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Applied Animal Behaviour Science 101 (2006) 102–110
APPLIED ANIMAL BEHAVIOUR SCIENCE
www.elsevier.com/locate/applanim

The demand of laying hens for feathers and wood shavings

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Accepted 10 January 2006
Available online 21 February 2006

Abstract

Feather eating is related to feather pecking in laying hens. The aim of this study was to investigate the birds demand for feathers compared to their demand for food and litter as feather pecking has been described as redirected ground pecking/foraging.

The maximum price in terms of the number of pecks that individual animals were prepared to pay was recorded to determine the importance of food (as a standard), feathers and wood shavings in operant conditioning test. Birds were also tested in a session in which no reward was given. Nine low feather pecking birds and 11 high feather pecking birds were used for this study and tested under progressive ratio 10 schedules (PR), where ratio values were progressively incremented by 10 each time reward was earned. Both high (HFP) and low (LFP) feather pecking birds completed the highest maximum ratios with feed as a reinforcement followed by wood shavings, feathers and ‘‘no reward’’ pecking. HFP and LFP birds did not differ in their achieved maximum PR with feed as reinforcement. HFP birds achieved higher maximum prices than LFP birds with feathers as reinforcement. No line differences were found in maximum ratios completed with wood shavings. The maximum price paid by HFP birds was higher than that of LFP birds in sessions where no reward was offered. The operant technique showed that HFP and LFP birds found feathers and wood shaving reinforcing when presented as a food component. For feathers, this was more pronounced in HFP birds.

Keywords: Laying hens; Feather pecking; Feather eating; Wood shavings; Progressive ratio; Maximum price; Conditioning

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0168-1591/$ – see front matter
doi:10.1016/j.applanim.2006.01.003

1. Introduction

Feather pecking is an abnormal behaviour in laying hens (Blokhuis and Wiepkema, 1998). There are various hypotheses on the causation of feather pecking in laying hens. One of them is that feather pecking could be a form of redirected behaviour, developing either from food pecking (Wennrich, 1974), ground pecking (Blokhuis, 1986) or pecking during dust bathing (Vestergaard and Lisborg, 1993). Riedstra and Groothuis (2002) suggested that early feather pecking is a form of social exploration.

These theories take a behavioural approach and try to explain feather pecking by indicating relevant motivations. Although the ground pecking/foraging theory is widely supported, studies rarely link to effects of nutritional requirements. Recent studies have underlined a relationship between feather pecking and feather eating in laying hens (Harlander-Matauschek and Bessei, 2005; McKeegan and Savory, 2001). Harlander-Matauschek et al. (2006) showed that high feather pecking birds (HFP) ate more feathers than low feather pecking birds (LFP) and these feathers stimulated feed passage in the digestive tract of HFP birds. The effect of feathers was similar to that of insoluble fiber (Krogdahl, 1986), which is also found in litter substrate.

Green et al. (2000) showed that availability of good litter until the end of lay reduces the risk of feather pecking. HFP birds have been reported to be attracted by feathers of their pen mates while LFP birds orient their pecking activities towards litter (Blokhuis, 1986). This raises the question if HFP birds have a higher demand for the intake of insoluble fiber in the form of wood shavings and, if wood shavings of good quality are not available, a higher demand for feathers as a substitute compared to LFP birds.

Such demand can be measured by finding out how hard an animal will work or what price it will pay to gain access to its preferred choice by an operant conditioning technique (Duncan, 1992). In this respect an important development in animal welfare science has been the use of consumer demand approaches (Hursh, 1984). Dawkins (1983) argued that the price an animal will pay to get access to a reward can provide a measure of how the reward is a need. An animal that shows inelastic demand for a reward is demonstrating that the reward is a need (e.g. food), rather than a luxury. Demand curves relate the consumption of a product to its price (Hursh, 1984). The reward (on the y-axis) is plotted as a function of price (on the x-axis), which is usually the number of key pecks or lever pressing. The relation between reward and price is calculated in terms of a linear regression equation. The elasticity is the negative slope of the regression. Two measures of behavioural elasticity have been recommended, elasticity of demand, where the price of commodities or environmental resources is varied and income elasticity, where the price of environmental resources is fixed, but the animals income is varied (Dawkins, 1990). Additionally the area under the demand curve can also be calculated (Houston, 1997).

An alternative approach to demand curves is maximum price, which is the highest price animals are prepared to pay in order to gain access to resources. This measure is similar to break point in studies with progressive ratio schedules (Cooper and Mason, 2001), in which the number of responses required increases up to the point where the animal ceases to respond (Hodos, 1961; Robinson et al., 1995). Having put forward maximum price paid as an alternative mean, the following paper will use this approach.

The purpose of the present paper was to evaluate if HFP birds find feathers and wood shavings more reinforcing than LFP birds when an operant conditioning technique is used.

2. Materials and methods

2.1. Animals and housing

Randomly selected 11 high (HFP) and 9 low (LFP) feather pecking birds were used for this experiment. The lines were divergently selected for high and low pulling at a bunch of feathers for four generations. These lines (Rhode Island Red) were used and described in previous experiments and showed a difference in their propensity to develop feather pecking and feather eating (Harlander-Matauschek and Bessei, 2005).

The birds were reared in a deep litter system prior to the experimental situation and were transferred to individual wire cages measuring 43 cm $\times$ 43 cm $\times$ 45 cm $(l \times w \times h)$ at 20 weeks of age. The feed trough was placed at the front and a nipple drinker at the back of the cage. Each cage was supplemented with a perch of 20 cm length. The distance between each cage was 10 cm, so the hens had visual contact, but no physical access to their neighbors. The hens were kept in a ventilated windowless room at a constant temperature (23 °C). Lights were on from 3:00 to 18:00 h. Birds were given a commercial mash diet and water ad libitum.

2.2. Test equipment

The Skinner box used in this experiment was located in a sound attenuated windowless test room within short distance of the home cages. The Skinner box measured 37 cm $\times$ 60 cm $\times$ 60 cm. One lighted key (white light) was presented 40 cm above the floor (5 cm diameter). The feeder was accessible through a square hole in the center of the intelligence panel, 25 cm above the floor (10 cm $\times$ 10 cm). Food was only accessible when the feeder was up for 5 s. A 5 W house light was fixed 60 cm above the floor of the box. The Skinner box was operated through the Trans IV program, which was used to create and compile programs for use with the MED-PC IV runtime system (Med Associates, St. Albans, VT, USA). Progressive ratio, number of pecks and latency to reinforcement were automatically recorded and stored on disk. Skinner box and computer were in the same room.

2.3. Training

The first step in the training procedure consisted of habituation of the birds to the test equipment. For two consecutive days the animals were placed in a randomized order in the Skinner box for 3 min and then removed in order to accustom the bird to the environment and to being handled. Birds were then trained to peck at the key by hand shaping for 7 min per day for 5 days for a food reward. Following the hand shaping phase, each bird was tested using individual programmes for each hen, until each bird achieved a progressive ratio schedules (PR) of 80 pecks.

For technical reasons a randomized complete block design was not used for testing the different substrates. The maximum price (PR) for the food reward was tested in all birds prior to the tests for feathers and wood shavings. The birds were tested in each test procedure in a random order.

2.4. Test procedure feed

To measure the reward value of food all individually caged test birds were maintained at approximately 90% of their free feeding body weights by adjusting the amount of daily feed allowance. In the test phase ratio values were progressively incremented in the sequence 5, 10, 20, 30, 40, 50, 60, 70, 80, etc. Sessions ended when 10 consecutive minutes elapsed without a key peck.

Each bird was tested in a randomized order in five test sessions over a period of 3 weeks. Due the length of sessions and the number of birds, it was not possible to test all birds daily.

2.5. Test procedure feathers

To familiarize birds with loose feathers, feathers were accessible to the birds in the home cage for 30 days prior to testing. Ten feathers inserted into small holes in a piece of clear plastic were fixed next to the food in the home cage. Downy feathers (~4–5 cm length), plucked from dead White Leghorn (LSL) birds were used. The number of feathers removed from the plastic and found in the drop pan was recorded daily. Missing feathers were considered eaten.

PR sessions were executed as described for the sessions with food as reinforcer. Every time the birds successfully reached the number of pecks required by the PR schedule, the birds were rewarded with one feather. During the test phase birds did not get access to feathers in the home cage.

2.6. Test procedure wood shavings

To familiarize birds with wood shavings in the home cage, shavings were accessible for the birds in the home cage for 30 days prior to testing. Plastic containers, measuring 17 cm $\times$ 9 cm $\times$ 9 cm ($l \times w \times h$), were filled daily with 5 g wood shavings and inserted in the feed trough in the home cage. Scratching and dust bathing was not possible in the containers. The amount of shavings eaten was recorded daily.

The tests for wood shavings were carried out as previously described for food and feathers. One gram of wood shavings was offered as reward upon successful key pecking. During the test phase wood shavings were available in the Skinner box only.

2.7. Test procedure extinction

Birds were tested in the Skinner box with no substrate available in the trough. The same PR schedule procedure was used as in the previous sessions.

2.8. Statistical analysis

Mean maximum price, average pecks at the key per minute and mean latency to obtain the first reward per session were transformed using a log transformation. The average amounts of the different substrates eaten in the home cage and the average amount of substrate eaten in the Skinner box were square root transformed to meet the assumptions of normality and to give equal variances necessary for parametric statistics. To determine whether there were significant differences in the recorded parameters of HFP and LFP birds we ran a one-way ANOVA using the following model: $Y_i = \mu + \alpha_i + \varepsilon_{ij}$, where Y is the log respectively square root transformed for each measurement, μ the general mean, α the fixed effect associated with the line and ε is the random variation.

The significance level is $P < 0.05$. Means are given ±S.D. Statistical results were obtained using the statistical software SPSS 11.0 (SPSS Inc., Chicago, IL, USA).

3. Results

Fig. 1 summarizes the mean maximum ratios completed in the sessions of the HFP and LFP birds. Both HFP birds and LFP birds achieved the highest maximum price with feed as a reinforcement followed by wood shavings and feathers. Between HFP birds and LFP birds, no differences in the achieved progressive ratio were found with feed as a reinforcement ($F_{1,19} = 0.02$; $P < 0.9$). HFP birds achieved higher PR ratios than LFP birds with feathers as a reinforcement ($F_{1,19} = 4.28$; $P < 0.05$). No line differences were found in maximum ratios completed with wood shavings as a reinforcement ($F_{1,19} = 1.03$; $P < 0.32$). HFP birds showed higher PR ratios than LFP birds when an empty food trough was offered ($F_{1,19} = 7.8$; $P < 0.02$).

As illustrated in Fig. 2 no line differences were found in pecks per minute for food ($F_{1,19} = 0.79$; $P < 0.39$), wood shavings ($F_{1,19} = 1.53$; $P < 0.23$) and feathers ($F_{1,19} = 0.0$; $P < 0.98$). HFP birds pecked significantly more per minute for an empty trough than LFP birds ($F_{1,19} = 10.93$; $P < 0.004$).

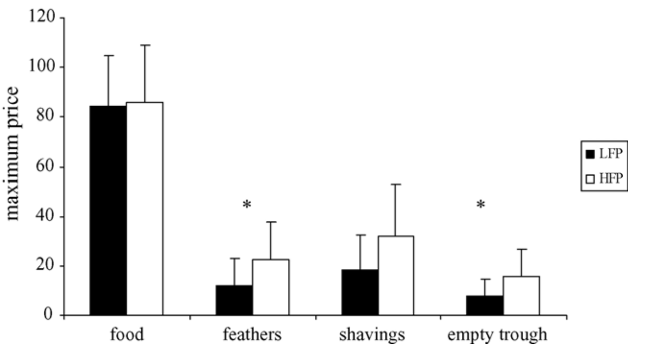

Fig. 1. The mean maximum price + S.D. paid by HFP and LFP birds for access to the four different substrates available in the Skinner box. *$P < 0.05$.

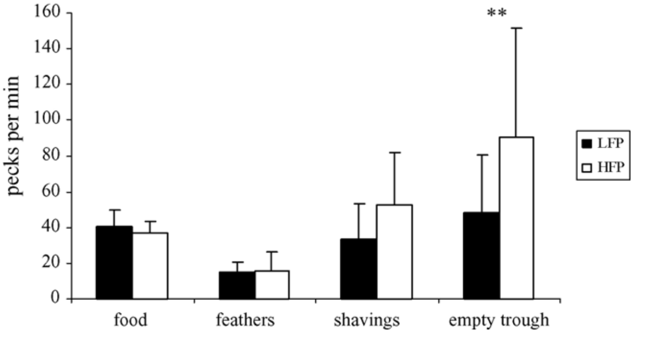

Fig. 2. Pecks per minute + S.D. of HFP and LFP birds under PR schedules pecking for the four different substrates. $^{**}P < 0.01$.

The amount of food eaten as a reward in the Skinner box was significantly higher in HFP (18.4 ± 3.1 g) than in LFP (13.2 ± 5.8 g) birds ($F_{1,19} = 10.93$; $P < 0.004$). Neither the number of feathers (0.5 ± 1.2 resp. 0.0 ± 0.0 number of feathers) nor the amount of wood shavings (0.3 ± 0.3 resp. 0.1 ± 0.3 g) eaten in the Skinner box differed between the HFP and LFP birds ($F_{1,19} = 2.29$; $P < 0.15$; resp. $F_{1,19} = 2.65$; $P < 0.12$).

The amount of food eaten in the home cage in the pre-test period did not differ between the lines ($F_{1,19} = 0.42$; $P < 0.52$). HFP birds ate a significantly higher number of feathers than LFP birds (3.5 ± 3.5 versus 0.7 ± 0.5) in the home cage ($F_{1,19} = 5.6$; $P < 0.03$). More wood shavings were eaten by HFP than by LFP birds (2.1 ± 1.6 versus 0.6 ± 0.7 g) in the pre-test period ($F_{1,19} = 8.24$; $P < 0.01$).

Fig. 3 shows that the lines did not differ in their mean latency to their first access to food ($F_{1,19} = 1.78$; $P < 0.2$) or feathers ($F_{1,19} = 0.48$; $P < 0.5$) in the Skinner box. HFP birds obtained access to wood shavings faster than LFP birds ($F_{1,19} = 6.19$; $P < 0.02$). The same was true for HFP birds achieving their first reinforcement for access to an empty trough ($F_{1,19} = 10.9$; $P < 0.004$).

Fig. 3. The mean + S.D. latency until the first reinforcement was earned for the different substrates available in the Skinner box by HFP and LFP birds. $^{*}P < 0.05$ $^{**}P < 0.01$.

4. Discussion

The aim of the present study was to determine if feathers and wood shavings are reinforcing in an operant conditioning task. Food, as suggested by Dawkins (1983) and no reward were the standards against which the other items were rated.

A rank ordering in HFP and LFP birds of the items (from most to least essential) using the maximum price paid gives a sequence of food, wood shavings, feathers and extinction (no reinforcer). This succession makes sense since food is more important than the other substrates. We cannot exclude in the present study that the sequence of testing influences the rank order. But Benda et al. (2005) showed in a preference test, where the same items were offered simultaneously, a rank order of wood shavings, food and feathers in non-food deprived laying hens.

Wood shavings seemed to be more important than loose feathers. This could be explained by the fact that wood shavings were available only via the operant task, whereas feathers were continuously available. It is not possible from an animal welfare point of view to prevent birds from plucking and eating their own feathers. This could reduce the apparent "demand" for feathers in the operant task. It has been shown that birds prefer a reward associated with greater deprivation (Marsh et al., 2004).

Savory and Duncan (1982) stated that reward size strongly influences the stimulus value. In the present experiment, only one feather was presented per reinforcement during the feather session. During the procedure involving wood shavings, a full trough was made available. The stimulus for feather eating is most likely influenced by the number of feathers presented. Consequently, the more feathers available, the higher the motivation to pluck and eat the feathers. In the familiarisation period (pre-test period) the birds could pluck ten inserted feathers out of small holes in a plastic lid. This artificial simulation of plumage looked and felt more like skin with feathers and may therefore have been more interesting for the birds than a single feather in the trough.

HFP birds achieved higher maximum ratios with feathers and with extinction. The former was no surprise as shown in Harlander-Matauschek and Bessei (2005) and McKeegan and Savory (2001) where HFP birds ate significantly more free available feathers than LFP birds. This result underlines the importance of structural indigestible components found in either food or elsewhere in the environment for HFP birds. Harlander-Matauschek et al. (2006) showed that in HFP birds feathers increased the speed of feed passage and, in this regard showed similar effects as insoluble, indigestible fiber. The dietary effect of feathers may be a crucial factor in the development of feather pecking. It has been found that insoluble fiber rich diets improved feather cover due to less feather pecking (Aerni et al., 2000). In this regard, the welfare of HFP birds could be improved by including structural insoluble food components in the diet.

Pecking for no reinforcement was shown in both lines. However, the birds were kept for several months in a restrictive environment where even little stimulus may have been quite important.

It is possible that differences in pecking behaviour observed in HFP and LFP birds relate to the different ways in which the respective lines cope with frustration. Rodenburg et al. (2005) found that HFP birds continued to show foraging behaviour in the Skinner box during repeated frustration sessions, where LFP birds did not show this behaviour. LFP birds could be more reactive to changes in the environment.

In addition feather pecking has a stereotypic component (Bessei, 1983; Kjaer and Vestergaard, 1999) which would explain why HFP birds paid the higher maximum price for extinction. The stereotypic pecking could also be the reason for the higher number of pecks per minute by the HFP birds especially when no reinforcement was given.

Rodenburg et al. (2002) hypothesized that HFP birds are more persistent in key pecking and covered feeder pecking than birds from a LFP line, reflecting a pro active, less flexible coping strategy. The results from the present study support the hypothesis of Rodenburg et al. (2002).

The maximum prices paid (where ‘‘price’’ is the number of responses required for reinforcement), as opposed to the number of substrate deliveries, was the primary determinant of maximum price in the present study. The birds did not in all cases eat the substrate which was offered. Similar results have been reported by Robinson et al. (1995).

It is remarkable that HFP and LFP birds found feathers and wood shavings (litter) reinforcing as a food component. This was more pronounced in pecking for feathers by HFP birds. In the investigations of Dawkins and Beardsly (1986) and Petherick et al. (1990) litter did not function as reinforcement when it was offered as a dustbathing substrate. Gunnarson et al. (2000) illustrated that laying hens showed a demand for litter (straw and feathers), although did not stimulate dustbathing consistently in their study. Keeping the results of the present study in mind, it is likely that the birds in the study by Gunnarson et al. (2000) were eating the litter as opposed to using it as a dustbathing substrate.

In conclusion, all laying hens used in this study learned the operant conditioning technique. Both HFP and LFP birds placed value on feathers and wood shavings in the pre-test period. HFP birds paid a higher price to gain access to feathers, wood shavings and an empty feeder in the Skinner box.

Our results imply that the birds had requirements for feathers and wood shavings but that HFP compared to LFP birds had significantly a higher requirement for feathers than their LFP counterparts.

Acknowledgements

This study was financed by a grant from the German Research Foundation (DFG). A. Harlander thanks Lindsay Matthews for a useful discussion on the operant conditioning technique in general and Bas Rodenburg for his comment on an earlier version of the manuscript.

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