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Are genetic differences in foraging behaviour of laying hen chicks paralleled by hybrid-specific differences in feather pecking?

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Abstract

Feather pecking is a behavioural disorder in laying hens which consists of pecking the feathers of conspecifics, causing feather damage or even injuries to the skin. Its development can be explained by redirection of foraging behaviour. While the occurrence of feather pecking strongly depends on the kind of housing condition, it is also known that there are strain differences in the tendency to feather peck. From the inverse relation between feather pecking and foraging behaviour found earlier, we hypothesised that genetically determined differences in foraging behaviour could be responsible for the observed differences in feather pecking between strains.

In a first experiment we tested whether there are differences in the foraging behaviour of two hybrids. As hybrids, we used Lohman selected leghorn (LSL) and Dekalb; eight groups of 20 1-day old chicks each. They were kept in enriched pens (265 cm×90 cm) with a litter area (200 cm×90 cm) consisting of wood-shavings, chaff, straw, polystyrene blocks, sand area (65 cm×90 cm) and elevated perches. Behavioural observations were carried out in week 4. In a subsequent experiment with the same birds we tested how the foraging behaviour of the two hybrids differed when housing conditions were changed from enriched to restricted and to what extent they developed feather pecking. A 2×2 factorial design with hybrid (LSL, Dekalb) and housing condition (restricted, enriched) as factors and with four replicates of each factor combination was used. Half of the pens of each hybrid were changed from enriched to restricted housing conditions by covering the litter area with slats. Behavioural observations were carried out in weeks 5 and 6.

In experiment 1, LSL and Dekalb spent the same amount of time foraging, but Dekalb spent significantly more of that time with pecking and hacking at the polystyrene blocks. On the other hand, LSL spent significantly more time at the feeding troughs and rested significantly less than Dekalb. In the restricted environment of experiment 2, again, the total foraging time did not differ between hybrids, but LSL chicks spent significantly less time scratching, while Dekalb spent

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significantly more time moving. Both hybrids developed feather pecking but LSL showed significantly higher rates than Dekalb.

Our results demonstrate genetic differences in the foraging behaviour and in the way hybrids cope with the change in housing condition from enriched to an environment that is restricted in relation to foraging possibilities. We conclude that the results support the hypothesis put forward that genetic differences in foraging behaviour could be the basis for the genetic influence in the development of feather pecking. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Chicken-anomalous behaviour; Feather pecking; Redirected foraging; Hybrids; Genetics

1. Introduction

Generally it is agreed that feather pecking is a redirection of normal pecking behaviour and that it is especially prominent in barren housing conditions (Hughes and Duncan, 1972; Hughes, 1982; Blokhuis and Arkes, 1984; Vestergaard and Lisborg, 1993). Clear evidence was found that it is influenced by the motivational system of foraging and feeding (Blokhuis and Arkes, 1984; Blokhuis, 1986; Huber-Eicher and Wechsler, 1997, 1998). Huber-Eicher and 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 behaviour is important with respect to feather pecking. Like other authors, they concluded that feather pecking is to be considered as redirected foraging behaviour.

A number of studies have explored the genetic influence on feather pecking behaviour. Walser (1997) found a significant difference in the feather pecking behaviour of two white layer hybrids kept under identical housing conditions. Bessei (1984) also observed strain differences and Cuthbertson (1980) and Kjær and Sørensen (1997) reported that feather pecking behaviour has an inherited component. Hughes and Duncan (1972) found extensive strain differences in the rates of feather pecking and they suggested that pecking of other birds has a genetic as well as a phenotypic basis. Craig and Muir (1993) concluded from their study, that stocks having high levels of cannibalism when kept with intact beaks could benefit from selection against beak-inflicted injuries.

To summarise, there is evidence for a genetic background that causes different hybrids of laying hens to show more or less feather pecking when confronted with restricted housing conditions. But to our knowledge no study has yet been done to investigate the genetic background of foraging behaviour. From the inverse relation between feather pecking and foraging behaviour found in earlier work (Blokhuis and Beuving, 1993; Huber-Eicher and Wechsler, 1998), we hypothesised that genetically determined differences in feather pecking are paralleled by genetic determined differences in foraging behaviour. With differences in foraging behaviour, different hybrids would have different prerequisites for coping with the change from an enriched environment to an environment that is restricted in relation to foraging behaviour. Different tendencies to develop feather pecking under the new housing conditions would be the result.

In a first experiment we therefore tested whether there are differences in foraging behaviour between two commercial laying hen hybrids, white Lohman selected leghorn (LSL) and white Dekalb, which had shown different tendencies to feather peck under

experimental conditions (Walser, 1997). On an average, the LSL hybrid is heavier and has a higher laying performance while eating less food per kg laid egg mass than Dekalb (Walser, 1997; Petersen, 1998). The chicks were kept in a rich environment that offered a wide range of possible foraging elements of domestic hens like for instance ground pecking, scratching or object pecking (Kruijt, 1964; Fölsch and Hoffmann, 1995).

In a subsequent experiment we tested how the foraging and feather pecking behaviour of the two hybrids differed when changed to be more restricted with respect to foraging possibilities. We chose a 2×2 factorial design to determine the influence of the housing conditions and the genetic background, i.e. the type of hybrid. We were especially interested in possible interactions between the two factors as they would indicate hybrid-specific differences in the behavioural reaction to restricted housing conditions.

2. Methods

2.1. Subjects and housing

In our experiment we used 400 female layer chicks (not beak trimmed) of two different hybrids; 200 white LSL and 200 white Dekalb. They were bought from commercial breeders and introduced into the experimental pens at the age of 1 day. Care was taken that both hybrids arrived in the pens at the same time and that the duration of transport was the same for both. The chicks were then divided into 16 groups and raised with a density of 10.5 birds per square metre.

The groups were kept in 16 identical pens (265 cm \times 90 cm, mean height 235 cm) described in detail by Huber-Eicher and Wechsler (1997). The average daily temperature was 22°C. Artificial light was provided with a light intensity of about 60 lx at the height of the animals. Day length was kept at 12 h with a 15 min twilight phase at the beginning and end of the day. The first 24 h light was switched on continuously. For the first 4 weeks the chicks were provided with extra heat from a ceramic heating lamp (250 W). The animals had ad libitum access to a commercial starter food (mash) and water.

2.2. Procedures

When the chicks arrived from the hatchery they were randomly assigned to groups of 25 or 26 individuals of the same hybrid and distributed among the pens. During the first 5 days, chicks only had access to an area of 100 cm \times 90 cm nearest to the corridor to ensure that they stayed close to the food, water and heating lamp. A wooden barrier (height 25 cm) separated the rest of the pen. On day 17 we had to remove six male chicks which had been wrongly sexed by the hatchery. We also compensated for the death of seven chicks (1.7% of all chicks which is in the range of commercial rearing) by removing chicks from pens with 26 chicks, so as to have no bigger differences in group sizes than one chick. This resulted in group sizes of 24 or 25 chicks each.

The pens were controlled for injured birds at least twice a day (morning and midday). When necessary, injuries were covered with tar (or commercial 'feather pecking spray')

which effectively prevented other chicks from pecking at the wounds. This was necessary for 6 out of 400 chicks. At any time during the experiments, we had the means to reduce the rate of feather pecking by lowering the light intensity and by adding foraging material as in previous experiments by Huber-Eicher and Wechsler (1997, 1998). The experiments were subjected to the authorisation procedure prescribed by Swiss animal welfare legislation (application no. 37/98).

2.2.1. Experiment 1

During the first 4 weeks we created an enriched environment where the front area (200 cm×90 cm) of all the pens was covered with deep litter consisting of wood-shavings, chaff and straw. In the litter area the chicks had access to pieces of peat, dry leaves, willow branches and polystyrene blocks (10 cm×10 cm×15 cm) attached to bricks by means of rubber bands. Polystyrene blocks had proven to be very effective in stimulating foraging behaviour of laying hen chicks (Huber-Eicher and Wechsler, 1998). They were offered in two degrees of hardness (15 and 30 kg polystyrene/m³) in succession: at the end of the third week, the softer type was replaced by the harder one, as it was too easily decomposed by the chicks at this age. In each pen there were perches, for the first 16 days at the height of 17 cm, and then, up to the end of week 5, at the height of 40 cm. Then they were removed for easier observation of the chicks. The remaining floor area (65 cm×90 cm) at the rear end of the pens was slightly elevated (25 cm) and covered with sand. To ensure access to sand from the first day on, up to week 3, additional sand was presented in a round plastic dish (diameter 40 cm, depth 6 cm) in the litter area at the front of the pen.

2.2.2. Experiment 2

At the end of week 4 we applied wing tags (2.5 cm×2 cm) to all chicks. The wing tags were fixed around the upper wings by means of a crêpe rubber tape (width 1.2 cm). At the same time we changed the housing conditions in half of the pens of each hybrid to a restricted environment, by adding slatted floor to the front area. The dustbathing area was still available, the foraging material, however, was no longer accessible. The changes in housing conditions resulted in a 2×2 factorial design with hybrid (LSL, Dekalb) and housing condition (restricted, enriched) as factors and with four replicates of each factor combination.

In week 7 we measured the weight in each pen of ten randomly chosen chicks.

2.3. Behavioural observations

Behavioural observations were made from the corridor, looking through the glass doors (72 cm×142 cm) at the narrow side of the pens. The observations were done similarly as described by Huber-Eicher and Wechsler (1997, 1998). The chicks of each pen were observed for periods of 30 min. During the observations we recorded all occurrences (Altmann, 1974) of non-aggressive feather pecking interactions between individuals. We recorded repeated pecks directed at the same individual as one interaction. An interaction ended when there were no more pecks during an interval of 4 s. Only pecks at feathered parts of conspecifics were classified as feather pecking. Pecks at legs, beaks, combs or wattles were disregarded. For each interaction we noted the actor and the receiver. The rate

of feather pecking interactions is given as number of feather pecking interactions per 30 chicks for 30 min.

Every 5 min the 'all occurrences sampling' of feather pecking interactions was shortly interrupted for a scan sample (Altmann, 1974) of the activities of the chicks. In each scan we noted the location of each chick (i.e. on sand, perch, polystyrene blocks, slats or litter, respectively) and in which of the 13 mutually exclusive activities it was engaged. We divided the activities into Foraging behaviour and Other behaviour. Foraging behaviour: 'pecking at polystyrene blocks' — pecking and hacking at polystyrene blocks; 'object pecking' — pecking at the wall, feeder, cup drinkers, peat, dry leaves, willow branches or at particles on the plumage, bill or toes of conspecifics; 'ground pecking' — pecking at the ground/litter; 'staring at objects' — the chick inclines its head and stretches its neck in the direction of an object; 'head down' — the chick has its head in a lower position than the rump while standing or moving without showing ground pecking and 'scratching' — the animal scratches the ground/litter, the wall or the feeder. Other behaviour: 'feeding' — the chick is next to the feeder with its head above the food; 'drinking' — the chick's bill is oriented to the cup drinkers, while not further away than 5 cm; 'dustbathing' — the chick is showing vertical wing-shaking (a typical behaviour of dustbathing; Kruijt, 1964) or has shown vertical wing-shaking before the scan and has not yet finished this dustbathing bout, i.e. has not shown body/wing shaking (Kruijt, 1964) in a standing position or moved away from the dustbathing site; 'moving' — locomotion without showing another defined behaviour; 'standing' — standing on both feet without showing another defined behaviour; 'preening' — the chick is nibbling, stroking or combing its plumage with its beak (Kruijt, 1964) or it is stretching its wings or legs while standing or sitting and 'resting' — the chick shows no other defined behaviour while its chest feathers touch the ground or the perch. The percentage of chicks engaged in each behaviour was calculated from the total number of chicks observed during all scan samples in each pen.

Additionally to the described methods we did 'focal animal sampling' (Altmann, 1974) to assess the quality of the foraging behaviour. We randomly chose an animal and for 3 min we recorded the time spent performing any of the 13 mutually exclusive activities and the location of the birds. We observed 12 focal animals per pen.

We did one observational session in week 4 during experiment 1 and two sessions in weeks 5 and 6 during the course of experiment 2. An observational session consisted of 3 days observations. The all occurrences sampling of feather pecking and the scan sampling took place on two consecutive days. Each pen was observed once in the morning (between 09.00 and 12.00 h) and once in the afternoon (between 13.00 and 16.00 h) by two observers in a randomised order. An observer recorded each pen randomly either in the morning or in the afternoon. The focal animal sampling took place on the third day. Six focal animals per pen were observed in the morning (between 09.00 and 12.00 h) and six in the afternoon (between 13.00 and 16.00 h) in a randomised order. Again, an observer recorded each pen randomly either in the morning or in the afternoon.

2.4. *Statistical analysis*

The pens were treated as independent observational units. Observational data from weeks 5 and 6 were pooled. Mann–Whitney *U* test, 2×2 ANOVA and Chi-squares

goodness-of-fit test were used for analysis. Tests are two-tailed with an alpha level of 0.05. All analyses were performed using JMP[®] (Sall and Lehman, 1996) and the tables of Rholff and Sokal (1981), except for when using the Chi-squares goodness-of-fit test (Siegel and Castellan, 1988). When there was a significant interaction in the 2×2 ANOVA, we additionally did M.S.D. tests (Sokal and Rholff, 1981).

From the data of the focal animal sampling we only analysed the foraging elements; we calculated the total foraging time per pen by summing up the time the 12 focal animals in each pen spent on the six foraging elements. The time spent on these elements was then calculated as a proportion of the total foraging time recorded for the 12 focal animals of each pen.

From the data of the scan sampling, we analysed the total time foraging and the other behaviour. Due to an interaction in the foraging element scratching we used scan data to examine the preference for the scratching location. The focal data was not suitable for such an analysis as the number of starting locations of focal chicks on the litter/slat area and the sand area did not correspond to the relative proportion of the two areas.

3. Results

3.1. Experiment 1

The amount of time the two hybrids spent with foraging did not differ significantly (median values for LSL and Dekalb are 31.1 and 32.3, respectively; Table 1), but the quality of foraging behaviour was different. Dekalb manipulated the polystyrene blocks significantly longer than LSL (median values are 25.6 and 6.0, respectively; Table 2). The chicks stood on or beside the block, hacked and tore intensely at the polystyrene, sometimes for 3 min or longer. Often they showed food-running (Kruijt, 1964): an individual ran away with a small piece in its bill while being followed by one or more chicks. Small pieces of polystyrene were also swallowed. LSL and Dekalb showed no significant differences in the time they spent scratching (median values are 11.5 and 7.0,

Table 1
Percentage of total time spent on various behaviour by LSL and Dekalb chicks in an enriched environment^a

Behaviour	Median (%)		<i>U</i>	<i>p</i> -value [*]
	LSL	Dekalb		
Foraging	31.1	32.3	33	NS
Feeding	14.3	9.0	58	<0.01
Drinking	2.8	2.6	33	NS
Dustbathing	0.4	0.0	57	0.01
Moving	8.6	7.9	39	NS
Standing	9.6	12.2	48	NS
Preening	13.4	12.5	44	NS
Resting	19.5	22.7	61	<0.002

^a Data from scan sampling.

^{*} Mann–Whitney *U* test, $N_1=N_2=8$.

Table 2

Percentage of total time spent on different foraging elements by LSL and Dekalb chicks in an enriched environment^a

Foraging element	Median (%)		U	p-value*
	LSL	Dekalb		
Pecking at polystyrene	6.0	25.6	60	0.002
Object pecking	5.0	3.4	35	NS
Ground pecking	38.6	39.9	38	NS
Staring at objects	24.9	18.0	46	NS
Head down	8.9	10.2	41	NS
Scratching	11.5	7.0	44	NS

^a Data from focal animal sampling.

* Mann–Whitney U test, $N_1=N_2=8$.

respectively; Table 2). However, when analysing the location of scratching, Dekalb showed a clear preference for scratching in the litter area (Chi-square goodness-of-fit test: Chi-square=4, $p<0.05$), whereas LSL showed no preferences (Chi-square=0.11, NS). As for the rest of the foraging elements no statistically significant differences were found.

In the other behaviour the hybrids differed in the time they spent with feeding, dustbathing and resting (Table 1). The percentage of LSL chicks feeding and dustbathing was significantly higher than the percentage of Dekalb chicks (median values for feeding are 14.3 and 9.0 and for dustbathing 0.4 and 0.0). However, LSL chicks spent significantly less time resting than Dekalb chicks (median values are 19.5 and 22.7, respectively). No differences were found with the rest of the behaviour.

Pecking of the plumage of conspecifics was hardly ever seen (median values for LSL and Dekalb are 3.6 and 1.2, respectively). Nevertheless, LSL showed a statistically higher frequency than Dekalb (Mann–Whitney U test: $U=53$, $N_1=N_2=8$, $p<0.05$).

3.2. Experiment 2

Both the factor hybrid and the factor housing conditions had a significant influence on feather pecking. LSL chicks showed significantly higher rates of feather pecking than Dekalb (two-way ANOVA, $F_{1,12}=5.37$, $p=0.039$; Fig. 1) and, as expected, chicks in restricted housing conditions showed higher rates of feather pecking than in enriched housing conditions ($F_{1,12}=159.25$, $p<0.001$).

The time spent foraging was influenced by the factor housing conditions ($F_{1,12}=11.28$, $p=0.006$; Fig. 2), but not by the factor hybrid ($F_{1,12}=0.06$, $p=0.81$). The chicks kept in restricted housing conditions spent significantly less time foraging than in enriched housing conditions.

There was no statistically significant main effect of the factor hybrid on the quality of foraging behaviour measured by focal animal sampling (Table 3), but there was a significant interaction of the two factors hybrid and housing conditions for the foraging element scratching ($F_{1,12}=8.79$, $p=0.012$). An in-depth analysis of this result revealed that in enriched environment LSL chicks did not show any preferences for litter or sand (Chi-square goodness-of-fit test: Chi-square=0, NS) as was already observed in experiment 1. In

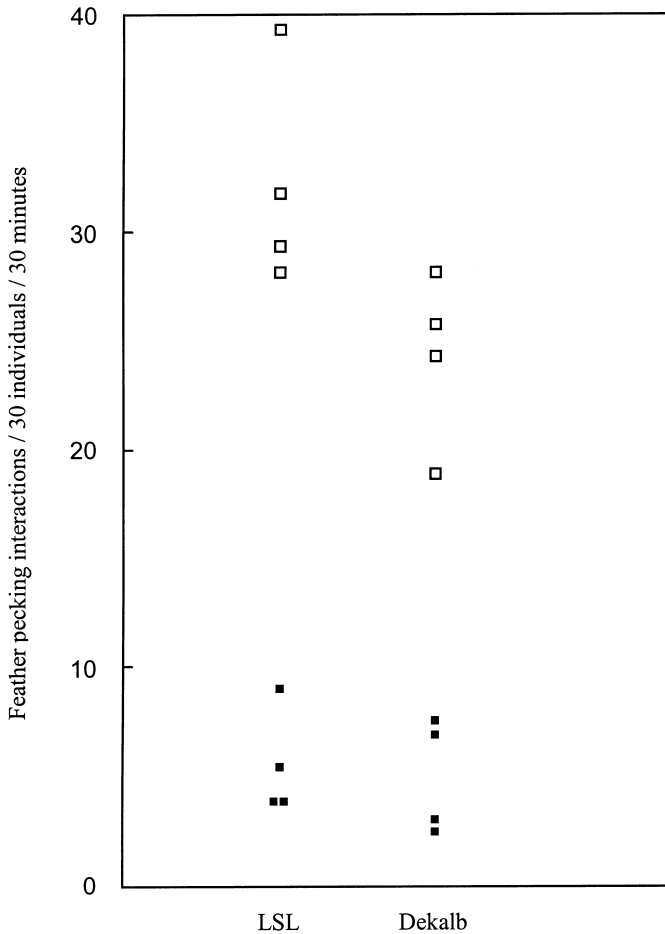


Fig. 1. Rate of feather pecking interactions in groups of LSL and Dekalb chicks kept in enriched (filled squares) and restricted (empty squares) housing conditions.

the restricted environment LSL completely stopped scratching in the littered area now covered with slats and increased scratching in the sand area (ANOVA: factor treatment, $F_{1,12}=6.13, p=0.029$), but this was not enough to compensate for not scratching outside the sand area and altogether LSL spent less time scratching in the restricted environment (M.S.D.=3.30). Dekalb chicks showed, as in experiment 1, a preference for scratching in the litter area when kept in an enriched environment (Chi-square goodness-of-fit test: Chi-square=6.3, $p<0.02$). When the litter area was covered with slats, they dramatically reduced scratching there, but at the same time they increased scratching in the sand area to such an extent that the total frequency of scratching was the same as in the enriched environment.

Contrary to the factor hybrid, the factor housing conditions had a significant influence on the foraging elements object pecking ($F_{1,12}=61.63, p<0.001$), ground pecking

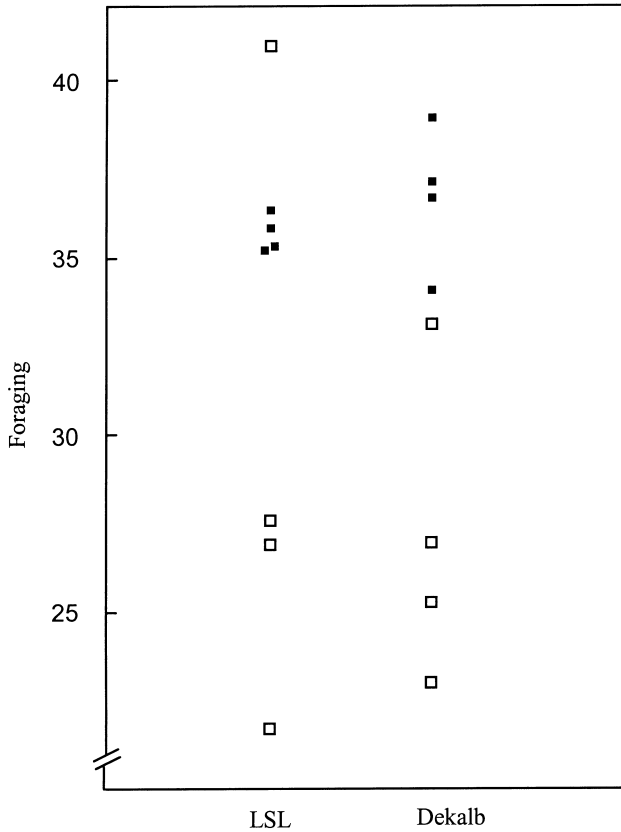


Fig. 2. Percentage of time spent foraging by groups of LSL and Dekalb chicks kept in enriched (filled squares) and in restricted (empty squares) housing conditions (data from scan sampling).

Table 3

Percentage of total time spent on different foraging elements by LSL and Dekalb chicks in restricted and enriched housing conditions^a

Foraging element	Mean (%)				<i>p</i> -value*		
	LSL	Dekalb	LSL	Dekalb	Factor		Interaction
	restricted	restricted	enriched	enriched	Hybrid	Housing condition	
Object pecking	30.8	24.3	4.5	5.4	NS	<0.001	NS
Ground pecking	19.8	23.6	41.2	38.5	NS	0.001	NS
Staring at objects	36.6	35.5	27.6	25.9	NS	NS	NS
Head down	10.5	12.2	9.2	6.2	NS	0.012	NS
Scratching	2.3	4.4	5.8	3.2	NS	NS	0.012

^a Data from focal animal sampling.

* Two-way ANOVA.

Table 4

Percentage of total time spent on different behaviour by LSL and Dekalb chicks in restricted and enriched housing conditions^a

Behaviour	Mean (%)				<i>p</i> -value*		
	LSL restricted	Dekalb restricted	LSL enriched	Dekalb enriched	Factor		Interaction
					Hybrid	Housing condition	
Feeding	10.9	9.6	10.3	8.9	NS	NS	NS
Drinking	3.3	3.0	3.1	2.6	NS	NS	NS
Dustbathing	1.2	0.4	1.1	3.1	NS	NS	NS
Moving	5.4	8.9	6.0	6.6	<0.001	NS	0.004
Standing	8.4	10.5	9.0	7.4	NS	NS	NS
Preening	16.3	13.4	15.4	14.6	NS	NS	NS
Resting	25.0	24.6	20.0	20.1	NS	0.042	NS

^a Data from scan sampling.

* Two-way ANOVA.

($F_{1,12}=16.63$, $p=0.001$) and head down ($F_{1,12}=8.72$, $p=0.012$). The chicks kept in restricted housing conditions spent more time on object pecking and head down, but less time on ground pecking than those kept in enriched housing conditions.

On the other behaviour the factors hybrid and housing conditions had no significant effects except for moving and resting (Table 4). There was an interaction of the two factors on moving ($F_{1,12}=12.14$, $p=0.004$). In enriched environment both hybrids spent the same amount of time moving about the pen (M.S.D.=1.75). When kept under restrictive housing conditions LSL did not change its behaviour, while Dekalb significantly increased moving around. As for resting, the factor hybrid had no effect but chicks in restrictive environment were more often observed resting than when the environment was enriched ($F_{1,12}=5.17$, $p=0.042$).

At the end of the experiment the weight of LSL and Dekalb chicks was not significantly different, but there was a tendency that LSL chicks (mean 477.7 g) were heavier than Dekalb (462.9 g) and that chicks in restrictive environment (477.3 g) weighed more than in enriched environment (463.3 g; ANOVA: factor hybrid, $F_{1,12}=4.59$, $p=0.053$; factor treatment, $F_{1,12}=4.02$, $p=0.068$).

4. Discussion

Although Dekalb and LSL chicks spent the same amount of time foraging, there were nevertheless differences in the foraging behaviour: Dekalb preferred litter to sand as scratching substrate and they showed a high motivation to peck, hack and tear at polystyrene blocks. LSL chicks, however, did not show such preferences. But, as was also found by Walser (1997), they spent more time at the food trough than Dekalb chicks. LSL chicks may have spent this additional time with actually feeding as a consequence of their larger weight gain or with only manipulating and pecking at the food. That they ingested food is suggested by the found tendency of LSL to be heavier when weighed in

week 7. But there is evidence that chicks direct their foraging behaviour at feed without actually feeding. Aerni et al. (2000) found that when chicks were deprived of access to long-cut straw as foraging substrate, they reduced the time spent foraging but increased the time spent at the food trough without an increase in body-weight (El-Iethey et al., 2000).

From the results of experiment 1 we conclude that genetic differences in foraging behaviour exist. They are not expressed in the total time spent foraging, but by different proportions of the various foraging elements. Thus, LSL and Dekalb indeed had different prerequisites for coping with the housing conditions of the second experiment which were restricted in relation to foraging behaviour.

The two hybrids showed different behavioural reactions to the changes in their environment. Dekalb increased moving around when kept in restricted housing conditions, whereas LSL did not show such a change. Increased moving is a sign of frustration. It can be interpreted as an attempt to increase the chance of meeting the stimuli in need. Wood-Gush (1972) observed that laying hens, when kept in barren battery cages, show intensive pacing in the pre-laying phase when searching for a nest-site. He also reported excessive pacing of laying hens as a response to frustration in a feeding situation.

Both hybrids developed feather pecking, but LSL showed higher frequencies than Dekalb. This is contrary to what Walser (1997) found and could be because the genetic differences of the two hybrids may have changed in the meantime as a consequence of the selection for higher productivity.

As in experiment 1, there were also differences in the foraging behaviour in experiment 2. LSL spent less time scratching in restricted than in enriched environment, whereas Dekalb showed no statistical difference in the time they spent scratching. Although both hybrids increased scratching in the sand area, only Dekalb seemed to be able to compensate for the loss of litter.

The results of experiment 2 demonstrate that the change to restricted housing conditions led to different reactions of the two hybrids, expressed by foraging behaviour and paralleled by varying frequencies of feather pecking. As a whole, we observed that chicks may react in different ways to an impoverishment of their environment in relation to foraging behaviour. Foraging behaviour may be redirected as with feather pecking and increased object pecking. The incentive value of a remaining stimuli may increase, inducing higher frequencies of a certain behavioural element whereby compensating for the loss of other stimuli relevant to that behavioural element. This was observed with scratching in relation to sand. Finally, there are changes that may be interpreted in terms of active and passive coping as in the case of increased moving or increased resting. Which possible reaction to the impoverishment of the environment was chosen and in which intensity it was employed, was hybrid-specific.

To summarise, the results of the study support our hypothesis that the basis for the genetic influence in the development of feather pecking, as observed by several authors (Hughes and Duncan, 1972; Bessei, 1984; Kjær and Sørensen, 1997; Walser, 1997), are genetically determined differences in the quality of the foraging behaviour. However, our results also show that housing conditions may have a stronger influence on foraging behaviour and the development of feather pecking than the genetic aspect (Fig. 1). We therefore think that more research should be done into the question with what means foraging behaviour can be promoted (Jones and Waddington, 1992; Jones and Carmichael,

1999) and how various hybrids perceive such stimuli. This kind of research will give us a better idea on how to improve housing conditions in order to meet the needs of birds that were bred for high performance.

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