ENVIRONMENTAL ENRICHMENT FOR LAYING HENS – SPHERICAL OBJECTS IN THE FEED TROUGH

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The welfare of caged laying hens could be improved by placing objects in the feed trough. Such objects might (a) simulate general ground-litter thus promoting more normal foraging activity and (b) give hens the opportunity to 'work' for feed – a behaviour usually thwarted in conventional cages. Spherical objects with various characteristics were placed in the feed trough of a tier of caged laying hens (n = 16). The hens pecked frequently at the objects, moving them to the trough space of adjacent cages. The mean proportion of hen heads over the trough containing these objects was significantly greater than before the objects were present (35.3 cf 32.9%) and significantly greater than the proportion of heads over a similar trough containing no objects (33.6%). Thirty days later, the mean proportions were still significantly different (33.5 cf 31.0%) showing that there was little habituation. Daily manual scattering of the objects increased the distance they were subsequently moved by the hens (23.0 cf 19.3cm/day) indicating increased pecking activity. In a second study 12 hens were given a choice of feeding from troughs containing 0, 12 or 36 spherical objects. There was no overall preference to feed from any of the troughs. All the hens fed from troughs containing the objects, possibly indicating that the opportunity to move the objects and forage or work for feed was desired on occasions. Brightly coloured spherical objects are considered to be a promising method of successful environmental enrichment for caged laying hens. Their use to improve the welfare of caged laying hens appears to be practical and reasonably inexpensive.

Keywords: animal welfare, laying hens, environmental enrichment, foraging

Introduction

Enriching the environment of poultry is desirable for several reasons, for example; reducing fearfulness (Jones 1982; Jones *et al* 1991), neophobia (Candland *et al* 1963; Broom 1969; Gvaryahu *et al* 1989), possibly general frustration (Faure 1991); lowering corticosterone levels; (Mench *et al* 1991); reducing feather-pecking (Braastad 1990; Norgaard-Nielsen 1991; Blokhuis & van der Haar 1992); and improving production performance (Jones *et al* 1980; Gvaryahu *et al* 1988).

Previous investigations of environmental enrichment for caged layers have placed objects completely within the cage (Gvaryahu *et al* 1988; Braastad 1990; Gvaryahu *et al* 1990; Sherwin 1991, 1993), thus largely ignoring the potential for enriching the feed trough (see Sherwin 1993). If multiple loose objects were placed in the feed trough, two advantages might be gained. First, it has been shown experimentally that several species including

pigeons (Neuringer 1969), rats (Neuringer 1969; Hothersall *et al* 1973), starlings (Inglis & Ferguson 1986) and laying hens (Duncan & Hughes 1972) on occasions prefer to work for food rather than eating freely available identical food. Similarly, under less contrived conditions, both feral domestic hens and red junglefowl will forage for considerable periods despite being fed regularly (Duncan & Hughes 1972; Dawkins 1989). Therefore, working or foraging for food might (at times) be a highly motivated behaviour. If so, placing hens in an impoverished cage which thwarts these feeding activities probably compromises welfare. Placing multiple loose objects in the feed trough of caged hens might simulate ground-litter, thus providing the opportunity for working and foraging for feed. This approach has a second advantage. It has been hypothesised (Blokhuis 1986) that feather-pecking amongst caged hens is due to a lack of suitable foraging substrate; pecks which would normally be expressed during foraging are redirected to the feathers of cage-mates (but see also Vestergaard *et al* 1993). If placing objects in the feed trough causes those pecks to be directed to the objects or food, feather-pecking should be reduced and welfare improved.

The physical characteristics of objects in the trough will influence both their attractiveness to the hens and their practicability within an animal production system. If the objects are spherical and reasonably large, two advantages would be gained when they are placed in an external feed trough which runs continuously between the cages. First, as the hens peck the objects the spherical shape will facilitate movement to the trough-space of adjacent cages, thus presenting novel stimuli to neighbouring hens. This would reduce, or perhaps eliminate, the rapid habituation observed when using simple and/or predictable environmental enrichment objects (see Braastad 1990; Sherwin 1991, 1993). Second, if the objects are suitably large the hens will not be able to grasp and lift the objects into the cage. This obviates the need to replace the objects which is often necessary in research-based enrichment programmes but rather impracticable for commercial production systems.

This paper describes two studies. The first examines whether various spherical environmental enrichment objects (balls) placed in the feed trough were attractive to caged laying hens, and whether changes in behaviour were long-term. The second study examines whether hens expressed a preference to feed from troughs with or without these objects, and whether experience and the number of balls influenced the preference.

Study 1

Methods

The cages, measuring 60x40x60cm and each with four roll-away nest hollows incorporated at the rear (see Sherwin & Nicol 1992), were arranged in three tiers each of four. Water was available from overhead nipples at the front of each cage and the floor slope was 5°. Food troughs were located at the front and were continuous for each tier. Hi-sex layer hens were placed in the cages (four per cage) 20 weeks prior to the experiment and were 38 weeks old at the start of observations. Lights were on between 0800 and 2400h and the hens had continuous access to standard layers' mash which was replenished daily between 0900 and 0930h.

The behaviour of hens in the middle and top tiers (n = 16 hens in each tier) was recorded before and after 22 balls with various characteristics (Table 1) were placed in the feed trough

of the middle tier (Day 0). Initially, data were collected during three periods; on 7 of the 10 days prior to the balls being present (Period 1), on days 0-10 (Period 2), and on days 40-51 (Period 3). On these days, behaviour was videoed from 1100 to 1200, 1500 to 1600, 1900 to 2000 and 2300 to 2400h. The number of hen heads over each trough, regardless of the behaviour engaged in, was determined at five minute intervals from the video tapes.

Table 1 Characteristics of the balls placed in the feed trough.

Ball type	n	Mass (g)	Diameter (cm)	Surface material	General comments
Leather	3	34.8	9.0	Leather	Soft foam filling. Black and white surface spattered with various coloured paints
Rubber	4	54.9	6.5	Hard rubber	Solid. Multicoloured (predominantly red) during manufacture
Tennis	3	73.3	6.5	Cotton/nylon	Friable covering material. Green surface spattered with various coloured paints
Coloured table tennis	6	2.7	4.0	Hard plastic	Hollow. White surface spattered with various coloured paints
Green table tennis	6	2.5	4.0	Hard plastic	Hollow. White surface spattered with green coloured paint

Movement of the balls was quantified at 1100 and 1700h by recording the position (±10cm) of each ball. The distance each ball moved between recordings was used to calculate a mean for each ball type. During Periods 2 and 3 the balls were touched by humans only for identification purposes, after which they were carefully replaced in the trough.

On days 52-60 (Period 4), the response of the hens to the balls being moved once daily by an extraneous source (human) were examined. At 0930h the balls were randomly scattered about the trough and the hens then fed. The position of each ball was noted at 1100, 1700 and at 0930h the following day (prior to the balls being scattered). The number of hens with their heads over the trough was determined as above.

Raw data for 'number of heads over the trough' were converted to a proportion of the total number of hens in the tier, and then subjected to arcsin, square root transformation as

recommended by Sokal and Rohlf (1981). Means presented in tables are non-transformed data.

Results

The hens frequently pecked the balls, adherent particles and at feed directly under the balls – even when there was ample trough space to feed without such hindrance. During these activities the hens moved the balls along the trough. The pecking activity was sufficiently intense to remove most of the paint from the leather and tennis balls by the end of Period 3. The tennis balls developed tufts in the surface material and on three occasions the hens apparently used these to grasp a ball and pull it into the cage. Other than this, the balls were never seen to be removed from the trough by the hens.

Paired *t* tests showed that except for Period 1 (when no balls were present), the mean proportion of heads over the trough with balls was significantly greater than over the control trough without balls (Table 2). The greatest difference (3.3%) was during Period 4 when the balls were manually scattered. A two-way ANOVA showed that both the Tier (presence of balls) and the Period had significant effects on the proportion of heads over the trough, with no significant interaction (F = 19.9, 5.7, 1.9; 1, 3, 3 *df*; and P = 0.0001, 0.0007, 0.129, respectively).

Table 2 **The mean percentage (± SEM x 10^{-2}) of hens with their heads over the feed trough (n = 16 hens for each trough) for each period and each treatment. Paired *t* test results are shown ($P<0.05$).**

Period	Mean percentage of heads over trough					
	Middle tier (balls in Periods 2, 3 & 4)	Top tier (no balls)	Difference	*df*	*P*	Significance
1	32.9 (±0.64)	32.6 (±0.49)	0.3	363	0.7342	ns
2	35.3 (±0.49)	33.6 (±0.36)	1.7	519	0.0217	s
3	33.5 (±0.49)	31.0 (±0.36)	2.5	519	0.0007	s
4	34.1 (±0.36)	30.8 (±0.36)	3.3	506	0.0001	s

s significant ns not significant

When data for movement were pooled for all ball types, the Period had a significant effect on the mean distance moved (Table 3). The balls were moved the greatest mean distance during Period 4, least during Period 3, and intermediate in Period 2.

Table 3 **The mean (±SEM) distance each ball type was moved between recordings (1100 and 1700h) for each Period.**

Ball type	Distance moved (cm)			
	Period 2	Period 3	Period 4	Period 2-3 (combined)
Leather	22.8 ±3.4	13.0 ±1.9	16.3 ±2.6	17.6 ±1.9
Rubber	15.8 ±2.1	17.7 ±1.9	18.3 ±2.0	16.8 ±1.4
Tennis	28.8 ±4.1	20.0 ±2.4	18.5 ±2.6	24.0 ±2.3
Coloured table tennis	16.8 ±2.5	8.3 ±2.0	28.7 ±3.2	12.3 ±1.6
Green table tennis	17.7 ±2.3	13.0 ±13.2	25.6 ±2.6	15.2 ±2.0
Overall mean	19.3[b] ±1.2	13.6[c] ±1.2	23.0[a] ±1.3	

Different superscripts denote significant differences between Periods (ANOVA: $F = 15.5$; 2 *df*, 1,295 *df*; $P<0.05$).

To determine if manual scattering influenced the distance each ball type was subsequently moved by the hens, movement data for Periods 2 and 3 were pooled and compared to Period 4. From Table 3 it can be seen that the rankings of the greatest distance moved were dissimilar, eg in Period 2-3 the coloured table tennis balls moved least whereas in Period 4 they moved most.

Discussion

Providing balls in the feed trough of hens caused the hens to place their heads over the trough more frequently. Although the differences were relatively small (approximately 2%), it indicates that the balls were attractive to the hens. The difference might be increased by the use of other objects. Since hens with their heads through the cage-front and over the trough are less able to peck the bodies of their cagemates, especially areas below the neck which are often targeted for feather-pecking (Braastad 1985; Tind 1985), the provision of balls in the feed trough might be a simple method of reducing feather-pecking amongst caged layers.

There was no evidence of habituation to the balls: the increased proportion of heads over the trough was still present several weeks after the balls were first placed in the trough. It has

been reported that laying hens habituate within five days to simple, passive objects or predictable motorised devices (Sherwin 1991, 1993), though straw (Norgaard-Nielsen 1989, 1991), food (Braastad 1990; Blokhuis & van der Haar 1992) or water related items (Sherwin 1993) appear less susceptible to habituation. Whilst the balls moved less during Period 3 compared to Period 2 (Table 3), this decrease was not the result of habituation. Rather, the smaller balls aggregated at the ends of the trough beyond the hens' reach thus preventing further movement. Furthermore, since the between treatment difference in the proportion of heads over the trough increased in Period 3 rather than decreased (Table 2), it seems very unlikely that habituation occurred. Supplying objects which are moved between adjacent cages and thus maintain their (relative) novelty, could overcome the problem of habituation to environmental enrichments intended as pecking substrates.

Some ball types were moved considerably greater distances than others (Table 3). This might have been due to preferential pecking by the hens and/or the physical characteristics of the balls. During Period 4 when manual scattering prevented aggregations at the trough ends, ball types of lower mass tended to be moved the greatest distances. However, during Period 2-3, amongst the larger ball types (which did not aggregate), the heaviest type (tennis ball) was moved the greatest distance. The larger balls were also considerably damaged at the end of the experiment. This observation indicates that the pliant or textured coverings attracted more frequent or stronger pecking than resilient surfaces.

When the balls were manually scattered each day there was an increase in both the proportion of heads over the trough and pecking activity (indicated by the distance the balls moved). Manual scattering apparently increased interest in the balls and should probably be adopted if they were to be placed in feed troughs routinely. It would be simple for attendants to move the balls as they collect eggs, inspect birds, etc. This would also overcome the potential problem of the balls aggregating in troughs. Alternatively, if balls were placed in automatic feeders, eg chain driven, these could move the balls whilst distributing the feed.

Study 2

Methods

Twelve, medium-hybrid ISA Brown hens were housed individually from 16 weeks of age in a bank of 'home' cages (40x35x45cm WxDxH) comprising three tiers each of six cages. Half the hens were housed in the top tier and half in the middle tier. Removable feed troughs, located on the front, extended the length of two cages. Twelve, white table-tennis balls painted with red, yellow, green, blue and black paint in various patterns, were placed in each trough of the top tier (Experienced hens) whilst none were placed in the middle tier (Naive hens). Lights were on between 0800 and 2200h.

A suitable preference testing cage was created by removing the internal sides of the six cages in the bottom tier thus making one wide, shallow cage (240x35x45cm). The three feed troughs for this cage were as described above; each trough could therefore be placed in one of three positions within this tier (left, middle or right).

Preference testing began 14 days after all the hens had been placed in the home cages. During preference tests, one trough of the preference cage contained 0 balls, another 12 and another 36. These quantities were chosen to cover approximately 25 per cent (12 balls) or 75

per cent (36 balls) of the surface of the feed. A hen was selected at random from the top two tiers and placed in the preference cage for six consecutive days. This was repeated for each hen. At 0900h on each day during this period the positions of the three troughs were allocated randomly, with the limitations that no trough was in the same position on two consecutive days and that each trough was in each position twice. If necessary feed was also replenished at this time (usually every 2-3 days), by pouring it into the troughs with no attention given to creating or reducing movement of the balls.

Behaviour of the hen in the preference cage was videoed between 1300 and 2100h. From the tapes it was determined, at five minute intervals, from which trough the hen was feeding, or if not feeding which third of the cage she was in. The proportions of each daily total of; feeding records spent feeding from each trough; and non-feeding records spent in each third of the preference cage, were calculated. These proportions were arcsin, square root transformed before being tested with a two-way ANOVA; the number of balls and experience are the treatments.

Results

When the hens were not feeding, there were no significant differences between the mean proportions of presence in each third of the preference cage (Table 4). This shows that non-feeding behaviours were distributed equally within the cage and that any preferences for feeding from a particular trough were unlikely to be due to a positional preference.

Table 4 **Mean (±SEM) proportion of non-feeding records for each group of hens (Experienced and Naïve) related to which third of the preference cage each hen occupied.**

Nos of balls in trough	Proportion of non-feeding records	
	Experienced hens	Naïve hens
0	0.32 (±0.03)	0.35 (±0.03)
12	0.34 (±0.03)	0.34 (±0.04)
36	0.34 (±0.03)	0.31 (±0.03)

Overall, the hens exhibited a significantly reduced tendency to feed from the trough containing 36 balls ($P<0.0001$, 2 *df*) (Table 5) though the significant interaction ($P<0.0001$, 2 *df*) showed this was due to the behaviour of the Naïve hens. The hens fed more from the trough containing 12 balls than the trough containing 0, though this difference was not significant. When data from Experienced and Naïve hens are considered separately, Experienced hens showed no significant trough preference whereas Naïve hens fed considerably less from the trough containing 36 balls.

Table 5 **Mean (±SEM) proportion of feeding records for each group of hens (Experienced and Naïve) related to which trough each hen was feeding from.**

Nos of balls in trough	Proportion of feeding records		
	Experienced hens	Naïve hens	Mean
0	0.27 (±0.04)	0.44 (±0.05)^{b}	0.36 (±0.04)^{b}
12	0.40 (±0.05)	0.46 (±0.06)^{b}	0.43 (±0.04)^{b}
36	0.34 (±0.05)	0.10 (±0.03)^{a}	0.22 (±0.03)^{a}

Means within columns with different superscripts differ significantly ($P<0.0001$, Fishers PLSD).

Considerable individual differences in trough preferences were evident (Table 6). No hen clearly preferred to feed from the trough containing 36 balls, though five of the six Experienced hens fed least from the trough containing 0 balls. The majority of Naïve hens fed significantly more frequently from the troughs with 12 or 0 balls.

Table 6 **Means of daily proportions (n = 6 days) of individual feeding preferences from troughs containing 0, 12 or 36 balls.**

Hen		Proportion of feeding records		
		0 balls	12 balls	36 balls
1	Experienced	0.26 (±0.12)	0.38 (±0.14)	0.36 (±0.12)
2	Experienced	0.25 (±0.08)	0.33 (±0.08)	0.42 (±0.09)
3	Experienced	0.32 (±0.14)^{ab}	0.56 (±0.13)^{b}	0.12 (±0.08)^{a}
4	Experienced	0.30 (±0.07)	0.35 (±0.1)	0.35 (±0.1)
5	Experienced	0.24 (±0.1)	0.39 (±0.12)	0.36 (±0.13)
6	Experienced	0.24 (±0.13)	0.36 (±0.15)	0.40 (±0.18)
7	Naïve	0.29 (±0.09)^{b}	0.66 (±0.1)^{c}	0.05 (±0.04)^{a}
8	Naïve	0.55 (±0.34)^{b}	0.43 (±0.35)^{b}	0.02 (±0.04)^{a}
9	Naïve	0.58 (±0.15)^{b}	0.30 (±0.11)^{ab}	0.12 (±0.07)^{a}
10	Naïve	0.52 (±0.15)	0.27 (±0.17)	0.22 (±0.12)
11	Naïve	0.37 (±0.13)^{ab}	0.51 (±0.12)^{b}	0.12 (±0.03)^{a}
12	Naïve	0.34 (±0.13)^{b}	0.60 (±0.14)^{b}	0.06 (±0.03)^{a}

Means within rows with different superscripts differ significantly ($P<0.05$, Fishers PLSD).

Discussion

The balls had no effect on spatial distribution of non-feeding behaviours but influenced which trough the hens fed from. The Naïve hens fed considerably less frequently from the trough containing the greatest density of balls (Table 5). Neophobia or preference to feed from a trough with a familiar appearance are unlikely to be the cause since the Naïve hens fed with a similar frequency from the trough containing 12 balls to that containing 0 (ie the presence of balls *per se* was not aversive).

All the hens were observed to feed from the trough containing 36 balls, indicating this density was not overly aversive. Although the Naïve hens fed significantly less frequently from this trough, they still fed from it 10 per cent of the time. Apparently enrichment of the feed troughs with brightly coloured spherical objects was attractive to the hens, but only at some times.

Free-ranging hens sometimes prefer to forage (Duncan & Hughes 1972; Dawkins 1989) and trained hens will activate an operant device (Duncan & Hughes 1972) to gain access to feed, even when identical food is freely available nearby. The present results show that caged layers had a partial preference to feed from troughs containing multiple enrichment objects simulating ground-litter, and thus possibly also preferred to 'forage' on occasions.

Experienced hens fed equally frequently from all troughs indicating they had no over-riding preference to gain free food, nor an aversion to 'forage' amongst the balls. It is widely acknowledged that interpretation of simple preference tests (such as here) is problematic if partial preferences are observed (eg Duncan 1978), ie at what proportion does the partial preference to feed with balls indicate these were required by the hens rather than regarded as a luxury? The evidence that foraging was desired by the hens is circumstantial; further work is necessary to elucidate the strength of their motivation to forage or work for feed.

Welfare implications

These data are from preliminary experiments which used relatively small numbers of hens, however, there was clearly a partial preference to feed from troughs containing balls. This technique of environmental enrichment therefore shows promise but requires further development. Further experiments should determine whether providing balls in the feed trough reduces feather-pecking. Even if this proves erroneous there are several welfare, production and husbandry advantages to be gained by providing environmental enrichment with such objects (see Introduction). The long-term changes in behaviour indicate this form of enrichment was relevant to the hens and not perceived by them simply as temporarily interesting, non-essential 'clutter'.

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