matauschek et al., 2010). Daigle et al. (2012) studied the behaviour of hens outfitted with similarly mounted sensors and found that aggressive interactions were not affected and that the hens habituated to the tags within two weeks in terms of resource use.

The pens were arranged in rows (two rows of three pens and one row of two pens) and were identical in size (3 m × 3 m) with sawdust bedding, three perches and ad libitum access to feed and water. To prevent seasonal effects of daylight, only artificial light was provided. At 18 weeks of age, the hens had 10 h of light from 6:30 to 16:30 h with a 15 min twilight phase at the beginning and end of the day. Light exposure was then gradually increased by 30 min each week until 15 h of light was reached at week 28 of age (1:30 to 16:30 h); the photoperiod then remained constant for the remainder of the study (until week 33 of age). The mean temperature was 21.3 ± 4.5 °C in the first trial and 16.1 ± 1.9 °C in the second trial. After the experiment, the hens were sold to local farmers.

The hens had unrestricted access to two commercial group-nests (0.56 m^2) positioned across from each other on either side of the pen door (Fig. 1). The nest positions (left or right of the door) were balanced across pen and trial. The nests were identical with the exception that the partition nest contained a wooden partition 10 cm high and 1 cm wide in the middle of the nest (Fig. 1). The partition was only 10 cm high in order for the hens to be able to move over the partition. The nests were of a rollaway type with a green Astroturf® covered floor sloping towards the front, allowing for manual egg collection underneath the nest entry platform. The nests were closed at the front with a plastic red curtain with two openings (width = 24 cm, height = 30 cm). The outer appearance of the nests was identical. The small width of the partition only marginally affected the actual surface area and volume of the two nest types (0.54% less surface area and 0.1% less volume in the partition nest compared to the control).

During week 28 of age, after the hens had been in full lay for four weeks, we switched the position of the nests in order to determine if hens would follow their preferred nest for egg-laying. In order to control for the effect of the nest vs. the partition, we swapped only the partition in half of the pens and the entire nest in the other half of the pens.

2.2. Data collection

The number of eggs per nest was recorded daily for the entirety of the experiment. A digital video camera (Samsung SCO-2080R) was located above each pen to provide a complete view of the nest exterior and surrounding floor; two infra-red video cameras (Conrad, BP258IR) were mounted in each nest.

Videos inside of the nests were taken on one day during week 24 of age and on one day during week 27 of age. Using continuous recording and focal animal sampling, we determined the timing of egg-laying of individual hens before possible disturbances associated with the nest switch.

Videos of the pen surroundings were taken on one day during week 24 of age and on one day during week 28 of age (after the nest switch). Using continuous recording and focal animal sampling, the number of nest visits of individual hens was assessed during the first 5 h of daylight (Table 1). Based on these observations, we further calculated the number of nest visits per egg for each nest (total number of visits per day/number of eggs per day) and the mean number of nest visits per hen per day.

To assess the relative social status of individual hens, we used continuous recording and focal animal sampling for the first hour

Table 1
Ethogram of behaviours recorded for individual hens (adapted from Cordiner and Savory, 2001; Lentfer et al., 2011; O'Connor et al., 2011; Struelens et al., 2005).

Behaviour	Definition
Enter nest	Hen enters the nest, whereby the head and at least one foot are inside the nest
Exit nest	Hen moves out of the nest, whereby the head and at least one foot are outside of the nest
Aggressive interaction[a]	Rapid peck(s) between two hens, the retreating hen was defined as the loser of the interaction

[a] If there was no clear winner, the interaction was recorded but not used to calculate the David's score.

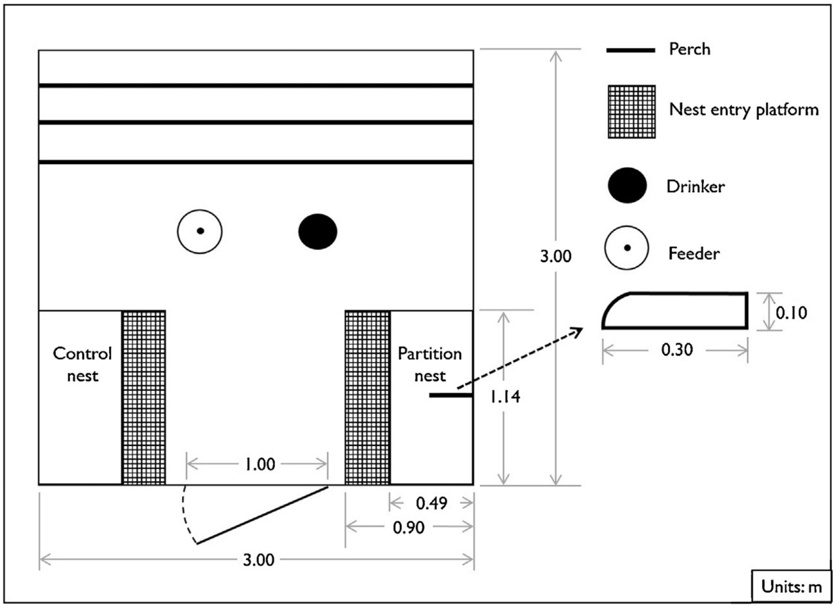

Fig. 1. Top view of an experimental pen for a group of 20 hens and cross section of the partition. Height of nest entry platform: 0.70 m; height of perches: 0.60, 1.30, 1.60 m.

after lights-on on three separate days: the second day after the hens were moved to the experimental pens during week 18 of age (to allow for some time to become accustomed to the backpacks), and one day each within weeks 24 and 27 of age. All aggressive interactions between hens were observed during that time (Table 1), in a similar manner to other authors who have assessed the social status of hens in small groups (Cordiner and Savory, 2001; Freire et al., 1998; O'Connor et al., 2011; Schütz and Jensen, 2001). Based on these observations, a David's score was calculated for each hen using SOCPROG 2.5 (Whitehead, 2009). The following formula is used to calculate David's score (DS) for each group member:

$$DS = w + w_2 - l - l_2$$

where w represents the sum of an individual's proportion of wins against each opponent, w_2 represents the sum of w values weighted by the proportion of wins of each opponent, and correspondingly for l and l_2 which represent the sum of losses (David, 1987; Gammell et al., 2003). Unlike other methods, this score takes the relative success of the opponent into account when determining the overall success of an individual (Gammell et al., 2003). The David's score has previously been used in studies on laying hens (O'Connor et al., 2011; Riedstra et al., 2013) as well as other birds (ex. Aplin et al., 2013; Bonisoli-Alquati et al., 2011). No assumptions of a linear hierarchy were made and hens were categorized using the David's score as either high (>0.5 × SD), medium (0.5 to −0.5 × SD) or low (<−0.5 × SD) ranking (as in Markham et al., 2014).

All behavioural data were viewed and analysed with the behavioural observation software package INTERACT (Mangold International GmbH, 2011, Version 9, Arnstorf, Germany). The observer (N.R.) was blind to nest type when analyzing pen videos as the nests looked identical from the outside. For the egg collection and analysis of videos inside the nests blinding was not possible as the partition was clearly visible.

2.3. Statistics

We performed all statistical analyses with R Studio (version 0.98.507, Racine, 2012) as the user interface for R (version 3.0.1, R Development Core Team, 2012). Our primary outcome variable to assess relative nest preference was the proportion of eggs laid per nest per week. The secondary outcome variables were the number of visits per egg, the number of nest visits per hen, the number of hens observed laying eggs in the nests, the timing of egg-laying and the number of aggressive interactions.

To verify normal distribution of errors and homogeneity of variance, we examined plots of residual quantiles vs. quantiles of a normal distribution, the Tukey-Ascombe plot (residuals vs. estimates) and a histogram of the residuals. To satisfy these assumptions, data on the number of nest visits per egg were log-transformed. *F*-test statistics were used for models with normally distributed errors and likelihood-ratio tests were used for models based on the binomial distribution.

The mean proportion of eggs per week was analysed from week 21 of age (50% production) to the end of the experiment (week 31 of age). A linear mixed effects model was fitted to the egg data with the function lme from the R package nlme (Pinheiro et al., 2013). Given that the distribution of eggs in the two nests was not independent, the outcome variable was the proportion of eggs in one nest minus 0.5 in order to test if it differed from zero, the null hypothesis being that the proportion of eggs in that nest did not differ from 0.5. To test the effect of the nest switch, phase (before switch, after switch) was included in the model as a fixed effect. The random term was pen nested in trial. The function stepAIC from the R package MASS (Venables and Ripley, 2002) was used to perform automatic stepwise backward model selection with Akaike's information criterion.

The mean number of nest visits per egg in weeks 24 and 28 of age was analysed with the function lme and model selection was performed as above. The random terms were pen nested in trial. Fixed terms were nest, week of age and nest switch phase as well as all two way interactions (except nest switch:week of age). The timing of egg-laying and the number of nest visits per hen during weeks 24 and 27 of age was also analysed as above. The random term was hen nested in pen nested in trial. The fixed terms were social rank, week of age, and their two-way interaction.

The number of hens observed laying their eggs in the nests at 24 and 27 weeks of age was analysed with a generalized mixed effects model with a binomial distribution (logit link function) with the function glmer from the R package lme4 (Bates et al., 2013). The random terms were trial, pen and an observation level term to control for overdispersion. Model selection was performed manually

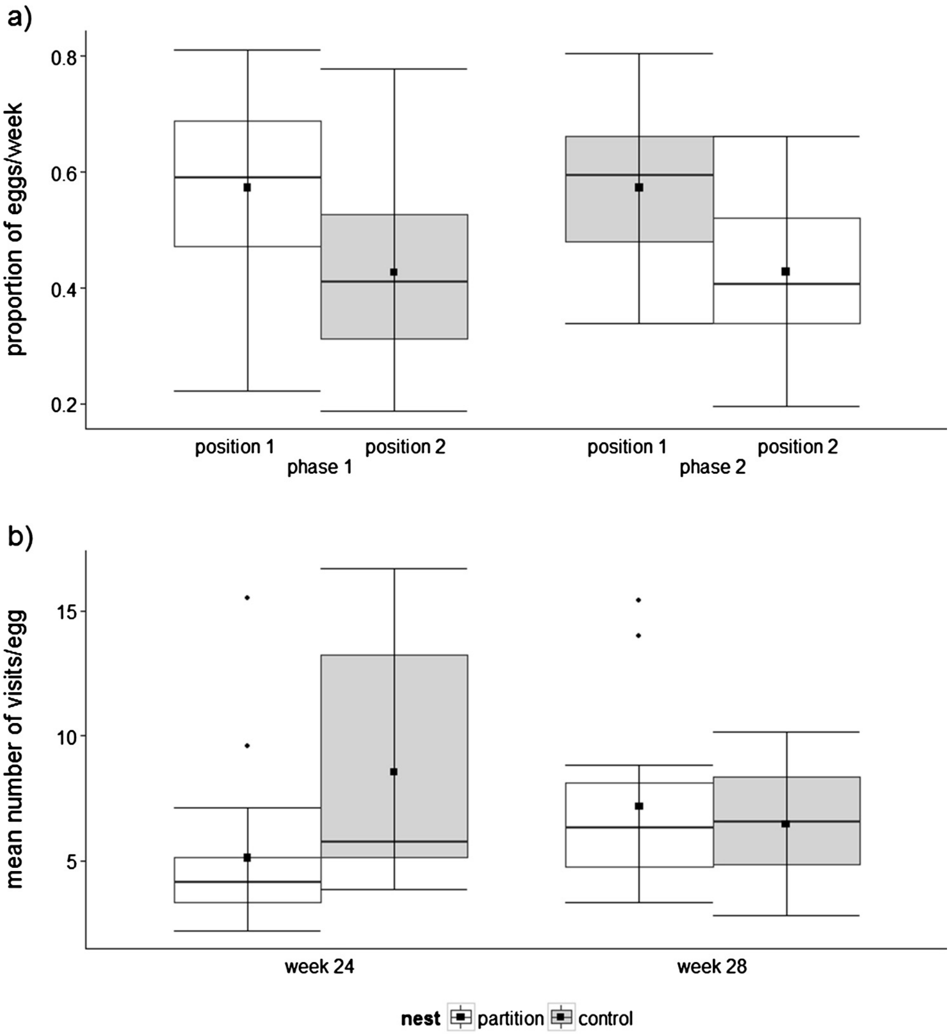

Fig. 2. (a) Mean proportion of eggs per nest in phase 1 (week 21 to week 27 of age) and phase 2 after the nest switch (week 28 to week 32 of age), position 1 refers to the initial position of the partition nest and position 2 refers to the initial position of the control nest. (b) Mean number of visits per egg (ratio of nest visits to eggs laid per nest) before (week 24 of age) and after the nest switch (week 28 of age). Boxplots: boxes represent 1st and 3rd quartile, the thick lines are the medians, the squares represent means, whiskers extend to most extreme data points (within 1.5 × interquartile range) and grey dots represent outliers.

with a stepwise backward model selection based on the AIC (there is no method for using stepAIC on a model with a binomial distribution). The number of agonistic interactions was analysed in the same manner with pen nested in trial as fixed effects and week of age as a random effect. For the same data, repeatability estimates (R) (varying from 0 to 1) were calculated according to Nakagawa and Schielzeth (2010) to estimate the consistency of location of egg-laying. The function rpt.binomGLMM.multi for binary data from the R package rptR (Schielzeth and Nakagawa, 2013) was used with 1000 permutations and hen as the group identity.

3. Results

3.1. Eggs

From week 21 of age (50% production) until week 27 of age (before the nest switch), hens laid 6062 eggs in the control nests and 8135 eggs in the partition nests. For the last 4 weeks of the experiment, after the nest switch, hens laid 3663 eggs in the control nests and 2757 eggs in the partition nests. Hens only laid 156 eggs on the floor, which is less than 1% of the total number of eggs laid throughout the experiment.

We found evidence that a greater proportion of eggs were laid in the initial position of the partition nest than expected by chance ($F_{1,160} = 6.34$, $P = 0.013$) (Fig. 2a). Phase (before and after nest switch) was not included in the best model, therefore the hens continued to lay their eggs in the same nest position as before the switch.

3.2. Behaviour

The number of nest visits per egg varied according to week of age, with more nest visits in control nests than partition nests before the nest switch but not after the nest switch (interaction between nest and week of age: $F_{1,41} = 5.91$, $P = 0.02$) (Fig. 2b).

The best model for the mean number of visits per hen per pen included the following fixed effects: the mean number of visits per egg tended to be affected by week of age with more visits in week 28 than 24 ($F_{1,160} = 3.33$, $P = 0.07$), social rank with lower ranking hens making more nest visits ($F_{2,160} = 3.33$, $P = 0.017$), and nest type with more nest visits in the control nests ($F_{1,160} = 5.53$, $P = 0.02$) (Fig. 3).

The hens observed laying their eggs on both days of observations (1 day during week 24 of age and 1 day during week 27

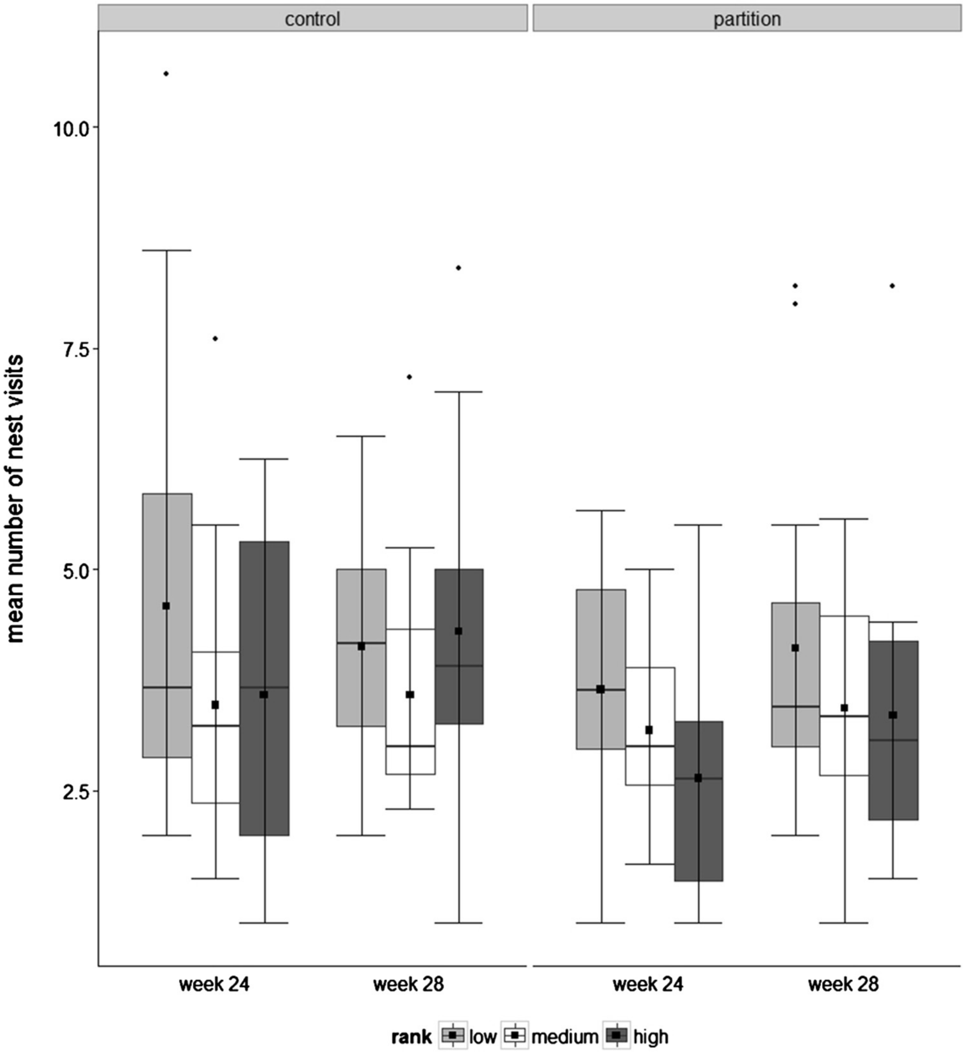

Fig. 3. Mean number of visits per hen per pen for control and partition nests, according to week of age and social rank. Boxplots: boxes represent 1st and 3rd quartile, the thick lines are the medians, the squares represent means, whiskers extend to most extreme data points (within 1.5 × interquartile range) and grey dots represent outliers.

of age) ($n = 273$, pens = 15) were consistent in their choice of nest type ($R = 0.73$, CI = [0.51, 0.75], $P = 0.001$). We found a main effect of nest ($X^2{}_2 = 13.42$, $P < 0.001$) on the number of hens observed laying their eggs in the nests but the interaction between nest and social rank was not in the best model. When hens laid their eggs in the same nest on both days of observations, more chose the partition nest than the control nest (partition nest: 8.67 ± 3.06 (mean ± SD), control nest: 6.20 ± 2.9; $Z = 2.44$, $P = 0.01$) and only few hens laid their eggs in both the control and the partition nest (3.14 ± 1.70).

The timing of egg-laying was affected by the interaction between social rank and week of age ($F_{2,214} = 3.00$, $P = 0.05$) (Fig. 4): during week 24 of age, rank did not affect timing of egg-laying, but in week 27 of age, low ranking hens laid their eggs later in the day compared with the higher ranked hens. In addition, timing of egg-laying occurred later in the day in week 27 of age than in week 24 of age for all ranks.

The number of agonistic interactions decreased with age ($X^2{}_2 = 770.92$, $P < 0.001$) with an initial high mean number of 85.00 ± 39.81 interactions per pen during week 18 of age (mean ± SD), 30.00 ± 10.60 interactions during week 24 of age and 22.06 ± 7.69 interactions during week 27 of age.

4. Discussion

We report that laying hens in small groups showed a relative preference for group-nests with a partition as they laid a greater proportion of eggs and performed fewer nest visits per egg in these nests; however, this was the case only before the positions of the nests were switched with each other. Unlike expected, social status did not seem to influence nest choice but low ranking hens laid their eggs slightly later in the day (in week 27 of age) and performed more nest visits compared with higher ranking hens.

4.1. Pre-laying behaviour and initial nest choice

From the assessment of our main outcome measure, proportion of eggs per nest, we conclude that hens showed a relative preference for the partitioned nest, at least until the nests were switched. In addition, the lower number of visits per egg in the partitioned nests clearly points to a preference for these nests. This measure – number of nest visits per egg – has previously been shown to be increased in least preferred nests as measured by the number of eggs (Buchwalder and Fröhlich, 2011; Ringgenberg et al., 2013,

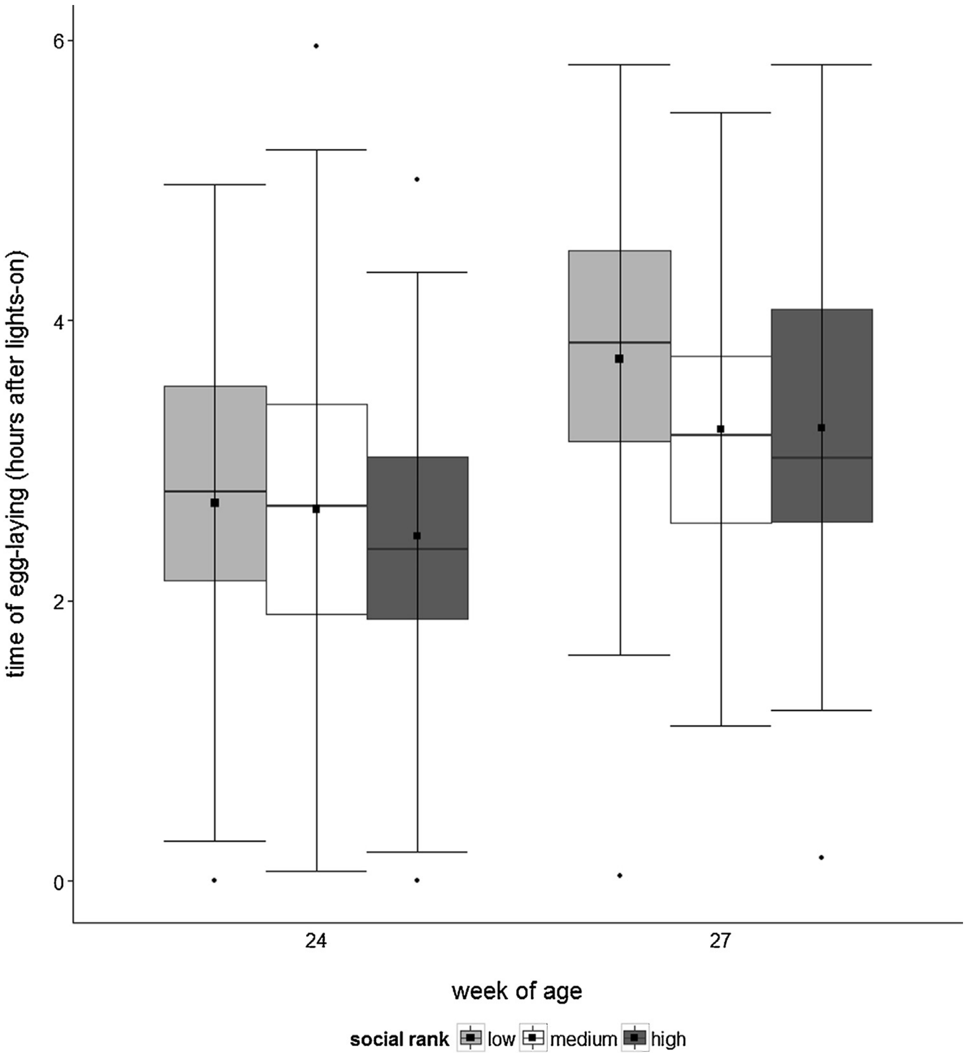

Fig. 4. Time of egg-laying (hours after lights-on) for the hens observed laying their eggs on both days of observation ($n = 273$, pens = 15). Boxplots: boxes represent 1st and 3rd quartile, the thick lines are the medians, the squares represent means, whiskers extend to most extreme data points (within 1.5 × interquartile range) and grey dots represent outliers.

2014b). The number of visits per egg provides information on the nest choosing phase of pre-laying behaviour, which begins 1–2 h prior to oviposition (Cooper and Appleby, 1995; Duncan and Kite, 1989; Kruschwitz et al., 2008a). An increased number of nest visits per egg points to an extended nest choosing phase in the least preferred nest and may be indicative of frustration (Wood-Gush, 1972; Yue and Duncan, 2003).

Hens likely preferred the partitioned nests due to the added cover that the partition provided, similarly, the use of structural elements in pens is known to be attractive to chickens (Cornetto and Estevez, 2001; Rodriguez-Aurrekoetxea et al., 2014). In this experiment, the level of enclosure was likely higher in the partition nest, and as in our previous study (Ringgenberg et al., 2014a), hens preferred nests offering a greater degree of enclosure. However, although the proportion of eggs laid in the partition nest was significantly higher than 0.5, hens in all pens also laid eggs in the control nest. Therefore, the control nests were either still attractive enough for egg-laying or the partitioned nests were too small to accommodate all egg-laying hens. In addition, there were four pens (out of 16) in which hens preferred the control nests both in terms of proportion of eggs and number of visits per egg. Although these pens were all located in corners of the barn, the side of the pen and the side of the barn on which the control nest was placed varied in each pen.

4.2. Nest position effects

We performed the nest switch in order to check whether hens showed a strong enough preference for the partition nest to switch egg-laying location after the nest partition swap. Contrary to our expectations, the hens did not switch nests. Several reasons can explain this nest position consistency. First, the control nests were not unattractive enough to warrant changing egg-laying position, an important point considering that we used commercial nests that were already shown to be attractive (nest CN1 in Buchwalder & Fröhlich, 2011) and some hens consistently laid their eggs in the control nest. Second, the nest partition was only important at the beginning of lay and once the hens were accustomed to laying their eggs in a nest on a specific pen side, they did not switch again seemingly preferring familiarity over greater structural complexity. Third, some hens may not have became aware that the nests were swapped. Riber and Nielsen (2013) found that after moving groups of hens to different pens with alternate nest arrangements, some hens were nest conservative (they continued to lay their eggs in the most isolated nest) while others were location conservative (they continued to lay their eggs in the same location). These results may also support the first explanation, that our control nest was not unattractive enough. In Riber and Nielsen (2013), the most isolated nests were clearly more attractive even after the pen switch, however, the nests were not rollaway nests so the hens may also have been attracted by eggs previously laid in the nests. In the present study, 65% of the hens visited both nests on the day after the nest switch which is slightly more than during week 24 of age (57%) and suggests that at least some hens noticed the nest switch. It must however be noted that the initial preference for the partition nest may still be important as an attractive nest at the start of lay is of particular importance to reduce floor eggs.

The number of visits per egg followed a similar pattern to the distribution of eggs before the nest switch (preference for partition nests); however, there was no difference between nest types in the number of visits per egg after the nest switch. This measure may therefore be more informative than the proportion of eggs and tells us that the hens no longer found a nest more attractive than the other. Alternatively, the hens that chose the nest with the partition before the switch may have performed more nest visits after the switch because they suddenly had the least preferred nest in their usual nest position, whereas hens choosing the control nest before the switch now had a more attractive nest in its place and performed fewer visits. This reasoning could explain the lack of a difference in the number of visits per egg after the nest switch. Interestingly, unlike in other experiments (Ringgenberg et al., 2014a, Submitted for publication) there was no increase in the number of visits per egg over time although this may be because the current experiment did not look at this measure later than week 28 of age and/or more attractive nests were used.

A limitation of this study is that data collection on nest visits was done only on one day in each of the two periods. However, egg-laying location was consistent on both days of observation before the nest switch and the number of eggs per nest collected each day backs up this consistency. Therefore we believe that the change in the number of visits per egg after the nest switch was due to that change.

4.3. Social status and nest choice

The number of agonistic interactions decreased sharply over time with most of the aggression occurring soon after re-grouping at 18 weeks of age, as expected from other studies (O'Connor et al., 2011; Cordiner and Savory, 2001; Rushen, 1982). We found no evidence that social status as measured by David's score had an effect on nest choice. As Rietveld-Piepers et al. (1985) suggested, the lack of an effect may be because nests in the wild would not be in short supply and are thus not a resource over which hens compete. These authors also found no relation between social status and nest choice, nor between social status and floor eggs. In captivity, however, nests that are more attractive may be in short supply (i.e. there are only two corner nests) and competition over them likely occurs, especially considering the high density of hens per nest (100 and 120 hens per m^2 of nest surface area in Switzerland and the EU, respectively) (Animal Welfare Ordinance, 2008; CEC, 1999). Hunniford et al. (2014) observed increased levels of aggression during the peak egg-laying time in furnished cages, suggesting competition over the designated nest site. However, it is difficult to compare the behaviour of hens housed in furnished cages and non-cage housing systems due to the differences in nest enclosure, space allowance, litter availability, breed, and freedom of movement.

Although social status did not affect nest choice in the present study, we found that low ranking hens performed more nest visits and laid their eggs slightly later (though only on one day of observation) compared with medium and high ranking hens. Similarly, Freire et al. (1998) reported that subordinate hens in small groups of four in a round pen with no nest boxes (all hens laid their eggs in one hollow) showed more locomotion and less resting behaviour in the 10–15 min prior to oviposition. Unlike Freire et al. (1998), we saw very little overt aggression in the nest sites although subtle dominance displays may have been missed. The prolonged searching phase (characterized by many nest visits) that the low ranking hens showed in our study was perhaps due to more dominant hens occupying the nests thereby preventing them from settling in the nests. Although this was only the case on the second day of observation in week 27 of age, the subordinate hens likely delayed their timing of egg-laying because of their prolonged searching phase and it is known that acutely stressed hens can delay the timing of egg-laying (Hughes et al., 1986; Reynard and Savory, 1999). We also found that all hens laid their eggs slightly later in the day at 27 weeks of age than at 24 weeks of age which is likely due to the increasing interval between eggs in the same laying sequence (Icken et al., 2008).

5. Conclusion

Small groups of hens with access to two commercial group-nests differing only in their internal structure (partition vs. no partition) showed a relative preference for the partitioned nest as measured by the higher proportion of eggs and the lower number of visits per egg in the partition nests. However this preference was no longer seen after the position of the nests was swapped during the 28th week of age. Thus this initial nest preference likely became associated with nest location. We also show that a low social status, as measured by David's score, does not affect nest choice per se, but is associated with a prolonged searching phase and a slightly later timing of egg-laying compared with more dominant hens. Nest partitions could be an easy addition to commercial group-nests in aviary systems to improve their attractiveness.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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