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Is there social transmission of feather pecking in groups of laying hen chicks?

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Feather pecking is an abnormal behaviour where laying hens peck the feathers of conspecifics, damaging the plumage or even injuring the skin. If it occurs in a flock, more and more birds show it within a short period of time. A possible mechanism is social transmission. Several studies have shown that laying hen chicks, *Gallus gallus domesticus*, are able to modify their own behaviour when observing the behaviour of other chicks, for example, when feeding and foraging. As there is good experimental evidence that feather pecking originates from foraging behaviour, we hypothesized that feather pecking could also be socially transmitted. To test this, we reared 16 groups of 30 chicks. After week 4, the birds were regrouped into 16 groups of 20 chicks into each of which we introduced either five chicks that showed high frequencies of feather pecking or, as controls, five chicks that had not developed feather pecking. We then determined the feather-pecking rate and the frequency of foraging, dustbathing, feeding, drinking, preening, moving, standing and resting of all birds in a group. Data from the introduced birds were analysed separately and excluded from the group data. Chicks in groups with introduced feather-pecking chicks had a significantly higher feather-pecking rate than chicks in the control groups. In addition, birds in groups with introduced feather peckers showed significantly lower foraging frequencies than those in the control groups, although the housing conditions were identical and there were no differences in either the number or the quality of the stimuli relevant to foraging behaviour. The study therefore suggests that feather pecking is socially transmitted in groups of laying hen chicks.

Feather pecking in laying hens, *Gallus gallus domesticus*, is one of the most widespread and serious problems of today's poultry production, as it is associated with reduced productivity (Leeson & Morrison 1978) and poor welfare (Hughes & Duncan 1972; Allen & Perry 1975; Appleby & Hughes 1991). In general, it is agreed that feather pecking is a redirection of normal pecking behaviour. There is clear evidence that it is influenced by the motivational system of foraging and feeding (Blokhuis & Arkes 1984; Blokhuis 1986; Huber-Eicher & Wechsler 1997, 1998) rather than of dustbathing as claimed by Vestergaard & Lisborg (1993) and Vestergaard (1994). Huber-Eicher & Wechsler (1998) found that foraging behaviour is inversely related to feather pecking and that not only the time spent foraging, but also the quality of foraging material, is important with respect to feather pecking.

Various studies have shown that the behaviour of individual chicks can be altered if they have the opportunity to observe the behaviour of conspecifics. Chicks, for example, learn to avoid an aversive object by observing the disgust response of a conspecific pecking at it (Johnston et al. 1998). Chicks tend to feed in groups rather than individually (Hughes 1971) and both foraging behaviour and the orientation of pecking behaviour are influenced by what the conspecifics in the group are doing. McQuoid & Galef (1992, 1993) reported that demonstrator chicks of Burmese red junglefowl, *Gallus g. spadiceus*, have a social influence on both feeding site preference and latency of feeding of observing individuals. Nicol & Pope (1994) observed social transmission of key pecking for food reward in small flocks of laying hens.

Feather pecking also contains social elements (Craig 1992) in the sense that it is observed in groups and is directed at other group members. If it occurs in a flock then all or most of the individuals show the behaviour and it is not limited to a few single birds (Wechsler et al. 1998). However, the fact that feather pecking spreads in a group (Appleby et al. 1992) implies that it is initially acquired by a single or only a few birds. How the other birds then start pecking at the plumage of their conspecifics is unclear. McAdie & Keeling (1999) presented data supporting the suggestion that feather pecking

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spreads through flocks because damaged feathers become an attractive target for feather-pecking behaviour. Wechsler et al. (1998) proposed two explanations: either the majority of the group members start feather pecking as a reaction to specific conditions of their inanimate environment as suggested by Cuthbertson (1978) and Nicol (1995) or the abnormal behaviour spreads by social transmission.

Some aspects of the influence of the social environment on feather pecking, mainly group size and density, have been investigated (Hughes & Duncan 1972; Hansen & Braastad 1994), but, to our knowledge, no study has yet investigated whether feather pecking is socially transmitted. We investigated whether feather-pecking rates are higher in naïve groups after introduction of individuals showing high frequencies of feather pecking than in control groups in which we introduced individuals not showing feather pecking. Additionally, from the inverse relation between feather pecking and foraging behaviour found earlier (Huber-Eicher & Wechsler 1998), we expected that with an increase in feather pecking the chicks would also spend less time foraging, although the housing conditions and therefore the stimuli for foraging did not change. We used chicks less than 6 weeks old, because social status may affect social learning (Nicol & Pope 1994) and stable dominance–subdominance relationships in female chicks do not become established until 8–10 weeks of age (Guhl 1958).

METHODS

Subjects and Housing

We used 480 female layer chicks (white 'Lohman Selected Leghorn' hybrids, not beak trimmed). They were bought from a commercial breeder and introduced into the experimental pens at 1 day old. Up to the end of week 4, they were kept in groups of 30 chicks at a density of 12.6 birds/m^2 which is close to the maximum density (14 chicks/m^2) permitted by the Swiss animal welfare legislation. Then we reduced group size to 25 individuals (10.5 birds/m^2) and rearranged the composition of the groups (see Regrouping). We sold the 80 surplus chicks to a commercial breeder, as were all the chicks after the experiment where they were kept in a poultry house with access to a bad weather run (for definition see Huber-Eicher 1999) and a freerange area.

The groups were kept in 16 pens of identical size (265 × 90 cm, mean height 235 cm) built side by side along a corridor in a poultry house. On the narrow side of each pen there was a glass door (72 × 142 cm) opening on to the corridor. Plywood walls 190 cm high ensured that there were only auditory but no visual contacts between the adjacent pens. Fresh air was introduced through the gap between the plywood wall and ceiling and the spent air was removed from each pen by a separate pipe. Ventilation was controlled by temperature; fresh air was heated when necessary. The average daily room temperature was 22°C. Each pen was illuminated by an incandescent light bulb (75 W) and one fluorescent tube (36 W) per two pens which resulted in a light intensity of ca. 60 lx at the height of the animals. Daylength was kept at 12 h with a 15-min twilight phase at the beginning and end of the day. An area of 200 × 90 cm closest to the glass door was made of wooden slats (width 1 cm, 2.5 cm apart, 28 cm off the ground) covered by a plastic grid (grid 2.5 mm, mesh 2 × 2 cm) to prevent chicks from falling between the slats. Up to the end of week 4, the remaining floor area (65 × 90 cm) at the rear end of the pen was either covered with sand (depth 3 cm; 12 pens with unrestricted housing conditions), or wooden slats (four pens with restricted housing conditions). In each pen there were two cup drinkers and a suspended feeder (30 cm in diameter) available to the chicks. The feeder was automatically refilled, and the animals had ad libitum access to a commercial starter food. During the experiment, the chicks were fed on pellets, save for the first 3 or 4 weeks (see below), when they were fed on mash.

Procedures

When the chicks arrived, they were randomly assigned to groups of 30 individuals and distributed among the pens. For the first 6 days, chicks had access only to an area of 100 × 90 cm nearest to the corridor, separated from the rest of the pen by a wooden barrier (height 25 cm). This ensured that they stayed close to food, water and the extra heat provided from a red heating lamp (250 W) suspended next to the feeder, which gave off a heat of 32°C at the height of the chicks just in the area below the lamp, and then after the first 19 days by a ceramic lamp which provided only heat but no light. The ceramic lamps were removed during the last week of the experiment, when the chicks were 5 weeks old. For the first 2 days after introduction, additional feed was offered on a sheet of cardboard (30 × 15 cm) adjoining the feeder. For the first 6 days water was provided in a bowl (24 × 10 cm) until the chicks had access to the cup drinkers at the rear end of the pen.

For the experiment we needed chicks that did not show feather pecking and chicks that did. To prevent the chicks of 12 groups from developing feather pecking we kept them in housing conditions that were not restricted regarding foraging behaviour, as in Huber-Eicher & Wechsler (1997): plastic grids covered by perforated plastic mats (polyester tissue coated with PVC) for the first 11 days, sand presented in a round plastic dish (diameter 40 cm, depth 6 cm, sand depth 2 cm) for the first 10 days, access to straw and fed on mash until the beginning of the regrouping (see below). On day 20 we replaced the red heating lamps with 150-W ceramic lamps.

To induce high rates of feather pecking among the chicks of the four remaining pens, we kept them under the following restricted conditions: the usual plastic grids were covered with a close-meshed plastic grid (grid 3 mm, mesh 1 cm^2) for the first 11 days, no access to sand or straw, and fed on mash for the first 3 weeks and then on pellets. After 3 weeks, the remaining plastic grids were removed and wing tags (2.5 × 2 cm) were put on the birds. The wing tags were fixed around the base of the upper wings (the narrowest part, allowing for growth up

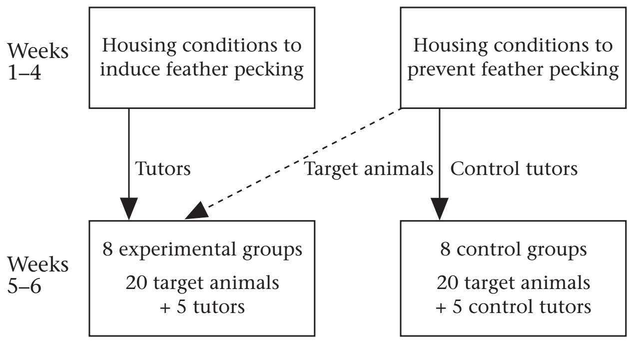

Figure 1. Methods: regrouping and age of chicks.

to the end of week 6 without being too loose in week 3) with foam-backed tape, to avoid discomfort, and insulating tape (width 1.2 cm). On day 20, we replaced the red heating lamp with a 250-W ceramic lamp. We used a stronger lamp than in the unrestricted housing because the additional plastic grids did not retain the heat as well as the perforated plastic mats.

These housing conditions produced chicks with the necessary differences in feather pecking needed for the experiment. In week 4, before regrouping, chicks in the pens with restricted housing conditions showed high rates of feather pecking (median 67.0/30 birds per 30 min), while in the pens with unrestricted housing conditions feather pecking was observed at a very low level (median 5.3/30 birds per 30 min).

After week 4, we formed new groups (see below) and put wing tags on all the chicks that were not yet marked. The remaining plastic grids of the 12 unrestricted pens were removed and we added sand to the rear end of the four pens that had previously had only slats. With these modifications there were the same housing conditions in all 16 pens: slatted floor and a sand area of 60 × 90 cm at the rear of the pen.

Regrouping

The aim of the regrouping after 4 weeks was to form 16 groups of 20 target birds each coming from the 12 unrestricted pens (Fig. 1). The target chicks were the chicks of interest to which feather pecking could be transmitted. In each group there was the same number of chicks that met for the first time or that were familiar with each other (i.e. always four groups of five randomly chosen chicks from a given pen).

To each of eight groups of 20 target birds we randomly added five 'feather-pecking tutors' from the four pens with restricted housing conditions. As tutors we chose the 10 'worst' feather peckers, that is, with the highest feather-pecking rate, of each of the four restricted pens. From these tutors the targets could learn feather pecking. The eight pens were now called 'experimental pens/groups'. To each of the remaining eight groups of 20 target birds, we added five chicks as control tutors from the remaining chicks of the 12 pens with unrestricted housing conditions. These eight groups were then called 'control pens/groups'.

After regrouping, the chicks in all 16 pens had access to sand until the end of the experiment. In addition, they had access to a handful of straw for the first 4 days after regrouping. The straw was given to counteract possible stress caused by the handling and to prevent the development of feather pecking as a consequence of the regrouping.

We marked the wing tags of the tutors and control tutors with a fine red contour to distinguish them from the target birds during the scans. Therefore, we were able to analyse the behaviour of the tutors, the target chicks and the control tutors. To compare the five tutors with an equal number of target animals we marked the wing tags of five randomly chosen target animals of each pen with a fine green contour.

Behavioural Observations

We made behavioural observations from the corridor, looking through the glass doors, as described by Huber-Eicher & Wechsler (1997, 1998). We observed the chicks of each pen (tutors and target birds) for periods of 30 min. During an observation all occurrences (Altmann 1974) of nonaggressive feather-pecking interactions between individuals were recorded. Only pecks at feathered parts of conspecifics were classified as feather pecking. Pecks at legs, beaks, combs or wattles were disregarded. Repeated pecks directed at the same individual were judged as one interaction. An interaction ended when there were no pecks for 4 s. For each interaction we noted the actor and the receiver. The rate of feather-pecking interactions is given as number/30 chicks per 30 min.

Every 5 min, the 'all occurrences sampling' of feather-pecking interactions was briefly interrupted for a scan sample (Altmann 1974) of the activity of the chicks. In each scan we noted the location (i.e. on sand or on slats) of each chick and in which of 12 mutually exclusive activities it was engaged. We divided the activities into foraging behaviour and other behaviour. Foraging behaviour included: 'ground pecking': pecking at the ground; 'object pecking': pecking at the wall, metal of the feeder, particles on bill, toes or feathers of conspecifics (e.g. food, dust); 'scratching': scratching the ground, the wall or the feeder; 'staring at objects': the chick inclined its head and stretched its neck in the direction of an object; 'head down': the chick stood or moved with its head lower than the rump, without showing another defined behaviour. Other behaviour was: 'dustbathing': the chick showed vertical wing shaking (a behaviour typical of dustbathing, Kruijt 1964) or had shown vertical wing shaking before the scan and had not yet finished this dustbathing bout, that is, had not shown body/wing shaking (Kruijt 1964) in a standing position or had not moved away from the dustbathing site; 'feeding': the chick was by the feeder with its head above the food; 'drinking': the chick's bill was oriented to, and within 5 cm of, the cup drinkers; 'preening': the chick nibbled, stroked or combed its plumage with its beak (Kruijt 1964) or stretched its wings or legs; 'moving': locomotion without showing another defined behaviour; 'standing': standing on both feet without showing another defined behaviour; 'resting':

the chick showed no other defined behaviour while its chest feathers touched the ground. The percentage of chicks engaged in each behaviour was calculated from the total number of chicks observed during all scan samples in each pen.

An observation session consisted of 2 days of observations during which the chicks of each pen were observed for 30 min once in the morning between 0900 and 1200 hours and once in the afternoon between 1300 and 1600 hours. As there were two observers, each pen was observed in a randomized order and once by each person during each session.

For all pens we had one observation session (2 × 30 min) before the regrouping at the end of week 4 to evaluate the degree of feather pecking of the group of chicks in the unrestricted housing conditions and of each chick in the restricted housing conditions. Additionally, we observed each of the restricted pens for an extra 30 min. Thus we were able to determine the 10 chicks with the highest feather-pecking rates of each of the four pens with restricted housing conditions. In weeks 5 and 6, after regrouping, we had two observation sessions to detect the effect of the tutors on the behaviour of their groups.

To record the data we used laptops and the software system 'The Observer 3.0' (Noldus Information Technology, Wageningen, The Netherlands).

Plumage Quality Control

Between the two observation sessions after regrouping, we assessed the quality of the feathers of the target chicks to check whether the high feather-pecking frequencies of the experimental tutors had an effect on the feathers of the target birds. In each pen we randomly chose five target chicks and scored their plumage from 1 to 4: 1: plumage without damage; 2: plumage with damaged feathers; 3: plumage with bare parts; 4: with bloody injuries. The person judging the plumage did not know from which treatment the chicks came.

Ethical Note

The number of birds was kept to a minimum that none the less ensured a reasonable statistical power. To prevent unnecessary suffering, we kept the time between the first occurrence of feather pecking and the end of the experiment as short as possible. The pens were checked for injuries at least twice a day (morning and afternoon) and also during behavioural observations when the observers moved from one pen to the next, and during the cleaning and rearranging of the treatments which had to be done roughly every second day. When there were pens with newly injured birds we checked all the pens more frequently. Checking the chicks for injuries caused no disturbance as the checks were done by looking through the glass doors. In this way all the chicks could be seen easily and it was not necessary to enter the pen.

We could reduce feather pecking at any time during the experiment by lowering the light intensity and by adding foraging material as in Huber-Eicher & Wechsler (1997, 1998). However, we never had to apply this measure.

To avoid unnecessary pain, we covered all injuries, which were never larger than 0.25 cm^2 and affected only the integument, not the muscle tissue, with tar or commercial 'feather-pecking spray', which effectively prevented other chicks from pecking at the wounds. This was necessary for 49 chicks out of 480. Two of these we had to remove from their groups in week 3 and keep in a separate pen. This was necessary because one had a blood drop from a 1-mm slit in the skin of the toe and we wanted to prevent the development of 'toe pecking', and the other showed a haematoma (0.5 cm^2) on one side of its head, which resulted in its penmates pecking continuously at the blue spot.

Nine birds (1.9%) died in the first 10 days, which is in the range of commercial rearing. They probably had problems digesting the food and so would not have been able to change from yolk to feed as their source of energy. While it is sometimes reported that chicks fail to start feeding, that is unlikely to have been the case here given the easy access to food described above.

The experiment was subjected to the authorization procedure prescribed by Swiss animal welfare legislation.

Statistical Analysis

We treated the pens as independent observation units and pooled the observation data of weeks 5 and 6. Given our small sample sizes, we could not reliably assess whether the data were normally distributed. We therefore used nonparametric statistics. Statistical tests are two tailed with an alpha level of 0.05. All analyses were performed using JMP (Sall & Lehman 1996) and the statistical tables published in Rohlf & Sokal (1981).

Of all the behaviour recorded by scan sampling, we analysed foraging behaviour and the activities feeding, drinking, moving and preening, as they are relevant to feather pecking (Hughes 1982; Eriksson 1995; Keeling & Jensen 1995; Huber-Eicher & Wechsler 1997).

RESULTS

As intended, after regrouping experimental tutors continued with high frequencies of feather-pecking interactions (median 50.3; Fig. 2) while the control tutors stayed at a low level (median 12.0; Mann–Whitney *U* test: U=64, N_1=N_2=8, P<0.002).

Target birds of the experimental groups showed significantly higher rates of feather pecking than the target birds of the control groups (median 15.9 and 6.8, respectively; Mann–Whitney *U* test: U=64, N_1=N_2=8, P<0.002; Fig. 2) and also spent significantly less time foraging (median 21.7 and 24.6, respectively; U=55, N_1=N_2=8, P=0.02). A significantly lower percentage of target chicks of the experimental groups engaged in ground pecking (median 11.2 and 13.2, respectively; U=53, N_1=N_2=8, P<0.05) and scratching (median 0.8 and 1.1, respectively; U=54, N_1=N_2=8, P<0.05). Target birds of both groups did not peck tutor birds more often than would be expected by the ratio of target to tutor birds (Wilcoxon signed-ranks test: experimental groups: T^+=27, N=8, NS; control groups: T^+=11, NS).

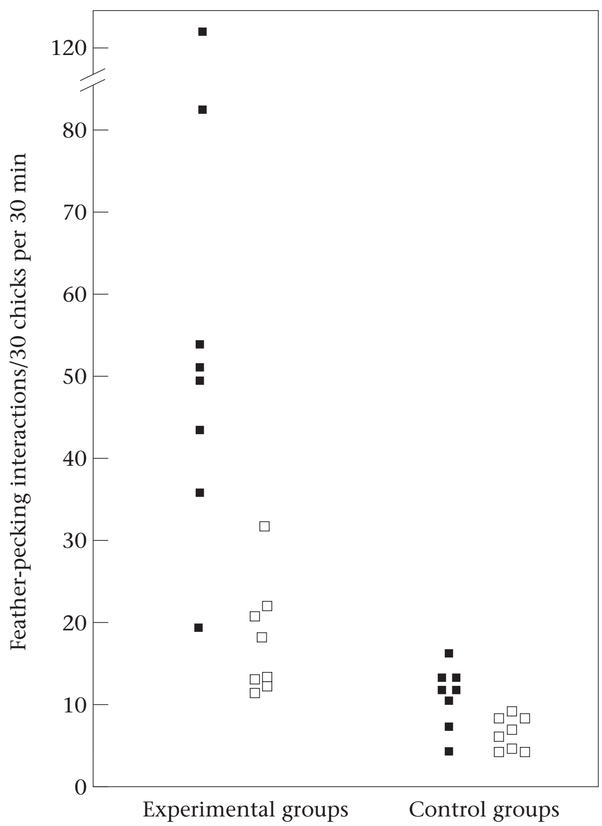

Figure 2. Rates of feather pecking of tutors (■) and target chicks (□) in experimental and control groups.

Mann–Whitney *U* tests showed no significant differences between the percentages of the target chicks of the experimental and control groups engaged in moving (median 6.4 and 5.7, respectively; U=39, N_1=N_2=8, NS), feeding (median 8.8 and 9.8; U=40, NS), drinking (median 2.8 and 2.9; U=32, NS) and preening (median 20.6 and 20.8; U=37, NS).

Save for feather-pecking frequencies, there were no differences in the behaviour of experimental and control tutors. There was no significant difference in the percentage of tutor chicks engaged in foraging behaviour in experimental groups compared to control groups (median 23.1 and 29.3, respectively; Mann–Whitney *U* test: U=44, N_1=N_2=8, NS), or in the other behaviour relevant to feather pecking (moving: median 6.9 and 5.7; U=48.5, NS; feeding: median 8.6 and 9.4; U=33, NS; drinking: median 3.99 and 3.61; U=39.5, NS; preening: median 16.74 and 18.42; U=36, NS).

No significant difference in plumage condition was detected between the target birds of experimental and control groups in week 6 (median 1.4 and 1.4 feather score; Mann–Whitney *U* test: U=35.5, N_1=N_2=8, P>0.2).

DISCUSSION

Introducing feather-pecking individuals into groups of laying hen chicks started the development of feather pecking in these groups and led to significantly higher frequencies of feather pecking than in control groups. Less foraging behaviour was observed simultaneously, while for other behavioural elements no changes were detected. Explanations for the observed differences in feather pecking such as increased pecking because of regrouping or differences in the behaviour of experimental and control tutors (except for the feather pecking) can be excluded. We can also exclude the possibility that the transmission of feather pecking simply results from pecked birds reacting to feather pecking by pecking their ‘adversary’. If this were the case, feather-pecking tutors, which delivered far more feather pecks than the other birds, should have been pecked more often than the target birds, which was not the case. The development of feather pecking was also not a reaction to an increased incentive value of damaged feathers as there were no differences in plumage quality of experimental and control groups. McAdie & Keeling (1999) found that in addition to damaged feathers ruffled feathers also elicit feather pecking. However, as they studied brown laying hens, it is likely that the bright spots from the uncovered down feathers rather than misalignment of the feathers elicited feather pecking. We conclude that social transmission is the only plausible mechanism explaining the observed differences in feather pecking in our study. Therefore feather pecking may be transmitted from one bird to the other which may explain how it spreads in groups of laying hen chicks.

There are mainly two ways in which social transmission may occur (for a review, see Galef 1988 and Nicol 1995): imitation and stimulus enhancement. While the former involves copying the exact motor pattern of the tutor, stimulus enhancement draws the attention of the observer to previously irrelevant features. Here the target animals’ attention seemed to be drawn to tutors pecking at the feathers of conspecifics. We frequently observed target animals watching a tutor pecking at the feathers of a third chick, approaching it, and then starting to peck the same animal. At times, this led to a ring of several birds, each pecking the tail of the bird in front.

Apart from feather pecking, the target birds in the experimental groups also differed in their foraging behaviour, but not in other behaviour. While showing higher frequencies of feather pecking, they spent less time foraging than the target birds in the control groups. They actually showed less ground pecking and scratching, even though the stimuli relevant to foraging were not different from control pens. The observed differences give clear evidence that feather pecking and foraging behaviour are governed by the same motivational system as proposed by several authors (Wennrich 1975; Blokhuis & Arkes 1984; Blokhuis 1986; Huber-Eicher & Wechsler 1997, 1998).

Social transmission, as found in this study, is a mechanism that facilitates the acquisition of pecking at the feathers of conspecifics. Another interesting aspect confirmed in this study is the strong influence of housing conditions on feather pecking. Differences in the feather-pecking rates of experimental and control tutors (induced by differences in housing conditions) were clearly larger than those of control and experimental target birds (differences induced by social transmission). We may conclude that the effect of social transmission is less pronounced than the effect of housing conditions that do not offer adequate opportunities for foraging. Nevertheless, we found significant differences in the rate of feather pecking that can be attributed to the social transmission of this behavioural disorder. Thus social transmission may explain how feather pecking spreads in a flock.

Acknowledgments

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