Effect of Diet Change on the Behavior of Chicks of an Egg-Laying Strain

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Injurious pecking has serious welfare consequences in flocks of hens kept for egg laying, especially when loose-housed. Frequent diet change is a significant risk for injurious pecking; how the mechanics of diet change influence pecking behavior is unknown. This study investigated the effect of diet change on the behavior of chicks from a laying strain. The study included a 3-week familiarity phase: 18 chick pairs received unflavored feed (Experiment 1); 18 pairs received orange oil-flavored (Experiment 2). All chicks participated in a dietary preference test (P); a diet change (DC); or a control group (C), 6 scenarios. All P chicks preferred unflavored feed. In Experiment 1, DC involved change from unflavored to orange-flavored; Experiment 2, orange-flavored to unflavored. Compared with controls, Experiment 2 DC chicks exhibited few behavioral differences; Experiment 1 DC chicks exhibited increased behavioral event rates on Days 1 and 7. They pecked significantly longer at their environment; by Day 7, they showed significantly more beak activity. There was little evidence of dietary neophobia. Change from more preferred to less preferred feed led to increased activity and redirected pecking behavior.

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Both feather and vent pecking are serious welfare and economic problems in hens kept for egg-laying purposes. Feather pecking is painful to the recipient (Gentle & Hunter, 1990), and both forms of injurious pecking can lead to cannibalism (McAdie & Keeling, 2000; Pötzsch, Lewis, Nicol, & Green, 2001). Although feather pecking can occur in hens that are kept in cages (Allen & Perry, 1975), injurious pecking and cannibalism are of greatest concern when hens are housed in barn, percrey, or free-range systems. In these systems, the phenomenon can spread throughout a flock (McAdie & Keeling, 2000). As the European Community ban on the use of conventional cages approaches (European Community, 1999), the need for research on the causes of injurious pecking becomes more pressing.

In an epidemiological study of hens in Great Britain, changing the diet formulation three or more times during the laying period increased the risk of feather pecking more than five-fold and the risk of vent pecking more than two-fold, compared to fewer diet changes (Green, Lewis, Kimpton, & Nicol, 2000; Pötzsch et al., 2001). During the course of rearing and during the laying period, pullets and hens are usually “phase fed” several different diets (Leeson & Summers, 1997). In addition, the policy of “least costing” of diet ingredients means that batches of the same diet may differ in raw ingredients. Little research has been conducted on the behavioral consequences of such diet changes, so it is not clear why diet changes should influence feather-pecking behavior. One explanation might be that chicks demonstrate a reluctance to eat the novel food and redirect their pecks to nonfood targets, such as conspecifics.

Evidence for food neophobia in chickens is mixed. Murphy (1977) reported increased latencies in chicks and hens to eat novel-colored feeds and Jones (2000) suggested that a reluctance to accept an unfamiliar diet may result in a redirection of pecking behavior. Vilarino, Leon, Faure, and Picard (1998) demonstrated that chicks of a meat-production strain, presented with both familiar and unfamiliar food “masked” by unfamiliar ground (maize cob) showed increased grooming and ground-pecking behavior, compared with controls offered unmasked, familiar food. Haskell, Vilarino, Savina, Atamna, and Picard (2001) trained chicks of a meat-production strain, fed on a low-quality feed, to traverse a runway for a high-quality feed reward. When chicks were offered only a low-quality feed reward after the training period, they showed increased activity, increased food searching behavior, and decreased food consumption—compared with chicks who received a high-quality reward. Both these studies provide some support for the hypothesis that pecks may be redirected away from food when chickens are presented with a novel diet. Curtis and Marsh (1992) also reported anecdotal observations of outbreaks of feather pecking in hens subjected to sudden diet change.

Despite this, Marples and Kelly (1999) suggested that food neophobia in chickens was transient and easy to overcome. In experimental work, Jones (1986, 2000) reported that neophobia was reduced by increased experience with food novelty or
the presence of a familiar odorant. It is apparent that the epidemiological and experimental information currently available does not yet provide a clear answer regarding the importance of diet change as a risk factor for injurious pecking in chickens.

The aim of this study was to compare the behavior of chicks that experienced a diet change with chicks of the same age that experienced no diet change. We predicted that diet change would stimulate an increase in pecking behavior. The study was focused on feeding behavior, feed consumption, and all aspects of pecking behavior. Chicks were studied so that the dietary intake of the birds could be controlled from the first day of age. The addition of orange oil to feed was chosen as the dietary change because previous work (Jones, 1987) indicated that this oil was not aversive but was detected easily by chicks. This technique also avoided confounding changes in the sensory properties of the food with large changes in its nutritional properties.

EXPERIMENT 1

Materials and Method

Animals and housing. Thirty six 1-day-old chicks of a laying strain (“Hy-line,” Studley, Warwickshire, England) were assigned randomly in pairs to 18 pens (.5 m wide × 1.0 m long × .83 m high) in three separate, but identically controlled, environment rooms. Each room contained six pairs of chicks. The pens were arranged evenly throughout each room. The pens contained a .1 m depth of wood shavings, a drinker, and a .4 m long perch .1 m from the floor. Food was provided at first in a small cardboard tray. Adequate early pecking and intake of food was ensured by brief pecking demonstrations (tapping close to the food by a human caretaker) for all chicks during the first 72 hr. After 5 days, the cardboard tray was replaced by 2 ceramic bowls (diameter = .125 m; depth = .045 m). These bowls were modified by the addition of a lid of chicken wire to prevent spillage of food by the chicks. The bowls were filled each morning with approximately .32 kg of food, to provide ad lib access to food.

Infrared lamps were used during the brooding period and were removed at 21 days. At this stage, the temperature in each room was kept between 17° C and 25° C. After 2 days of continuous light, the light regime was changed so that 16 hr of light, commencing at 0600, was followed by 8 hr of darkness for the duration of the experiment in all three rooms. Light was provided by four 60-watt bulbs near the four corners of the room, giving an average of 32 lux near the floor of each box.

Experimental procedure. Chicks were fed normal chick starter crumbs (Chick Starter CRB ACS, BOCM Pauls Ltd, Ipswich, England) for a 3-week famil-
arity period. The treatment period started when the birds were 22 days old (Treatment Day 1). To avoid inadvertent olfactory cues spreading between treatment groups, the three different treatments were carried out in three separate rooms. Because of the limitations of video equipment, the start of treatment was staggered in all treatment groups: The first three pairs started treatment 24 hr prior to the last three pairs of chicks. The birds in all treatment groups were weighed each day from 3 days prior to the treatment and for 7 days subsequent to the treatment. In addition, all food bowls were weighed each day before emptying and were refilled to a total weight of .86 kg. This allowed the calculation of daily food consumption from each bowl.

Preference test, Group P. All chicks participated in a dietary preference test (Group P; n = 6 pairs). The purpose of this treatment was to assess whether familiarity with a diet affected preference for that diet. Food was taken away from approximately 0800 to 1000 hr, and then the birds were presented with a choice of feeds. One bowl was filled with normal chick starter mash and the other bowl was filled with the same food modified by the addition of orange oil (.01 L/kg of food; Boyajian Pure Orange Oil, Lakeland Ltd, Windermere, Cumbria, England). There was no discernible change in the appearance of the flavored food to the human observer. The bowl position remained constant within boxes for the remainder of the experiment.

Between boxes, bowl position was balanced so that for three pairs the orange bowl was adjacent to the perch and, for the remaining three pairs, adjacent to the water. The birds were filmed on Day 1 for 10 min in every hour for 12 hr.

Diet change, Group DC. The purpose of this treatment was to observe the behavior of the chicks experiencing a diet change (Group DC; n = 6 pairs). On Day 1, both food bowls were emptied and refilled with food flavored with orange oil, as described above. For the remaining 6 days of the experiment, the birds were fed orange-flavored food in both feed bowls. The start of treatment was staggered, so that the first 3 pairs started treatment 24 hr before the last 3 pairs. Four 10-min recordings were taken at 0800, 1100, 1400, and 1700 on Days 1 and 7.

Control, Group C. Pairs of birds (n = 6 pairs) in this treatment were treated in exactly the same way as birds in the diet change group except that they were presented with the normal, flavored mash, with which they had been fed previously, on the day of treatment. Four 10-min recordings were taken at 0800, 1100, 1400, and 1700 on Days 1 and 7.

Video Analysis

Videos were analyzed using Observer 4.0 (Noldus Information Technology, Wageningen, The Netherlands).
**Group P.** In analyzing the videos, the experimenter was blind as to which bowl contained which feed type. For each bird, frequencies and durations of bouts of pecking at each food bowl were recorded. Means for the two birds within each pair were calculated and pair means were used as independent units for analysis. The latency to peck at the food in either bowl during the first 10-min observation was recorded. In addition, the percentage of total observation time spent pecking at normal and orange-flavored food was calculated. The mean rate (bouts per minute) of food pecking bouts and their mean duration were also calculated.

**Groups DC and C.** For each bird, the frequencies of several different behaviors were recorded. The means for the two birds within each pair were calculated and used as independent units for analysis. Some infrequent and short duration behaviors were recorded as single events, others as bouts, as defined in Table 1. A bout was considered at an end when the bird moved away from the target object or if more than 2 sec elapsed without the behavior being repeated. For single events, an event frequency per minute of total observation time was calculated. For bouts, bout frequency (in bouts per minute of total observation time), mean bout durations, and the percentage of total observation time spent performing these behaviors were calculated. For beak inactivity (see definition in Table 1), all bouts of nonpecking behaviors were combined. Therefore, a bout of beak inactivity could include transitions between other behaviors such as perching and walking that were uninterrupted by pecking.

**Data treatment and analysis.** To correct for differences in feed consumption between pairs of birds due to differences in body weight, the daily feed consumption in grams was expressed in terms of metabolic live weight (LW; mean of two birds in a pair on relevant day) using the formula:

\[
\text{Corrected feed consumption} = \frac{\text{Feed consumption (g)}}{\text{LW (kg)^0.75}}
\]

Behavioral data were tested for normality using Kolmogorov–Smirnov and Shapiro–Wilk tests. All statistical tests were two-tailed with an alpha level of .05 and were conducted using SPSS Edition 11.5.

**Preference test groups.** Repeated measures analysis of variance (ANOVA), with diet type and day of treatment as within-subjects factors, was carried out on feed consumption data for the 7 days of the treatment period. Behavioral differences between diet types were analyzed using \(t\) tests or Mann–Whitney \(U\) Tests, as appropriate. Results are presented as means ± SE of the mean.
Diet change and control groups. Repeated measures ANOVA was performed on feed consumption data for the 7 days of the treatment period. Treatment group was the between-subject factor and day of treatment was the within-subject factor. Age at the start of treatment and amount of food consumed on Day 0 were used as covariates. A t test was performed on body weight gain data over the 7 days of the treatment period.

Behavioral data were analyzed separately for the first 10 min of Day 1 and for the total observation periods of Day 1 and Day 7 of treatment. This was done to investigate the immediate and longer term responses of the chicks to diet change.

Although all behaviors were analyzed separately, some additional categories were calculated—as described in Table 2—and analyzed in the same way. The categories of “combined bouts” and “combined pecks” were created to pool data about pecking behavior that might share the same motivational basis: According

<table>
<thead>
<tr>
<th>Behavior Name</th>
<th>Description</th>
<th>Single Events Recorded</th>
<th>Bouts of Behavior Recorded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affiliative pecks</td>
<td>Gentle pecks at the other bird’s head or beak</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Aggressive pecks</td>
<td>Hard, rapid pecks at anterior of the other bird often accompanied by the recipient retreating</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Beak inactivity</td>
<td>Includes all non-pecking time spent sitting, standing, lying, perchimg, dustbathing, walking or preening</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Dustbathing</td>
<td>Bird sitting or lying and performing litter tossing, feather fluffing, litter pecking and/or scratching, bill raking and side rubbing</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Feed pecks</td>
<td>Pecks directed at food in either feed bowl</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Furniture pecks</td>
<td>Pecks directed at perch, box walls or structure of drinker</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Litter pecks</td>
<td>Pecks directed at litter on floor</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Mild feather pecks</td>
<td>Gentle pecks at the plumage of the other bird without pinching or pulling of feathers</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Perchings</td>
<td>Bird standing on any part of perch</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Preening</td>
<td>Bird preening its own plumage</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Severe feather pecks</td>
<td>Vigorous pecks of the plumage of the other bird or pinching/pulling at its feathers</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Vent Pecks</td>
<td>Pecks aimed at or around the cloaca of the other bird</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Water pecks</td>
<td>Pecks directed at water in drinker</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
to Blokhuis (1986), feather pecking represents redirected ground pecking and there is a possibility that object pecking may also result from such a pecking re-direction (Blokhuis & Van Der Haar, 1992). The category of “Total Behavioral Events” was created to assess treatment effects on the overall activity of the chicks.

Normally distributed data were analyzed for differences in means between the control and diet change groups using a $t$ test. Nonnormal data were log transformed if possible, or analyzed using a Mann–Whitney $U$ Test. Results are presented as $M \pm SE$ of the mean with exact $p$ values where appropriate.

Results

Group P. The overall mean consumption of orange-flavored feed during the treatment period was significantly less than the amount of normal feed consumed, ANOVA GLM; $F(1, 10) = 22.060$, $p = .001$; orange: $37.9 \pm 4.2$ g per pair per day; normal: $121.4 \pm 8.1$ g per pair per day.

On Day 1, there were no differences in latencies to peck at orange or normal food. However, the chicks spent a greater percentage of time pecking normal feed than orange feed, $t(10) = -2.380$, $p = .039$; normal: $11.4 \pm 2.04\%$; orange: $5.14 \pm 1.65\%$. Mean bout durations of pecks at normal feed were longer than those at orange feed, $t(10) = -5.308$, $p < .001$; normal: $40.5 \pm 2.9$ sec; orange: $17.5 \pm 3.2$ sec, although the frequency of bouts of pecking at the two feed types were not significantly different.

Diet change and control groups: Feed consumption and body weight. The mean daily food consumption (g) over the treatment period was $93.1 SD 17.7$ (DC)
and 166.5 SD 18.5 (C), but when corrected for covarying differences in age and body weight, these did not differ significantly, ANOVA GLM; $F(1, 9) = 3.058, ns$.

Mean daily weight gain (g) over the treatment period was 83.2 SD 15.2 (DC) and 85.6 SD 8.4 (C). These did not significantly differ, $t(10) = .459, ns$.

**Diet change and control group behavior: First 10 min of Day 1.** Descriptive statistics and an analysis summary for behaviors with significant differences between birds in control and diet change groups during this period are presented in Table 3. Dustbathing, severe feather pecking, and vent pecking were not observed at all in this period. There were no differences between control and diet change groups for affiliative pecks, aggressive pecks, mild feather pecks, furniture pecks, perching, preening, or water pecks. The frequency of total behavioral events was more than twice as high for DC chicks as for C chicks.

Table 3 shows that DC chicks had a higher rate of bouts of feed pecks but shorter bouts than C chicks. DC chicks also showed a greater frequency of combined pecking bouts than C chicks and a higher frequency of litter-pecking bouts than C chicks.

### Table 3

Descriptive Statistics and Summary of Analysis for First 10 Minutes of Experiment 1, Day 1

<table>
<thead>
<tr>
<th>Behavior</th>
<th>C M ± SE</th>
<th>DC M ± SE</th>
<th>Test Statistic</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed pecking bout frequency (min⁻¹)</td>
<td>0.91 ± 0.16</td>
<td>1.93 ± 0.84</td>
<td>$t = -5.560$</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Feed pecking bout duration (sec)</td>
<td>50.10 ± 8.10</td>
<td>14.50 ± 3.30</td>
<td>$U = 2.000$</td>
<td>.009</td>
</tr>
<tr>
<td>Feed pecking bout percentage of observation time</td>
<td>66.33 ± 7.72</td>
<td>45.89 ± 10.36</td>
<td>$U = 8.000$</td>
<td>.132</td>
</tr>
<tr>
<td>Combined pecking bouts frequency (min⁻¹)</td>
<td>0.41 ± 0.15</td>
<td>1.21 ± 0.30</td>
<td>$t = -2.355$</td>
<td>.040</td>
</tr>
<tr>
<td>Combined pecking bouts duration (sec)</td>
<td>9.46 ± 2.68</td>
<td>8.76 ± 1.13</td>
<td>$t = 1.341$</td>
<td>.210</td>
</tr>
<tr>
<td>Combined pecking bouts percentage of observation time</td>
<td>8.36 ± 3.86</td>
<td>19.92 ± 5.69</td>
<td>$t = 1.680$</td>
<td>.124</td>
</tr>
<tr>
<td>Litter pecking bout frequency (min⁻¹)</td>
<td>0.41 ± 0.15</td>
<td>1.19 ± 0.29</td>
<td>$t = -2.347$</td>
<td>.041</td>
</tr>
<tr>
<td>Litter pecking bout duration (sec)</td>
<td>7.88 ± 2.87</td>
<td>8.85 ± 1.17</td>
<td>$t = -0.313$</td>
<td>.764</td>
</tr>
<tr>
<td>Litter pecking bout percentage of observation time</td>
<td>8.36 ± 3.86</td>
<td>19.80 ± 5.66</td>
<td>$t = -1.670$</td>
<td>.130</td>
</tr>
<tr>
<td>Beak inactivity bout frequency (min⁻¹)</td>
<td>1.30 ± 0.27</td>
<td>2.65 ± 0.28</td>
<td>$t = -3.48$</td>
<td>.006</td>
</tr>
<tr>
<td>Beak inactivity bout duration (sec)</td>
<td>8.48 ± 1.21</td>
<td>7.13 ± 1.11</td>
<td>$t = .820$</td>
<td>.431</td>
</tr>
<tr>
<td>Beak inactivity bout percentage of observation time</td>
<td>17.57 ± 3.06</td>
<td>32.04 ± 5.51</td>
<td>$t = -2.297$</td>
<td>.004</td>
</tr>
<tr>
<td>Total behavior event frequency (min⁻¹)</td>
<td>3.14 ± 0.51</td>
<td>6.37 ± 0.68</td>
<td>$t = -3.768$</td>
<td>.004</td>
</tr>
</tbody>
</table>

**Note.** C = control group; SE = standard error; DC = diet change group.

*$n* = 6 pairs.
**Behavior: All observations Day 1.** All behaviors listed in Table 1 were observed, except severe feather pecks. Descriptive statistics and an analysis summary for behaviors with significant differences between control and diet change groups during this period are presented in Table 4. As for the first 10 min, there were no differences between C and DC chicks for the following behaviors: aggressive pecking, dustbathing, mild feather pecks, perching, preening, and water pecking.

Overall, birds spent less time in feed-pecking bouts during the whole day than they did in the first 10 min. Unlike the first 10 min of observations, the rate of DC affiliative bout pecking tended to be greater than C chicks (which showed no affiliative bouts), as was the proportion of observation time that DC chicks spent in such bouts. Also unlike the first 10 min of observation, DC chicks engaged in a higher rate of furniture-pecking bouts and spent a greater percentage of the observation time performing these bouts.

DC chicks also showed a higher, single, combined peck rate and a higher rate of single litter pecks than C chicks. As in the first 10 min of observations, the rate of total behavioral events for this observation period was significantly greater for DC chicks than for C chicks.

### TABLE 4
Descriptive Statistics and Summary of Analysis of Experiment 1, Day 1

<table>
<thead>
<tr>
<th>Behavior</th>
<th>C M ± SE</th>
<th>DC M ± SE</th>
<th>Test Statistic</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed pecking bout frequency (min⁻¹)</td>
<td>0.47 ± 0.06</td>
<td>0.59 ± 0.06</td>
<td>U = 8.000</td>
<td>.132</td>
</tr>
<tr>
<td>Feed pecking bout duration (sec)</td>
<td>43.40 ± 9.20</td>
<td>16.60 ± 3.0</td>
<td>U = 4.000</td>
<td>.026</td>
</tr>
<tr>
<td>Feed pecking bout percentage of observation time</td>
<td>31.86 ± 5.54</td>
<td>17.33 ± 4.28</td>
<td>t = 2.075</td>
<td>.065</td>
</tr>
<tr>
<td>Affiliative pecking bout frequency (min⁻¹)</td>
<td>0.00 ± 0.00</td>
<td>0.03 ± 0.01</td>
<td>U = 6.000</td>
<td>.065</td>
</tr>
<tr>
<td>Affiliative pecking bout percentage of observation time</td>
<td>0.00 ± 0.00</td>
<td>0.48 ± 0.27</td>
<td>U = 6.000</td>
<td>.065</td>
</tr>
<tr>
<td>Furniture pecking bout frequency (min⁻¹)</td>
<td>0.01 ± 0.01</td>
<td>0.04 ± 0.01</td>
<td>U = 2.000</td>
<td>.009</td>
</tr>
<tr>
<td>Furniture pecking bout duration (sec)</td>
<td>9.40 ± 2.85</td>
<td>6.27 ± 1.00</td>
<td>U = 3.000</td>
<td>.429</td>
</tr>
<tr>
<td>Furniture pecking bout percentage of observation time</td>
<td>0.14 ± 0.09</td>
<td>0.47 ± 0.12</td>
<td>t = -2.205</td>
<td>.052</td>
</tr>
<tr>
<td>Single litter peck frequency (min⁻¹)</td>
<td>0.05 ± 0.01</td>
<td>0.10 ± 0.02</td>
<td>U = 3.000</td>
<td>.015</td>
</tr>
<tr>
<td>Beak inactivity bout frequency (min⁻¹)</td>
<td>1.22 ± 0.07</td>
<td>1.66 ± 0.12</td>
<td>t = -3.232</td>
<td>.009</td>
</tr>
<tr>
<td>Beak inactivity bout duration (sec)</td>
<td>20.11 ± 2.22</td>
<td>18.36 ± 2.29</td>
<td>t = 0.820</td>
<td>.431</td>
</tr>
<tr>
<td>Beak inactivity bout percentage of observation time</td>
<td>40.89 ± 5.32</td>
<td>49.31 ± 4.37</td>
<td>t = -1.223</td>
<td>.249</td>
</tr>
<tr>
<td>Total behavior event frequency (min⁻¹)</td>
<td>3.32 ± 0.19</td>
<td>4.37 ± 0.29</td>
<td>t = -3.232</td>
<td>.009</td>
</tr>
</tbody>
</table>

*Note.* C = control group; SE = standard error; DC = diet change group.

*n = 6 pairs.*
Behavior: All observations Day 7. All behaviors—except vent pecking—listed in Table 1 were observed on Day 7 and there was only one severe feather peck. There were no differences between DC and C chicks for the following behaviors: affiliative pecking, aggressive pecks, dustbathing bouts, mild feather pecks, feed pecking, perching, and preening.

Table 5 shows that DC chicks engaged in more frequent single water pecks, furniture pecks, and bouts of litter pecking than C chicks. They also had a higher frequency of combined pecking bouts. DC chicks showed a higher rate of beak inactivity bouts than C chicks, similar to Day 1 observations. However, C chicks spent a larger percentage of observation time in such bouts, and their mean beak inactivity bout duration was longer than DC chicks. The frequency of total behavior events again was significantly higher for DC chicks than for C chicks.

Discussion

Experiment 1 demonstrated that the chicks responded to a diet change from a familiar, unflavored food to a novel, flavored food. The results of the preference test indicated that the novel diet was less preferred than the familiar diet. To determine whether similar results would be obtained if the direction of diet change

<table>
<thead>
<tr>
<th>Behavior</th>
<th>C M ± SE</th>
<th>DC M ± SE</th>
<th>Test Statistic</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single water peck frequency (min⁻¹)</td>
<td>0.01 ± 0.01</td>
<td>0.07 ± 0.01</td>
<td>t = -9.532</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Combined pecking bout frequency (min⁻¹)</td>
<td>0.47 ± 0.04</td>
<td>0.71 ± 0.07</td>
<td>t = -2.902</td>
<td>.016</td>
</tr>
<tr>
<td>Combined pecking bout duration (sec)</td>
<td>21.55 ± 4.43</td>
<td>18.31 ± 2.42</td>
<td>t = 0.641</td>
<td>.536</td>
</tr>
<tr>
<td>Combined pecking percentage of observation time</td>
<td>15.55 ± 1.77</td>
<td>21.97 ± 4.13</td>
<td>U = 12.000</td>
<td>.394</td>
</tr>
<tr>
<td>Single furniture peck frequency (min⁻¹)</td>
<td>0.06 ± 0.01</td>
<td>0.10 ± 0.01</td>
<td>t = -3.077</td>
<td>.012</td>
</tr>
<tr>
<td>Litter pecking bout frequency (min⁻¹)</td>
<td>0.46 ± 0.11</td>
<td>0.67 ± 0.15</td>
<td>t = -2.855</td>
<td>.017</td>
</tr>
<tr>
<td>Litter pecking bout duration (sec)</td>
<td>22.33 ± 4.88</td>
<td>19.03 ± 2.61</td>
<td>t = 0.596</td>
<td>.565</td>
</tr>
<tr>
<td>Litter pecking bout percentage of observation time</td>
<td>15.42 ± 1.74</td>
<td>21.62 ± 4.03</td>
<td>U = 12.000</td>
<td>.394</td>
</tr>
<tr>
<td>Beak inactivity bout frequency (min⁻¹)</td>
<td>1.12 ± 0.05</td>
<td>1.37 ± 0.08</td>
<td>t = -2.665</td>
<td>.024</td>
</tr>
<tr>
<td>Beak inactivity bout duration (sec)</td>
<td>26.60 ± 1.70</td>
<td>15.50 ± 1.00</td>
<td>t = 5.688</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Beak inactivity bout percentage of observation time</td>
<td>48.97 ± 1.34</td>
<td>35.90 ± 4.29</td>
<td>t = 2.911</td>
<td>.016</td>
</tr>
<tr>
<td>Total behavior event frequency (min⁻¹)</td>
<td>3.23 ± 0.12</td>
<td>3.88 ± 0.16</td>
<td>t = -2.991</td>
<td>.014</td>
</tr>
</tbody>
</table>

Note. C = control group; SE = standard error; DC = diet change group.
*a = 6 pairs.
were reversed—and whether familiarity with a diet affects preference for that diet—a second experiment was conducted.

EXPERIMENT 2

Materials and Method

Animals and housing. A total of 36 1-day-old chicks (“Hy-line,” Studley, Warwickshire, England) were housed and managed in an identical fashion to Experiment 1.

Experimental Procedure

The procedure of Experiment 2 was almost identical to that of Experiment 1, except that chicks were fed chick starter crumbs flavored with orange oil (.01 L/kg of food; Boyajian Pure Orange Oil, Lakeland Ltd, Windermere, Cumbria, England) for the 3-week familiarity period rather than unflavored feed. As in Experiment 1, treatments began when the birds were 22 days old (Day 1).

Preference test, Group P. This treatment served a similar purpose as the P group in Experiment 1, except that the “familiar” diet in this case was orange-flavored. The six pairs of chicks housed in Room 1 were assigned to this treatment. The birds in this treatment groups were treated in the same way as birds in Group P of Experiment 1.

Diet change, Group DC. On Day 1, both food bowls were emptied and refilled with unflavored food. For the remaining 7 days of the experiment, the birds were fed unflavored food in both feed bowls. The start of treatment was staggered, so that the first 3 pairs started treatment 24 hr before the last 3 pairs. On Day 1 and on Day 7, the birds were filmed for 10 min at approximately 0900, 1200, 1400, and 1500 hr.

Control, Group C. Birds in control group pairs were treated in exactly the same way as diet change pairs except they were presented with orange-flavored mash—with which they previously had been fed—on all treatment days. On Day 1 and on Day 7, the birds were filmed for 10 min at approximately 0900, 1200, 1400, and 1500 hr.

Video Analysis

Group P. Video analysis of this group was carried out in an identical fashion to group P in Experiment 1, except that only 40 min of video were analyzed for each bird. This consisted of four recordings of approximately 10 min in length. Record-
ings started at approximately 1000 hr, when food was returned to the birds after a 2-hr fast, and were made every 3 hr. Unlike Experiment 1, the birds also were filmed on Day 7 of the treatment period.

**Groups DC and C.** Video analysis of these groups was carried out in an identical fashion to Groups DC and C in Experiment 1.

**Results**

**Group P.** The overall mean amount of orange-flavored feed consumed during the treatment period was significantly less than the amount of normal feed consumed, ANOVA GLM, $F(1, 10) = 10.806, p = .008$; orange: $34.14 \pm 2.27$ g per pair per day; normal: $88.83 \pm 3.91$ g per pair per day, confirming that, as in Experiment 1, this was the less preferred feed.

On Day 1, there was no difference in latency to peck at orange or normal feed, in percentage of observation time spent pecking at each feed or in bout length or frequency. On Day 7, there again was no difference in latency to peck at the orange and normal feed; however, chicks spent a greater percentage of observation time pecking at normal food than at orange food ($U = .000; n = 12; p = .002$; normal: $24.34 \pm 2.70\%$; orange: $3.60 \pm 2.24\%$). They also pecked at normal food for longer bouts ($U = 1.000; n = 12; p = .004$; normal: $48.4 \pm 12.5$ sec; orange: $13.3 \pm 4.1$ sec) and the frequency of such bouts was higher for normal than for orange food ($U = 1.000; n = 12; p = .004$; normal: $.34 \pm .08$ min$^{-1}$; orange: $.14 \pm .03$ min$^{-1}$).

**Diet change and control groups: Feed consumption and body weight.** The mean daily food consumption (g) over the treatment period was $151.6 \pm 19.6$ (DC) and $132.8 \pm 19.5$ (C), but when corrected for covarying differences in age and body weight these did not differ significantly, ANOVA GLM; $F(1, 9) = .007, ns$. Mean daily weight gain (g) over the treatment period was $86.1 \pm 4.2$ (DC) and $91.2 \pm 10.2$ (C). These did not significantly differ, $t(10) = –1.794, ns$.

**First 10 min of Day 1.** Dustbathing and severe feather and vent pecking were not observed during this period. There were no differences between control and diet change groups for most of the behaviors listed in Tables 1 and 2. The only significant difference was that C chicks had longer perching bouts than DC chicks ($U = 1.000; n = 9; p = .032$; C: $99.9 \pm 46.7$ sec; DC: $11.7 \pm 5.5$ sec).

**Behavior: All observations Day 1.** There were no differences between control and diet change groups for any of the behaviors listed in Table 1.
Behavior: All observations Day 7. DC chicks showed a higher frequency of single litter pecks than C chicks, \( t(10) = -3.635, p = .005 \), DC: .22 ± .02 min\(^{-1}\), C: .11 ± .02 min\(^{-1}\); although there were no differences in measures of litter-pecking bouts. DC chicks also had longer furniture-pecking bouts than C chicks, \( t(7) = -2.715, p = .044 \), DC: 11.0 ± 2.50 sec, C: 3.80 ± .80 sec; although these bouts were not more frequent and did not occupy any more observation time.

C chicks showed longer bouts of preening than DC chicks, \( t(10) = 2.928, p = .015 \), C: 28.40 ± 8.40 sec, DC: 17.70 ± 1.40 sec. These preening bouts occupied more observation time in C chicks than in DC chicks, \( t(10) = 2.661, p = .024 \), C: 18.39 ± 3.34%, DC: 8.78 ± .78%; although they were no more frequent.

DISCUSSION

Few studies have examined the overall, behavioral consequences of diet change in birds, so possible mechanisms by which diet change may lead to injurious pecking are unknown. These experiments looked at the effect of diet change on general pecking and activity in layer chicks. One aim was to explore whether food neophobia might result in the redirection of feed and foraging pecks to other targets.

In classic descriptions of neophobia, exposure to a novel food elicits a fear response (Hogan, 1965). In the initial 10 min of Experiment 1, DC chicks showed less beak activity than C chicks, following presentation with the novel diet. Jones (1977) viewed beak inactivity as an index of fear. However, one would expect fear to manifest also as a reluctance to peck at the feared object, but there were no differences in latency to the first feed peck between DC and C chicks—DC chicks showed more frequent bouts of feed-pecking during the first 10 min following diet change. Furthermore, there was no difference in the latency of P chicks to peck at either diet when first presented. There also was no other behavioral evidence of panic in response to the presence of the feed.

The other classic signs of feed neophobia are increased latency to feed, refusal to feed, or reduced consumption (Jones & Roper, 1997; Murphy, 1977). Again, however, there were no such consistent markers. Instead, the chicks given preference tests strongly preferred unflavored over orange-flavored food—regardless of novelty. This is consistent with the findings of Jones and Roper (1997), in which chicks reared for 7 days on a control diet avoided an orange-flavored diet, whereas the converse was not true. It is also consistent with the findings of Balog and Millar (1989), in which chicks of a meat-production strain—offered a choice between normal food and various flavored foods from hatching—consistently preferred the unflavored food. However, these findings are not consistent with studies showing that chicks prefer familiar feed (Capretta, 1969) or water (Shettleworth, 1972). These contradictory findings
could be explained if the preference for unflavored food in the current experiment reflects an innate bias that is stronger than the tendency for neophobia. A bias against a fruit-flavored diet would be unsurprising in graminivorous birds (Balog & Millar, 1989; Kare, Black, & Allison, 1957).

My results suggest that DC birds in Experiment 1 experienced dissatisfaction with their new food. They spent less time pecking at it on Day 1 and pecked in shorter bouts than C chicks. That this dissatisfaction did not suppress their intake or weight gain is consistent with the comments of Forbes (1995), who noted that very high concentrations of even aversive chemicals are needed to suppress appetite in chickens. There were fewer differences in feed-pecking behavior between the DC and C groups of Experiment 2, which could indicate that dissatisfaction with orange feed diminishes with long-term prior exposure. Alternatively, it is possible that the difference between Experiment 1 and 2 was due to thwarted expectations in the DC birds of Experiment 1 when the expected, preferred food type was replaced by food perceived as inferior. Whether chickens can form such expectations is not certain (Haskell et al., 2001; Petherick, Watson, & Duncan, 1990).

A change in diet from a preferred to an unpreferred feed (Experiment 1) appeared to have more effect on pecking behavior than a change in diet from an unpreferred to a preferred feed (Experiment 2). In Experiment 1, DC chicks showed more beak inactivity during the first 10 min. They spent more time in furniture-pecking bouts than C chicks on Day 1. By Day 7, they showed a higher rate of single, furniture pecks. Beak inactivity of C chicks was greater than DC chicks on Day 7. Although, as outlined earlier, beak inactivity may reflect fear in an acute situation, over a longer period it is more likely to reflect a shift in general pecking tendency. By Day 7, the DC chicks may have been “redirecting” pecks away from the dissatisfactory food source to the environment. This is supported by the findings that DC chicks tended to spend less time pecking at food on Day 1.

The relevance of increased furniture pecking in chicks undergoing diet change can be seen in the light of the view that litter, feed, object, and feather pecking are interchangeable (Savory & Mann, 1999). Blokhuis (1986) viewed feather pecking as a form of redirected foraging and suggested that pecking at objects is also a form of redirected ground pecking (Blokhuis & Van Der Haar, 1992). Murphy (1977) noted an increase in litter pecking and environmental pecking in chicks experiencing a novel, colored food for the first time. Vilarino et al. (1998) noted that chicks showed redirected floor pecking on presentation with novel feeds and masked, control feeds. This overall pattern of results suggests that—in an adaptive attempt to find new food sources—chicks, dissatisfied with a new food source, redirect food pecks elsewhere.

Mild feather-pecking rates generally were low, and almost no severe feather pecks were observed in either experiment. This is unsurprising, because few of the risk factors for feather pecking were present: Group size and stocking den-
sity were low, friable litter was available at all times for foraging, and a perch was available. All these factors would be expected to encourage pecking at substrates rather than conspecifics (Bilcik & Keeling, 1999; Blokhuis & Arkes, 1984; Gunnarsson, Keeling, & Svedberg, 1999; Huber-Eicher & Wechsler, 1998; Nicol, Lindberg, Phillips, Pope, Wilkins, & Green, 2001; Savory, Mann, & Macleod, 1999).

Although feather pecking has been seen in chicks as young as those used here (Riedstra & Groothuis, 2002; Savory et al., 1999), there is some doubt as to how it relates to the more severe phenomenon seen in older birds. Under commercial farming conditions, diet change would involve changes in composition and nutritional value as well as sensory appearance. Our subsequent work suggests that a more commercial-type diet change can also provoke general beak activity in adult laying hens (Dixon, 2004). However, it remains to be seen whether such beak activity is redirected toward the plumage of other birds under truly commercial conditions. Diet change from a preferred to an unpreferred feed also influenced general activity.

In Experiment 1, DC chicks showed a higher frequency of total behavioral events, particularly during the first 10 min of Day 1 and during Day 7. An informal comparison of data between both experiments reveals the birds in control groups in Experiment 2 showed relatively low, behavioral event frequencies, comparable to those of the control group of Experiment 1. This indicates that the increase in behavioral event rate was unlikely to be due to some specific effect of the orange oil. Vilarino et al. (1998) also reported an increase in behavioral transitions in chicks presented with a novel food and Haskell et al. (2001) found that a sudden decrease in food quality resulted in an increase in activity.

An increase in activity and behaviors associated with foraging may make adaptive sense in the natural environment of the chicken when food supplies become low, unpalatable, or unsuitable: These behaviors increase the chance of discovering a new food source. There are several reports of increased activity in chickens in these types of circumstances. Increased general activity levels and food-searching behaviors have been demonstrated in chicks and hens undergoing fasts (Brown-Webster, 1995; Haskell et al., 2001) or prevented from accessing food for short periods (Nicol & Guilford, 1991; Zimmerman & Koene, 1998). Many studies have shown a link between activity levels and feather pecking (Keeling & Jensen, 1995; Lindberg & Nicol, 1994).

**CONCLUSIONS**

In conclusion, there was little evidence for dietary neophobia in these experiments; however, there was some evidence for dietary dissatisfaction. Dissatisfaction did not relate to the novelty of the diet but to its palatability. Chicks undergoing a diet change from normal to less-preferred orange-flavored food demonstrated behavioral changes—including redirecting pecks toward objects,
increasing their general activity levels, and increasing their beak-related activities. The nature of the relation between general activity levels and the tendency to feather peck is not yet fully understood, but these behavioral changes can be viewed as adaptive under natural conditions. Under conditions that are more commercial, however, these behavioral changes could contribute to an increase in injurious pecking—with serious welfare consequences.

ACKNOWLEDGMENTS

The experiments were approved by the University’s Ethical Review Panel. There were no deaths during the experiments and all the birds were rehomed in either free range or backyard flocks. We are grateful to Annie Cornish and Pauline Hunt for help with bird husbandry and Stuart Pope for technical help.

REFERENCES


