Relationship between feather pecking and ground pecking in laying hens and the effect of group size

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Accepted 31 December 1999

Abstract

The aim of this experiment was to study the relationship between feather pecking and ground pecking in laying hens and the effect of group size on feather pecking behaviour. Hisex White hens were kept in floor pens in group sizes of 15, 30, 60 and 120 birds, each with four replicates. Behavioural observations were performed at four different ages and focused on the number of feather pecks and aggressive pecks, both given and received. The part of the body pecked and the location of the bird was recorded as well as the number of pecks made to the floor, feeder and drinker.

The results showed that most feather pecking activity occurred in the largest group size (120 birds) and there was some evidence of an increasing frequency of aggressive pecks with increasing group size. The parts of the body which were targets for feather pecking varied depending on the location of the bird giving the peck and the bird receiving it. When looking at the behaviour of individuals, birds doing a lot of feather pecking also showed more ground pecking. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Chicken-social behavior; Feather pecking; Ground pecking; Group size

1. Introduction

The term feather pecking is understood to mean pecking directed at the feathers of other birds, with feathers sometimes being pulled out and eaten. Apart from being a
serious welfare problem, feather pecking has considerable economic consequences. Poorly feathered birds have higher energy needs and feed intake can rise by almost 30% (Emmans and Charles, 1977; Tauson and Svensson, 1980).

It is known that factors such as light intensity, food composition, stocking density, group size and hormonal changes, can influence the occurrence of feather pecking (for an overview see Hughes, 1982; Hughes and Duncan, 1972; Savory, 1995). It has also been shown that breeds differ in their propensity to feather peck (Hughes and Duncan, 1972; Abrahamsen et al., 1996; Savory and Mann, 1997) and that it is possible to use genetic selection to increase or decrease feather pecking activity (Craig and Muir, 1993; Keeling and Wilhelmsson, 1997; Kjaer and Sørensen, 1997).

Feather pecking can occur in several forms and authors classify them differently, e.g. severe and gentle (Keeling, 1994) or pecking, pulling, pinching and plucking (Wechsler et al., 1998). However, it has been shown that only the most severe type of feather pecks are responsible for damage to plumage (Bilčik and Keeling, 1999).

Although many factors can influence feather pecking (as mentioned earlier), the primary cause is still not clear. Currently, there are two hypotheses explaining the causation of feather pecking. Both of them build on the idea of “redirection” of pecks from the substrate to the feathers of other birds. One hypothesis suggests that feather pecking represents misdirected pecks at the substrate during dustbathing (Vestergaard et al., 1993). The alternative hypothesis considers that feather pecking evolves as part of foraging behaviour and so is redirected ground pecking (Hoffmeyer, 1969; Wennrich, 1975; Blokhuis and Arkes, 1984). The latter is supported also by recent findings from Huber-Eicher and Wechsler (1997, 1998). A common point in both hypotheses is the importance of early experience (Blokhuis, 1986; Vestergaard et al., 1993). Although provision of an appropriate pecking substrate from an early age can affect the occurrence of feather pecking in adult birds, it does not prevent it from developing (Huber-Eicher and Wechsler, 1997; Johnsen et al., 1998).

Further studies showed that a higher feather pecking rate is usually associated with a lower rate of ground pecking (e.g. Blokhuis and van der Haar, 1992; Savory and Mann, 1997); however, the opposite results can also be found, i.e. a positive correlation between feather pecking and ground pecking (Hansen, 1994).

In the present experiment, laying hens kept in deep litter pens were used to study the relation between feather pecking and ground pecking in individual birds and the effect of group size on feather pecking behaviour.

2. Material and methods

2.1. Animals and housing

Nine hundred Hisex White laying hens, raised on deep litter from day 1 were used in this study. They were kept in groups of 15, 30, 60 and 120 birds, with each group size having four replicates, making 16 pens in total. Pens were arranged within a randomised
block design in one building. The space allocation (0.2 m²/bird) was the same in all pens, i.e. the size of the pen varied according to the group size. Also, for all other resources such as space at the feeder, drinker, perch or nest, the allocation per bird was kept constant across all group sizes, as was the arrangement of these in the pen. Perches were at three different heights from the ground (25, 50 and 75 cm). Food and water were provided ad libitum. During the experiment the birds were kept on a 16-h day, with an average temperature of 20°C. Twelve randomly chosen birds from each pen were marked with large plastic wing tags on both wings and used as focal birds for behavioural observations. The tags allowed us to identify focal birds from outside the pen and did not attract pecking.

2.2. Behavioural observations

A series of observations was performed at the ages of 22, 27, 32 and 37 weeks. Each series covered observations of all 192 focal birds and was carried out over four days. Two pens were observed in the morning and two in the afternoon, combining group size, replicate and time of the observation in a balanced way. The observer sat outside the pen on an elevated chair, with a good view over the whole pen. To get the birds accustomed to the observer’s presence, the observer sat quietly for 5 min before starting the recording session. The observation started by recording the behaviour of the bird with the lowest tag number, then switching to the next highest tag number, until all 12 focal birds had been observed. Each bird was observed for 5 min. The same observation order within the pen was used at each age. Data were recorded directly on a portable computer, using The Observer® software for behavioural research, version 3.0 for DOS (Noldus Information Technology, 1990). All behavioural observations were carried out by the same observer.

The following behavioural activities were observed.

1. Feather pecks (gentle, severe) — feather pecks were classified as gentle (exploratory pecks, not resulting in feathers being pulled out and usually without reaction from the recipient bird) and severe (forceful pecks, often with feathers being pulled out and with the recipient bird moving away).

2. Aggressive pecks — aggressive pecks were directed mainly at the head, given in a downward direction and were always severe and fast. When the attacked bird tried to escape, an aggressive peck could be directed to another part of its body. These latter pecks, however, were rare and are not included in the analysis.

3. Part of the body pecked (11 regions) — the body was divided according to Gunnarsson et al. (1995) into 11 areas: head, upper neck (back side of the neck), back (part between wings), rump, tail, belly (abdomen), breast, under neck (front side of the neck), wings — primary feathers, wings — coverts and legs.

4. Pecks on non-feathered areas (beak, toes, wing tag).

5. Pecks at feeder, drinker, floor and other objects.

6. Manipulation of feathers on the floor — pecking at feathers on the floor, eating feathers and running with feather in the beak.

The location of the bird (floor, perch, nest box, other) was recorded, and for behaviours (1), (2), and (4) whether the peck was given or received was also noted.
2.3. Statistics

Observations of our focal animals were repeated at four different ages. Since these observations did not differ consistently when the data was plotted out for each age separately, we have pooled the data to increase the number of pecks in the different categories. Thus, instead of having $4 \times 5$ min of observations, we used one 20-min data set per bird.

To examine the differences between groups, ANOVA and for post-hoc comparisons Tukey HSD tests were used. The data were transformed to logarithms prior to analysis; however, in the figures, we report back-transformed mean values with 95% confidence intervals. Correlations were calculated using Pearson correlation. Differences in the number of pecks to different body parts depending on the location of the bird were calculated using a $z$-test based on proportions.

3. Results

3.1. Variation in pecking activity with group size

When comparing hens reared in the four different group sizes, we found most feather pecking in the largest group and an increasing frequency of received aggressive pecks with increasing group size.

We found no significant difference in the number of gentle feather pecks given (Fig. 1a). For severe pecks given (Fig. 1c), groups 120 differed from groups 15 ($p = 0.045$) and 60 ($p = 0.028$). For gentle feather pecks received (Fig. 1b), group 120 differed significantly from groups 15 ($p < 0.001$), 30 ($p = 0.004$) and 60 ($p = 0.028$). In the number of severe feather pecks received (Fig. 1d), groups 120 differed significantly from all other groups ($p < 0.001$ for all). We found no significant difference in the number of aggressive pecks given (Fig. 2a). A gradual increase in aggressive pecks received as group size increased can be seen in Fig. 2b; however, only the differences between groups 15 and 30 ($p = 0.019$) and groups 15 and 120 ($p < 0.001$) were significant.

The average frequency of ground pecking in the groups of 15, 30, 60 and 120 hens was 195, 208, 252 and 163 pecks per bird per hour. Groups did not differ in the amount of pecks on the ground, food, drinker and other objects. Neither were there differences in pecks on beak, toes and wing tag or manipulating feathers on the floor, according to group size. However, birds in the groups of 120 were observed to eat significantly more feathers than the groups of 15 ($p = 0.006$).

3.2. Location in the pen and body parts pecked

Along with pecking activity, the location of the pecking/pecked bird in the pen and the part of the body where the peck was targeted was recorded. There were no
significant differences between groups in the time spent at certain locations in the pen. Birds spent on average 70% of the time on the floor, 26% on the perch, 3% in the nest and 1% on other locations (such as the top of the feeder, etc.).

Our next question was whether the target of feather pecks differs depending on the location of the pecking/pecked bird. To ensure a sufficient number of pecks at each body part, severe and gentle pecks were combined. We compared the distribution of pecks to different body parts while the birds were on the floor, with the distribution of pecks when the birds were on the perch (expressed as percentages of the total number of pecks given or received on either floor or perch).

While standing on the floor, the birds gave significantly ($p < 0.001$) more pecks to the belly of other birds than when the peckers were on the perch (Fig. 3a). However, when the birds were on the perch, they pecked significantly more to the neck
Fig. 2. (a,b) Back-transformed mean frequencies of aggressive pecks (given or received) per bird per hour with corresponding 95% CI, comparing the four different group sizes. Columns with different superscripts differ significantly at least $p < 0.05$.

($p = 0.006$) and rump ($p < 0.001$) of others than when the pecking birds were on the floor. Other areas did not differ or were not comparable (zero values).

The percentage of pecks received by a bird when on the floor and when on the perch differed even more (Fig. 3b). The percentage of pecks received on the head, back and tail when the bird was on the floor was significantly higher (head: $p < 0.05$; back and tail: $p < 0.001$) than the percentage of pecks received at those areas when the bird was on the perch. On the other hand, wing-coverts, belly, breast and underneck were the areas receiving significantly more pecks when the bird was on the perch (coverts, underneck and belly: $p < 0.05$; breast: $p < 0.001$).

### 3.3. Relation of feather pecks and ground pecks

To look more specifically at the relation between feather pecking and ground pecking, we correlated gentle and severe feather pecks of our focal birds with the number of pecks directed at the ground, food and drinker. This was carried out for each group size separately. In none of our four group sizes could we find a negative correlation between any of the combinations of feather pecking and other types of pecking (pecks at the ground, food or drinker), that would support the hypothesis that feather pecking is redirected ground pecking. Correlating group averages was not significant either. In case the result was influenced by the large number of birds that showed zero feather pecking, the correlations were repeated using only the birds that performed at least one feather peck, but still no significant negative correlation was found.

On the contrary, in the groups of 120 we found a significant positive correlation between severe pecks given and the number of pecks to the floor ($r = 0.41; p = 0.004$).
Fig. 3. (a,b) Location of pecking/pecked bird (floor or perch) and the distribution of feather pecks over the 11 body parts, expressed as a percentage of the total number of feather pecks (a) given or (b) received on a particular body part. (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$).
4. Discussion

The results of our experiment showed that most feather pecking activity occurred in the largest group size and that the part of the body which became the target for pecking varied depending on the location of the bird giving the peck and the bird receiving it. We found no evidence of a negative correlation between the number of feather pecks and the number of pecks on the ground, as might be expected if feather pecking is redirected ground pecking. In fact, in the largest group size we found a positive correlation.

4.1. Feather pecking

Feather pecking is usually examined on a group basis, taking the mean or median as the indication of feather pecking activity. Only a small percentage of birds, however, is responsible for most of the feather pecking. When looking at individuals, Keeling (1994) reported that less than 9% of hens kept in floor pens accounted for over 50% of all severe pecks, which is comparable with 8.3% peckers in our experiment. In the study of Wechsler et al. (1998), 12% of the birds were classified as “high rate” peckers.

That only a small percentage of our focal birds gave severe pecks, but almost all birds received them, can probably account for the overall number of feather pecks given being smaller than the number of feather pecks received in this study. Also, the fact that in the numbers of pecks received, the pecks from focal birds but also from non-focal birds were included, whereas pecks given were only recorded for focal birds, probably contributed to this difference. A similar difference in given/received pecks can be seen in the numbers of aggressive pecks.

4.2. Group size effect on feather pecking and aggression

Several authors have already studied the effect of group size on feather pecking and aggression. Those experiments which have controlled for variation in stocking density, however, have usually been carried out on rather small groups or on caged birds. Allen and Perry (1975) found more feather pecking in groups of six hens than in groups of three hens housed in cages, whereas Cunningham et al. (1988) failed to find differences in feather scores between groups of four and six hens. When comparing groups of 10, 20 and 40 pen-housed hens, Hughes and Duncan (1972) found most pecking damage in the largest group. In our study, the most pronounced difference was between groups of 120 and smaller groups. Feather pecking is highly unpredictable and commercial flocks with much larger group sizes can often have no problems with feather pecking. When controlling for other factors, however, group size certainly plays an important role. Based on the number of aggressive pecks received, we found an increasing level of aggression with increasing group size. Hughes and Wood-Gush (1977) also found more aggression in larger groups, though with much smaller group sizes (three and six birds per cage). Although as is the case with feather pecking, increasing the size of the group does not necessarily mean an increase in the level of aggression. The relationship might not be linear and, as proposed by Pagel and Dawkins (1997), birds in very large groups
may have a different strategy to establish relations in the group. Aggression in these
groups can actually be lower than in small groups (Lindberg and Nicol, 1996; Hughes et
al., 1997).

4.3. Location in the pen and body parts pecked

A different approach when studying feather pecking is to look at the location in the
pen where feather pecking occurs and also on the activity of the pecked bird. Both
Gunnarsson et al. (1995) and Johnsen et al. (1998) observed most feather pecking to
occur on perches, followed by the floor and around the feeder, although there were
differences between flocks, treatments and ages. In our study, the most received feather
pecks were observed on the floor (63%), compared to the perch (37%), perhaps
reflecting that there was much more floor space than perching space. That so much
feather pecking occurs on perches might be surprising, but it could be explained by the
fact that a perching bird is an easy target to a bird below it. It would be reasonable in the
future, therefore, to design perches so that birds standing or walking on the floor could
not reach birds on perches.

Concerning the activity of pecked birds, Keeling (1995) found that gentle feather
pecks were directed mostly towards a dustbathing bird, whereas severe feather pecks
were directed at a feeding or preening bird. This finding differs from Vestergaard et al.
(1993), who found a high rate of severe feather pecking during dustbathing in hens who
failed to synchronize their dustbathing with other pen mates. Depending on the genetic
strain, Savory and Mann (1997) observed most feather pecks while the pecked bird was
standing or dustbathing (Hisex) and standing or feeding (White Leghorn) and Wechsler
et al. (1998) showed that most feather pecks were received during resting or standing,
with very few during eating or dustbathing. Thus, there is considerable variation
between studies. In our experiment, we tried to explain some of this variation by looking
further at the distribution of feather pecks depending on the relative locations of the
pecker and the pecked bird. The clear preference to peck on the rump and neck of
another bird while the pecker is on the perch can be explained by the accessibility of
those parts by the bird perching beside it. While the pecker was standing on the floor,
most pecks were directed at the belly of another bird, probably because of the fine
downy feathers which are easy to pull out. On the other hand, when looking at the bird
receiving feather pecks, if this bird was perching it received most pecks on the breast,
belly and coverts. This again probably reflects the easy accessibility of those parts to
birds on the floor. On some occasions, a bird on the floor was even seen to jump to
reach up and peck at the belly or breast of birds on the highest perch. This effect of the
relative locations of the pecker and pecked bird in this study dominated any minor
differences due to the activity of the pecked bird.

4.4. Redirection of ground pecks

Blockhuis and van der Haar (1992) showed that by increasing the incentive value of
the ground (by adding grain), one can decrease the amount of feather pecking in the
group. A similar effect was achieved by providing hens with straw (Huber-Eicher and
Wechsler, 1997). On the group level, this effect was very clear, however, the analysis did not show whether individual birds that do a lot of feather pecking actually show less ground pecking than birds that do not show feather pecking. Unlike the previous papers, Hansen (1994) directly correlated the numbers of floor pecks and feather pecks and found them to be positively correlated, in both cages and aviaries. This is in agreement with the positive correlation found in our experiment in the largest group. One possible explanation for this might be that feather peckers are generally more active, performing more feather pecking as well as ground pecking. When comparing time budgets of feather peckers and nonpeckers, Eriksson (1995) found that peckers spent significantly more time walking and there was a tendency to ground peck more (see also Keeling and Wilhelmson, 1997). Savory and Mann (1997) also found feather pecking positively linked to the activity of the group. Age might play a role as well, since the frequency of pecking-related activities changes over time (Hughes and Grigor, 1996; Savory and Mann, 1997). Adult birds were studied both in Hansen (1994) and our experiment, whereas Huber-Eicher and Wechsler (1997, 1998) studied young birds.

Although we did not find a negative correlation between the number of feather pecks and ground pecks, our results are not necessarily in contradiction with the ground peck redirection hypothesis. The observations would need to be repeated on young chicks. This experiment does confirm, however, that no such redirection occurs in adult birds and even suggests the opposite, that feather pecking birds ground peck more.

5. Conclusions

Group size is one of the important factors influencing the occurrence of feather pecking. When looking at the behaviour of individuals, birds doing a lot of feather pecking also showed more ground pecking. The parts of the body which became targets for feather pecking depend on the relative locations of pecking and the pecked birds.

Acknowledgements

This research was supported by the Swedish Board of Agriculture, the Federation of Swedish Farmers, the Swedish Institute and ODAL (the Swedish Farmer’s Cooperative). Thanks are also due to the Bergsten family and the members of the Department of Animal Environment and Health for practical help.

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