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The effect of early colour preference and of a colour exposing procedure on the choice of nest colours in laying hens

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Abstract

It has been observed that hens at the start of lay show a strong preference for a limited number of nests, i.e. those at the corners and at the ends of rows. This leads to overcrowded nests and, as a consequence, to more aggression and an increase in cracked and mislaid eggs. This study aims to verify whether nest colour can be used to increase the attractiveness of nests, as this could counter-balance the aforementioned positional effects. In detail, a contemporary hybrid was tested to see whether it demonstrates early colour preference, and if this affects nest colour preference, and additionally, whether exposing chicks to specific colours at an early age could influence nest colour preference later on.

During the first 12 days of life, eight groups of 15 chicks were exposed to one of four colours (blue, green, yellow and red; two groups per colour). In two additional groups of 92 chicks, individuals showing high preferences for these colours were identified. 50.5% chose yellow more often than any other colour, 32.1% chose red, but only 7.1 and 2.2% preferred green and blue, respectively. 8.1% of the chicks did not show preferences for a single colour but preferred two or three different colours equally.

Sixteen hens from each of the following eight categories were then tested for their choice of nest colours at the start of lay (weeks 19–22): those exposed to blue, green, yellow or red during the first 12 days of life, those selected at the same age for their preference of yellow, red, yellow and red, and those which were selected because they had shown no preference to any particular colour during the first 12 days of life. Not enough individuals had shown clear preferences for blue or green at an early age to be tested later on. As hens, the birds were tested in 32 groups of four. Each bird of a group originated from a different category and each group had a choice of four double nests, each painted in one of the four colours blue, green, yellow or red.

Hens that were exposed at an early age to blue, green or red did not prefer corresponding nest colours when in lay. The same is true for hens showing preference of red or red and yellow at an early age. All these hens showed a significant preference of yellow nests when in lay, and were indifferent to blue, green and red nests. However, birds selected for their preference of yellow at an early age,

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and also those that were exposed to yellow did not show this general preference of yellow nests, but were indifferent to all four nest colours offered. It is discussed how these results may contribute to the reduction of overcrowded nests at the start of lay.

Keywords: Colour preference; Nest site selection; Chicks; Laying hens; Imprinting

1. Introduction

Nests for laying hens used in commercial poultry farming are usually widely accepted by the hens and the amount of mislaid eggs is generally far below 10% (Kathle et al., 1996; Kathle and Kolstad, 1996; van Horne et al., 1997; Leyendecker et al., 2001). Unfortunately this is only true after an initial phase of several weeks in which the percentage of floor eggs declines. At the start of lay, the amount of mislaid eggs may be high as 15% to over 80% (Hurnik et al., 1973b; Rietveld-Piepers et al., 1985; Petherick et al., 1993; Sherwin and Nicol, 1993). In floor systems and aviaries in which nests are usually arranged in rows, it may be observed that during this time most eggs are laid in only a few of the available nests, usually nests in the corners or at the end of a row. This strong preference for a limited number of nests results in an actual shortage of available nests of choice, increasing not only aggression between the hens (much of the aggression in a flock occurs around the nest boxes; Nicol et al., 1999), but also the number of mislaid eggs. Therefore, it would be desirable in terms of animal welfare and economy to find a means by which to make nests away from the corners and the ends of nest rows more attractive and thereby distribute the hens more evenly among the nests.

One way to do this could be the use of coloured nests. Hurnik et al. (1973b) offered coloured (blue, green, yellow and red) and plain (i.e. galvanised) nests to samples of 170 hens of two different breeds. They found that with coloured nests the percentage of mislaid eggs in the first period of 8 weeks was reduced by 3.7 and 5.8% (breeds 1 and 2, respectively), with the strongest decline in the week when the hens started to lay. In an other study, hens showed a tendency of preferring yellow and red nests to blue and green ones, however not statistically significant (recalculated from Hurnik et al. (1973a)). Additionally, a correlation was found between colour preference in nesting and colour preference at an early age, and Hurnik et al. (1977) demonstrated that colour preference has a genetic background with moderate inheritance of a preference for blue or green (0.23/0.23) and a low inheritance of a preference for yellow or red (0.15/0.03). The question arises as to whether these results are still applicable to breeds used in today's poultry farming since we have seen a very intense selective breeding of laying hens in the past 25 years. Even though colour preference was not a trait selected for, it might well have been affected, but unrecognised in the course of the selection of other traits. To what extent colour preference is still present at an early age and whether it correlates with a possible colour preference in nesting later on was therefore studied using a contemporary breed (ISA brown).

The fact that colour preference may be inherited offers the possibility of manipulation using selection, but this is not without pitfalls as with today's highly specialised breeds, selecting for one trait often affects the performance of other traits. Colour preference, at least at an early age, may also be influenced by imprinting, conditioning or exposure to colours (Hess, 1959; Schaefer and Hess, 1959; Taylor et al., 1969; Miklosi et al., 2002). Therefore, by exposing chicks to blue, green, red or yellow tests were carried out to see if it were possible to influence colour preference in nesting later on.

2. Animals, materials and methods

The experiments were carried out in two series, starting 8 weeks apart. The birds of each series were bought as 1-day-old chicks and were first kept for 8 weeks in the poultry house at our institute (rearing period I), then moved to a commercial rearing house outside the institute for 8 weeks (rearing period II) and finally brought back to the institute for 7 weeks of testing for nest colour preferences (laying period).

2.1. Rearing period I (weeks 1–8)

In each series 152 1-day-old ISA brown chicks were used and randomly allocated to one group of 92 (selection group) and four groups of 15 (exposure groups). For each series, chicks were collected from the hatchery the morning after hatching and brought back in six boxes (22 cm × 24 cm × 13 cm) with the inside painted in grey (selection group) and in four boxes painted in one of the four colours: blue, green, yellow or red (exposure groups). At the institute all chicks were individually marked with leg bands, which were replaced with larger ones three times during the course of the experiment. During days 1–12, the chicks were subjected to a selecting and exposing procedure in specially built apparatus, similar to that used by Hurnik et al. (1977).

2.1.1. Apparatus

The apparatus had a layout similar to a large four-leaf clover with a diameter of 260 cm and a square compartment at the centre (Fig. 1) formed by a frame (60 cm × 60 cm; height: 60 cm) made of plywood. The dimensions were chosen to give a density of 15 birds/m^2, as described by Hurnik et al. (1977). The four sections surrounding the central square compartment were made of wire mesh (60 cm high) covered with packing paper and painted in one of the four colours: blue, green, yellow or red (see Section 2.5). The paper was attached to the mesh by pegs and could easily be interchanged between the sections. The floor was littered with wood shavings and each section contained one suspended feeder (diameter: 30 cm), two lamps with ceramic bulbs (150 W) emitting heat but no light, two water containers (10 cm × 24 cm × 6 cm) and two additional feeding troughs (40 cm × 7 cm). Mean ambient temperature in the sections was 28.5 °C. Each section was illuminated by one fluorescent lamp fitted with a special tube (Osram 72-965 Biolux, 36 W) that emits light across the whole spectrum from 700 nm down to 380 nm, i.e. including the range of the near-ultraviolet. The same kind of tubes were used during the laying period. Light intensity at the height of the animals was approximately 100 lx (mean of five measurements made at the centre of a section, to the left, right, front, rear and upwards). There was no difference

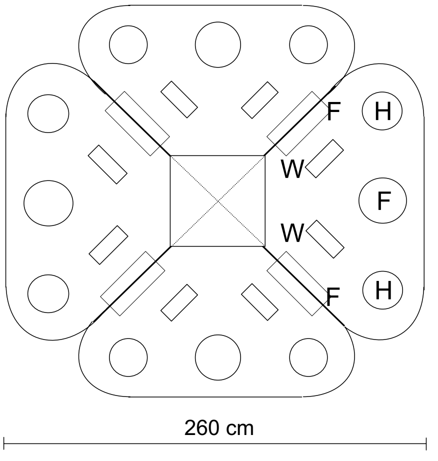

Fig. 1. Top view of the apparatus used for selecting chicks for their colour preference or exposing them to colours. For more details see text. F: food; H: heat; W: water. Drawn to scale.

in light intensity between the apparatus used in the selection procedure and that used in the exposure procedure but it was different between the colours (ANOVA, factor apparatus: $F_{1,24} = 0.69$, n.s.; factor colour: $F_{3,24} = 4.59$, $P = 0.011$; interaction: $F_{3,24} = 0.44$, n.s.). Light intensity in yellow sections (128 lx) was significantly higher than in blue, green and red sections (89, 98 and 91 lx, respectively).

2.1.2. Selecting procedure (days 1–12)

In the apparatus used for the selection procedure the square frame at the centre was continuously suspended 20 cm above the floor so that the 92 chicks could move freely between the four sections. Four times a day the frame was lowered ‘invisibly’ from outside the pen by an arrangement of two pulleys, trapping the chicks in the section that they had chosen. The point of time that these observations were made was randomised within four blocks of 3 h, starting 2 h after the light came on and ending 2 h before the light went off. Care was taken to leave the chicks undisturbed for at least 1 h between the observations.

After lowering the frame, a water container (10 cm × 24 cm × 6 cm) was put in the centre and chicks were collected from the sections, lifting them up by hand, noting the colour of the leg bands and the colour of the section they had stayed in. This was taken as the colour choice of the chick at the time of the observation. Finally the chick was put into the central compartment. After all the chicks had been removed from the sections, water containers and food troughs were cleaned and refilled, and the litter rearranged and replenished where necessary. Once a day the colours of the sections were interchanged at random. This was done to balance possible uncontrolled environmental factors. After everything had been newly set up, the water container was removed from the centre and the frame was lifted from outside. The chicks could again move freely between the sections and were left undisturbed until the next observation. The selection procedure started with two observations on day 1 and ended on day 12, resulting in 46 observations of each chick. The number of times a chick was found in a section of a certain colour was taken as a measurement of preference for this colour.

2.1.3. Exposing procedure (days 1–12)

The sections of the apparatus used for the exposure procedure were slightly smaller to keep the density the same, thus compensating for the smaller number of animals (60 versus 92). Two fixed diagonal plywood boards divided the square at the centre. This created a triangle shaped compartment at the base of each section. The walls separating the compartments and the sections were designed to slide up and down, allowing the chicks to move between the two areas when pulled up, but usually they were closed. Sixty chicks (15 per section) were introduced to the apparatus at the same time as the chicks in the selection procedure. After each lowering of the frame in the selection apparatus, the chicks in the exposure apparatus were collected and put in the adjoining triangular compartments. The sections were then set up again in exactly the same way as in the selection procedure and the dividing walls were then opened briefly to allow the chicks to move back to their section. The colours of the sections were interchanged daily according to the same schedule as in the selection procedure. Chicks moved with their colour to the next section and therefore stayed the whole 12 days with the same colour.

On day 13 the chicks were regrouped. Three chicks were chosen randomly from each "exposure group" and 18 or 19 chicks were chosen from the "selection group", resulting in three groups of 30 and two of 31 birds. These groups were then housed in pens (180 cm × 260 cm; height: 235 cm) littered with wood shavings and long cut straw. Each pen was provided with four cup drinkers, a suspended feeder (diameter: 30 cm), two perches (180/210 cm; height: 45/85 cm) and a lamp with a ceramic bulb (250 W). The chicks had free access to a commercial starter food. Lights were ON for 16 h per day in weeks 1 and 2, and 14 h thereafter until week 8 when they were ON for 12 h. There was a twilight phase of 15 min at the beginning and end of each day. Fluorescent light was used during the day and an incandescent bulb for the twilight phase. Light intensity at the height of the animals was approximately 100 lx. The chicks were moved out at the end of week 8 and the pens were cleaned, disinfected and prepared for the second series of the experiment.

2.2. Rearing period II (weeks 9–16)

After 8 weeks, all the animals were moved to a commercial rearing house outside the institute and kept in one single group. The pen was 7.4 m × 4.8 m and equipped with an aviary system with two tiers. The floor was littered with wood shavings and long cut straw. Density was 3.2 animals/m^2 of available area (base and tiers). The chicks had free access to feed which was provided in four feeders (diameter: 40 cm). Lights were ON for 12 h in weeks 9 and 10, then reduced to 10 h in week 11 and finally to 9 h in week 12. Light intensity from incandescent lamps was approximately 30 lx at the height of the animals. At the end of week 16, 64 birds were selected (see Section 2.3.1) and brought back to the institute. The remaining 88 birds were sold to poultry farmers. On the same day the chicks from the second series of experiments were moved from the institute to the pen. Before putting the chicks in the pen, it was cleaned, disinfected and new litter was added.

2.3. Laying period (weeks 17–23)

2.3.1. Selection criteria and formation of groups

From each of the four lots of 15 hens that had been exposed as chicks to one of the four colours blue, green, yellow or red, eight individuals were chosen at random. From the 92 hens that had been tested as chicks for their colour preference four lots of eight individuals were selected. The selection criteria were based on the number of times out of 46 observations that a chick was observed in a section of a certain colour, and the following categories were defined—(i) selected yellow: yellow was chosen most often and at least six times more than any other colour; (ii) selected red: red was chosen most often and at least six times more than any other colour; (iii) selected yellow and red: either yellow or red was chosen at least six times more often than blue and green, and the number of times yellow or red were chosen did not differ from each other by more than three; (iv) no preference: the number of times the four colours were chosen did not differ from each other by more than five.

If there were more than eight individuals fulfilling the criteria, the number of hens required was chosen at random. There were no enough eligible individuals preferring blue or green (see Section 3). There were 16 groups of four hens for the 16 pens available at the poultry house at the institute (see Section 2.3.2). Eight groups consisted of four birds, each having been exposed to one of the four colours. Each of the remaining groups consisted of one hen which had selected yellow, another red, another yellow and red, and one that had not shown any colour preference as a chick. The 16 groups in the first series of experiments were assigned to the pens in a random order. In the second series this order was reversed between the groups of exposed and selected birds. In this way, each of the 16 hens (eight per series) of each of the eight different categories (exposed to blue, green, yellow, red; selecting yellow, red, yellow and red, or having no preference) was assigned to a different pen of the 16 available ones. The data of the 16 hens of a category were therefore considered independent of each other. In both series of experiments the hens were sold to commercial and private poultry farmers at the age of 23 weeks.

2.3.2. Housing

The poultry house at the institute is divided into 16 pens (90 cm × 260 cm; height: 235 cm) built side by side along a corridor from where the pens are accessible through a glass door (72 cm × 142 cm). For this experiment the glass was covered with packing paper up to a height of 100 cm. The pens are separated by plywood walls (height: 190 cm) which allow auditory but no visual contact between the groups. Fresh air is introduced above the plywood walls and spent air is removed from each pen by a separate pipe. Each pen was littered with wood shavings and long cut straw and equipped with two cup drinkers and one feeder (diameter: 30 cm, Fig. 2). The hens had free access to a commercial laying hen feed. Four double nests (Fig. 3) were available to the hens on the long side of the pen. Nests of the rollaway type were used to prevent laid eggs influencing the nest choice of other hens. Nests were positioned directly on the base to permit easy access. The inside and outside were painted blue, green, yellow or red. Paint and colours were identical to the ones used for the selecting/exposing apparatus. A 260 cm long perch was installed above the nests at a height of 85 cm.

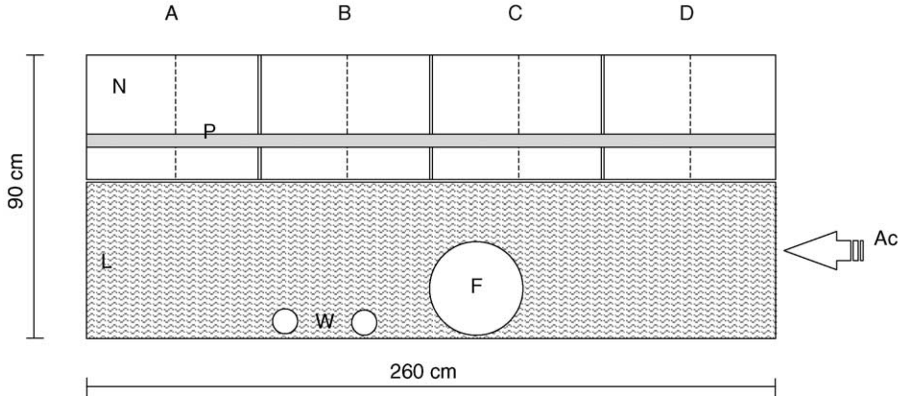

Fig. 2. Outline of a pen to accommodate four hens. Ac: access; A–D: nest positions; F: food; L: litter; N: nests; P: perch; W: water.

Pens were illuminated with one fluorescent tube per two pens. The tubes were of the same kind as the ones used during rearing period I. Lights were ON for 10 h in week 17, 12 h in week 18, 14 h in weeks 19–21 and 15 h thereafter. An incandescent light bulb (75 W) was used to produce a twilight period of 15 min at the start and end of the day.

Light intensity was measured at the height of the birds and 20 cm in front of the nests with the sensor pointing upwards for one reading and pointing towards the nests for a second reading. Measurements were taken for each combination of nest colour and positions A–D

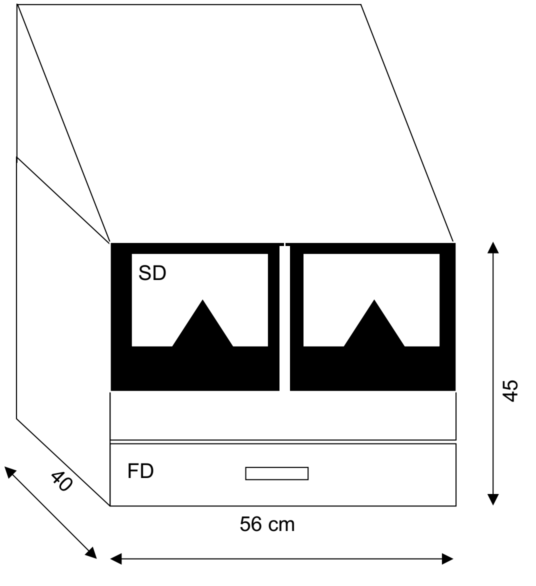

Fig. 3. Double nest of the type rollaway used in this study. Entrance (27 cm × 23 cm) is through swinging doors fixed at the top (SD) and egg collection is facilitated by a front drawer (FD).

(A for the position at the far end of the pen and D for the position nearest to the glass door, Fig. 2) and averaged over all pens. Nest colour did not affect light intensity in front of the nests, but position did (ANOVA, factor colour: $F_{3,46} = 0.76$, n.s.; factor position: $F_{3,46} = 42.37$, $P < 0.001$; interaction: $F_{9,46} = 1.29$, n.s.). Scheffe's multiple-comparison test revealed that light intensity was not different in B and D (42.4 and 42.7 lx), highest in C (50.4 lx) and lowest in A (28.1 lx). Light intensity inside the nest was measured at its centre with the sensor pointing upwards. It was very low, however, affected by nest colour and position (ANOVA, factor colour: $F_{3,48} = 56.23$, $P < 0.001$; factor position: $F_{3,48} = 14.70$, $P < 0.001$; interaction: $F_{9,48} = 1.94$, n.s.). Yellow nests were significantly brighter (0.51 lx) compared to blue, green and red nests (0.32, 0.33, 0.32 lx, respectively), and position D was significantly brighter (0.43 lx) than A, B and C (0.33, 0.33, 0.37 lx, respectively).

2.3.3. Procedures

Four double nests were used per pen, one of each colour. Thus, for each colour there was one nest per two hens. Under commercial conditions a ratio of one nest per five hens is considered sufficient. Therefore, it is assumed that availability of nests was not critical and that hens in our experiment had a free choice of the different coloured nests. Nests were introduced to the pens at day 131 (week 19) and the first egg in both series was recorded the day after. The position of the nests in the pen was changed every day between the four possible positions in such a way that after 8 days (i) each nest had been in each position twice, (ii) each colour of nest had been adjacent to each of the other colours of nest four times and (iii) each nest had been moved eight times.

Eggs were collected daily on 24 consecutive days. Egg collection was only started 9 h after the lights came on and care was taken that no person entered the poultry house before this point in time in order not to influence the hens when choosing a nest site. For each egg laid in a nest, the colour and the position of the nest were noted. For floor eggs, the position (A–D) in the litter was noted. After eggs had been collected, the nests were thoroughly cleaned with warm water and then rearranged according to the schedule.

To identify eggs laid by individual birds a technique was used based on the fact that fat-soluble dye, when given orally to female birds, is laid down in discrete layers of colour in the yolk of eggs developing in the ovary. The method was successfully used in several studies and is described in more detail by Appleby and McRae (1983). To identify the eggs of the four hens per pen two different dyes (Scarlet Red and Sudan Black B from Fluka Chemie, Buchs, Switzerland), a mixture of these and a placebo were used. Seventy milligrams of dye was mixed with 70 mg of glucose per dose and placed in a size 2 gelatine capsule (Eli Lilly and Co., Indianapolis). For the placebo 70 mg glucose was used. A pilot study with five laying hens showed that one such dose produced a clearly identifiable coloured layer in the yolk from the second to at least on day 9 after administration. Therefore, capsules were given on the day when the nests were introduced (day 131) and then twice more after 8 days. Eggs were hard boiled the same evening after collection and the yolk cut across the middle with a knife. The dye could then be seen as a clear, red, dark greenish-blue or olive-coloured ring. The method was successful, with only eight out of 2705 of the eggs collected not attributed to individual hens.

2.4. Statistical analyses

The magnitude of the colour preference shown in the selecting procedure was assessed by calculating the deviation of a chick's number of choices for its preferred colour from what could be expected with no preference made.

Data from the laying period were analysed separately for each of the eight treatments. Data from the first 16 eggs of each hen laid in a nest was used. Some hens laid less than 16 eggs in the course of the 24 days of observation; therefore, the number of hens included in the analyses is less than the 16 available hens per treatment and slightly different between treatments (11–13).

To analyse colour preference at an early age and in nesting χ^2 goodness of fit and subdividing χ^2 analyses following Zar (1999) were used. The latter method tests statistical hypotheses developed after examining the data. The results should therefore be interpreted with caution and evaluated again with a new set of data. Actual numbers of observations were used in the analysis, but percentages are given in the text.

Associations between the number of choices for a specific colour during the selecting procedure and the number of choices for a nest of that colour later on was tested using linear regression. Normality of the residuals and homogeneity were tested and data were transformed whenever necessary. If the assumption for linear regression could not be achieved, Spearman rank–order correlation was used instead.

2.5. Predefinitions

This study was not intended to reveal the role of attributes such as saturation or brightness. When using the term 'colour preference', this refers to a preference among the four presented colour stimuli with the chromaticity co-ordinates (x, y; C.I.E. 1931 Standard Observer, 2°) 0.140, 0.148 (blue), 0.246, 0.546 (green), 0.433, 0.487 (yellow) and 0.626, 0.319 (red).

3. Results

3.1. Colour preference at an early age (days 1–12)

A total of 8464 observations were made (46 observations × 92 birds × 2 series) of which 263 observations (3.1%) concerned chicks found in the centre compartment. The total numbers of choices for the available colour alternatives were significantly different ($\chi^2 = 589.35$, d.f. $= 3$, $P < 0.001$, Table 1) and subdividing χ^2 showed all differences to be

Table 1
Distribution (%) of colour choices at an early age in this study and the one by Hurnik et al. (1977)

	Blue	Green	Yellow	Red
This study	16.1 a	21.3 b	33.1 d	29.5 c
Hurnik et al. (1977)	15.8 a	24.5 b	35.5 c	24.2 b

Values with no common letters are significantly different ($P < 0.05$, subdividing χ^2 analyses).

significant. Yellow was chosen most often, followed by red, green and blue. The distribution is similar, but statistically different ($\chi^2 = 77.97$, d.f. $= 3$, $P < 0.001$) to the one found by Hurnik et al. (1977), where, in contrast to the present study, the difference between red and green was not significant.

Out of the 184 chicks tested, 50.5% chose yellow more often than any other colour, 32.1% chose red but only 7.1% preferred green and only 2.2% preferred blue to the other colours. 8.1% of the chicks did not show preferences for a single colour but preferred two or three different colours equally. Additionally, chicks preferring yellow also showed the strongest preference for that colour with a mean of 14.3% more choices made than expected, followed by red with 12.4%, green 6.5% and blue 5.7%.

3.2. Preferences of nest colours (weeks 19–23)

Hens from most treatment groups significantly preferred yellow nests for egg laying, but did not significantly differentiate between blue, green and red nests (Fig. 4): exposed to blue ($\chi^2 = 16.26$, d.f. $= 3$, $P < 0.001$), exposed to green ($\chi^2 = 16.26$, d.f. $= 3$, $P < 0.001$), exposed to red ($\chi^2 = 19.54$, d.f. $= 3$, $P < 0.001$), selected red ($\chi^2 = 67.86$, d.f. $= 3$, $P < 0.001$), selected red and yellow ($\chi^2 = 23.11$, d.f. $= 3$, $P < 0.001$) and no preference ($\chi^2 = 70.27$, d.f. $= 3$, $P < 0.001$). The preference of yellow nests was not found in the treatment groups where the hens were exposed to yellow at an early age ($\chi^2 = 2.04$, d.f. $= 3$, n.s.) or when they were selected for their preference of yellow ($\chi^2 = 6.50$, d.f. $= 3$, n.s.). These hens did not significantly differentiate between the four nest colours.

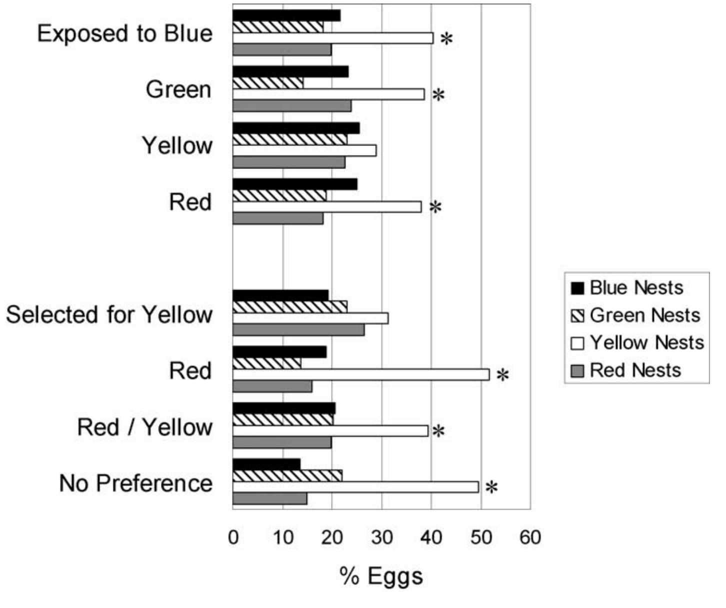

Fig. 4. Distribution of eggs among differently painted nests, laid by hens that were exposed to these colours at an early age or that were selected for their colour preference. Nests with ∗ are significantly different ($P < 0.05$) from the rest of the group.

Table 2
Number of eggs laid at nest position A (at the far end of the pen) through D (position nearest to the door of the pen)

	Exposed to																			
	Blue					Green					Yellow					Red				
Position	B	C	A	<	D	C	<	B	A	<	D	C	<	B	D	<	A	B	C	<	A	D
Number of eggs	36	37	47	<	88	27	<	39	48	<	62	21	<	43	56	<	88	28	32	<	61	71
	Preference for																			
	Yellow					Red					Red/yellow					No preference				
Position	B	C	A	<	D	B	C	D	A		A	B	<	C	<	D	B	C	<	A	D
Number of eggs	34	48	52	<	74	34	41	50	51		29	29	<	51	<	99	36	44	<	59	69

“<” symbolises significant differences ($P < 0.05$) according to subdividing χ^2 analyses.

In all treatments, except where red was selected at an early age ($\chi^2 = 4.41$, d.f. = 3, $P > 0.10$), hens also showed preferences for certain positions of the nests within the pen (d.f. = 3; exposed to blue ($\chi^2 = 34.65$, $P < 0.001$); exposed to green ($\chi^2 = 14.86$, $P < 0.005$); exposed to yellow ($\chi^2 = 45.23$, $P < 0.001$); exposed to red ($\chi^2 = 28.21$, $P < 0.001$); selected yellow ($\chi^2 = 15.85$, $P < 0.005$); selected red and yellow ($\chi^2 = 62.85$, $P < 0.001$); no preference ($\chi^2 = 12.65$, $P < 0.01$); Table 2). Subdividing χ^2 analyses showed that the most frequented positions were A and D at the ends of the pen; however, not all differences were statistically significant and in the category where red and yellow preference was selected for, position A, together with B, was the least popular.

Preference for nest colours was independent of positional effect in all treatments (χ^2-test for independence, d.f. = 9; exposed to blue ($\chi^2 = 9.74$), exposed to green ($\chi^2 = 8.70$), exposed to yellow ($\chi^2 = 6.45$), exposed to red ($\chi^2 = 5.88$), selected yellow ($\chi^2 = 4.34$), selected red ($\chi^2 = 5.91$), selected red and yellow ($\chi^2 = 11.50$), no preference ($\chi^2 = 10.29$); all non-significant).

For the categories where the hens were selected for their colour preference at an early age, it was also possible to test for a relationship between the number of choices for a specific colour during days 1–12 and the number of eggs laid in nests of this colour later on, but no significant relationships were detected.

4. Summary and discussion

The results of this study show that laying hen chicks of a contemporary laying hybrid do demonstrate colour preference at a very early age. Using the same methodology as that of Hurnik et al. (1977), yellow was found to be the most favoured colour, followed by red, green and blue. Except for a slight but significant shift towards red, the distribution is similar to that found 25 years ago. Strong selection for production traits did not much affected colour preference in young laying hen chicks.

Chicks exposed to blue, green or red at an early age did not prefer the corresponding nest colour when in lay but preferred yellow nests instead. Chicks exposed to yellow were indifferent to all four nest colours offered. Chicks selected for their preference of yellow showed the same indifference whereas chicks selected for their preference of red also preferred yellow nests when in lay. These results and the fact that chicks showing no colour preference at an early age preferred yellow nests later on may be taken as indications that hens may have a general preference of yellow nests and that this is not altered by early colour preferences (selection groups) or experience with colours (exposure groups) except in the case of yellow. A preference of yellow at an early age and being exposed to yellow at this age reduces the general preference of yellow nests when in lay. This reducing effect may also be observed with chicks selected for preference of yellow and red. The extent of their preference of yellow nests lies in between one group selected for preference of yellow and the one selected for preference of red.

It may be argued that the observed particularity of yellow is not due to the colour but to the intensity of the reflected light. As it was not within the aim of this study to reveal the role of the inherent attributes of the colours used, we cannot definitively distinguish between the two effects. However, it was observed that light intensity in front of yellow nests was not different and that inside the nests there was a very small difference of only 0.2 lx. This suggests that hens chose yellow nests because of the colour rather than the light intensity. However as chicks, the hens were exposed to a higher light intensity in the yellow sections of the apparatus (128 lx versus 89, 98 and 91 lx in blue, green and red ones, respectively) and one may hypothesise that the observed preference for yellow nests is due to this and not to early exposure to yellow. Also, a mechanism could be suggested whereby an early preference for higher light intensities in chicks (Zolman and Lattin, 1972) would lead to an increased exposure to yellow, which in turn would lead to the reduced preference of yellow nests. Further experiments are needed to evaluate such hypotheses.

In commercial poultry farming it may be observed that at the start of lay hens often use only a few of the available nests, usually nests to the corner or end of the row. Making nests away from the corners more attractive could help distributing the hens more evenly among the available nests and thus reducing the negative effects of clustering, i.e. aggression and mislaid eggs. In order to do this by applying the results, the proportions of colour preferences that would be found in an unselected flock of laying hens should be known. This may be estimated using the results from the selected hens and the found proportion of colour preferences at an early age. From the selection procedure it is known that 50.5% of the chicks preferred yellow and are therefore expected to show equal preferences for the four nest colours, whereas 40.2% may be expected to show a preference for yellow nests (32.1% preferring red as a chick and 8.1% not showing a clear preference for one colour). Taking into account that hens preferring red and those with no preference laid about 50% of their eggs in yellow nests (Fig. 4) and were indifferent to other colours, it may be estimated that with an unselected flock one should expect approximately 33% of the eggs in yellow nests and 19.2% in each of the blue, green and red nests. No data are available on the remaining 9.3% of hens preferring blue or green as chicks.

Taking these considerations into account and recognising that preferences for nest colours were independent of positional effects, it may be concluded that in systems where nests are arranged in rows it should be possible to distribute the hens more evenly among the available nests by painting the mid-third of nest rows yellow, and in such a way to reduce aggression between the hens and decrease the number of cracked and mislaid eggs at the start of lay.

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