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Applied Animal Behaviour Science 79 (2002) 285–297

APPLIED ANIMAL BEHAVIOUR SCIENCE

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How important is social facilitation for dustbathing in laying hens?

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Accepted 9 July 2002

Abstract

Hens in a group usually synchronize dustbathing, such that when one hen starts to dustbathe she will often be joined by others. The sight of another hen dustbathing could thus possibly act as a stimulus increasing motivation for dustbathing, with important implications for hens in furnished cages, where the size of the dustbath normally allows only one hen to dustbathe at a time. If a hen is more motivated to dustbathe when she can see another hen dustbathing but she cannot get access to the litter since the dustbath is occupied, frustration may arise. The aim of this study was to investigate the effect of social stimuli on dustbathing motivation. Pairs of hens were exposed to one of three stimuli while being thwarted of dustbathing and they were thereafter given access to dustbathing material. The stimuli were (1) the sight of other hens dustbathing (DB-HEN), (2) the sight of a dustbath with other hens not dustbathing (NODB-HEN) and (3) the sight of a dustbath only (NO-HEN). Twelve pairs of hens were tested both deprived and non-deprived of litter in a balanced within-subject design. Irrespective of deprivation state, hens walked more and spent more time facing the stimulus in DB-HEN than in NO-HEN, and when they were not deprived they also walked more in DB-HEN than in NODB-HEN. Subsequent dustbathing behaviour when hens were given access to litter after the stimulus exposure was unaffected by the type of stimuli. We suggested that subtle effects of social stimuli on dustbathing motivation may have been masked by the effect of long litter deprivation and that it may be important for the birds to be able to join the stimulus birds to dustbathe together. For these reasons we repeated the experiment with individual hens and with a shorter litter deprivation time and a shorter stimulus exposure, after which the test hen was allowed to join the stimulus hen. Furthermore, in this second experiment hens were tested only in DB-HEN and NODB-HEN treatments. We found more displacement preening and less time facing the stimulus in DB-HEN than in NODB-HEN, but dustbathing behaviour was still unaffected by previous social stimuli.

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PII: S0168-1591(02)00117-X

In summary, dustbathing behaviour of the test hens was not affected by seeing other hens dustbathing, but increased walking and displacement preening indicated a possible change in the motivation of test hens observing other dustbathing hens.

Keywords: Hens; Dustbathing; Social facilitation; Behaviour; Poultry; Motivation

1. Introduction

Adult birds with access to litter dustbathe about every second day (Vestergaard, 1982) and hens in a group will synchronize dustbathing, so that when one hen starts to dustbathe she will be joined by others (Wood-Gush, 1989). Behavioural synchronization has been found for a number of behaviour patterns both in free-living hens (Wood-Gush, 1959) and in hens in cages (Hughes, 1971; Webster and Hurnik, 1994). Since synchronization results in animals performing the same behaviour in a group, the risk of predation of each individual may also decrease (Lazarus, 1972; Forkman et al., 1994; Keeling et al., 2002), which may be particularly important when performing behaviours where animals are more vulnerable, such as dustbathing (Lundberg and Keeling, 2002). Social facilitation, that is the initiation of or the increase in frequency or intensity of a behaviour when shown in the presence of others engaged in the same behaviour (Clayton, 1978), is one mechanism which could contribute to such synchronization. There is some indication that the presence of dustbathing companions may elicit dustbathing both in quail (Healy and Thomas, 1973) and in laying hens (Duncan et al., 1998), and on the basis of the social nature of the behaviour, it has been suggested that dustbathing is socially facilitated (Vestergaard, 1981; Vestergaard et al., 1990; but see Lundberg and Keeling, 2002).

But social facilitation is not the only way to synchronize behaviour. The same synchronization will result if other factors important for the motivation of the behaviour affects all animals at the same time and in the same place. Dustbathing behaviour is regulated through an interaction of internal and external factors, such as time since last dustbathing (Vestergaard, 1982; van Liere and Wiepkema, 1992), an endogenous circadian rhythm (Vestergaard, 1982; Hogan and Van Boxel, 1993), the sight of a dusty substrate (Petherick et al., 1995) and the presence of a light/heat stimulus (Hogan and Van Boxel, 1993; Duncan et al., 1998).

When social facilitation acts, the sight of one individual performing the behaviour enhances the motivation of others (see Colgan, 1989). Consequently, if dustbathing is affected by social facilitation, the sight of another hen dustbathing will act as a stimulus increasing motivation for dustbathing. This may have important implications for hens in furnished cages, which are now being introduced as an alternative to battery cages in Swedish egg production and which will be the only cages allowed from 2012 according to the European Union legislation. In this system, a group of hens has access to a dustbath, but the size of the dustbath normally allows only one hen, or at a maximum two hens, to dustbathe at the same time. If an observing hen becomes more motivated by seeing a cage mate dustbathe, at the same time as she is prevented from dustbathing because the dustbath is occupied, she may experience frustration.

The aim of this study was to investigate the effect of social stimuli on the motivation to dustbathe. The hypothesis was that the sight of a dustbathing hen will increase motivation to dustbathe and that this increase in motivation will result in frustration when hens are prevented from dustbathing, and in an increase in dustbathing behaviour when subsequently given access to litter. In the initial experiment, we studied the behaviour of pairs of hens, deprived or non-deprived, when dustbathing was thwarted in three different stimulus situations:

1. the sight of other hens dustbathing in litter,
2. the sight of a dustbath with other hens *not* dustbathing, and
3. the sight of a dustbath only.

To confirm the results suggested by this first experiment, a second experiment was performed where individual hens were allowed to join a stimulus hen that was either dustbathing or not dustbathing in litter.

2. Experiment 1

2.1. Materials and methods

Forty-eight beak-trimmed pullets of the commercial hybrid Black Dekalb were used in the experiment. The birds were raised on a litter floor and were transported to the experimental facilities at the age of 9 weeks. Testing started when the birds were 10 weeks of age and ended when they were 13 weeks. The birds were divided into three groups of 16 birds each and, according to the experimental treatment, could be housed in one of two pen-types. The first type had a litter floor with 2/3 of the floor covered with woodshavings and 1/3 with peat, whereas the second type had a wire-floor. Both pen-types measured $1.0\,m \times 1.2\,m \times 0.6\,m$ ($l \times w \times h$). When birds were to be tested litter deprived, they were kept in the wire-floor type holding pen between tests. When they were to be tested undeprived, they were kept in the litter type pen 22 h prior to the test. Perches 10 cm above floor level were provided in both pen-types. Hens had ad libitum access to pelleted growers' feed and water. The birds were kept on an 8.5 h light schedule, with lights coming on at 8.00 h.

The birds were tested in pairs, together with a pair of stimulus birds. To ensure that birds were familiar with each other, the same pair of test birds were always tested with the same pair of stimulus birds and all four hens came from the same holding group. Because social facilitation may be affected by rank (Forkman, 1996; see also Lundberg and Keeling, 2002), we attempted to determine the rank relationship by paired feed-competition tests. However, these resulted in very little aggression and it was not possible to measure a clear social hierarchy so experimental sets of birds were randomly composed.

The hens were tested in a separate room, in pens with the same dimensions as the holding pens. The test pens were divided into two parts, separated by plexiglass. One part with a standard wire-floor ($1.0\,m \times 0.66\,m$) held the experimental birds and one part with concrete floor covered with peat ($1.0\,m \times 0.54\,m$) held the stimulus birds. A set-up with four equal test pens and multiplexer video equipment allowed four sets of birds to be tested simultaneously.

Prior to the testing, the sets of four birds were habituated to the test pens for 30 min during each of five consecutive days. Hens were tested every third day, starting at 14.00 h (6 h after lights-on). Test birds were introduced and left on the wire-floor side for 5 min, after which the appropriate treatment started on the peat side. The test pair of birds were exposed to the treatment for 30 min (the expected duration of a stimulus hen dustbathing bout) after which they were moved to the stimulus side with peat. In treatments 1 and 2, the stimulus birds were lifted out and returned to their home pen before the test pair of birds was moved to the stimulus side with peat. Since there were no stimulus birds in treatment 3, the test hens could be lifted over to the peat immediately following the end of the stimulus period. The test birds were left in the stimulus side for 40 min, to allow them to complete a dustbathing bout before being returned to the home pen.

The hens were exposed to the following treatment stimuli:

1. stimulus hens dustbathing in peat (DB-HEN);
2. same as treatment 1, but with stimulus hens not dustbathing (NODB-HEN); and
3. peat only (NO-HEN).

A balanced within-subject design was used, in which each test bird pair was exposed to all treatments. Furthermore, birds were tested both deprived and non-deprived. When deprived they had no access to litter between tests and so were deprived for 70.5 h. When tested non-deprived, hens were moved to the litter pen at 15.30 h the day before the experiment and so had access to litter and peat for dustbathing for 22.5 h prior to test. The same treatments were applied to the stimulus birds, which were deprived when they were to act in DB-HEN and non-deprived in NODB-HEN.

All behaviour observations were taken from the video tapes. For the experimental birds on the wire-floor, continuous observations with rotating focal sampling were used, switching focal animal at 3 min-intervals. The following behaviour patterns were registered as stated, that is to say, both the duration and frequency were recorded: preening, squatting, standing near and facing stimulus (in the part of the pen nearest the stimulus with the beak positioned at an angle of $\pm 45^\circ$ to the plexiglass), standing far and facing stimulus (in the half of the pen furthest away from the stimulus, but still with the beak positioned at an angle of $\pm 45^\circ$ to the plexiglass), standing and not sfacing stimulus and other behaviour. The following behaviour patterns were recorded as events, that is recording frequency only: step, displacement preen, head shake, ground peck, peck own body, peck object, non-aggressive peck, aggressive peck, threat and avoidance. For the observations of experimental birds on the peat, latency to start dustbathing, duration of dustbathing and number of vertical wingshakes were registered for each bird.

2.2. *Statistical analysis*

In DB-HEN, two observations were excluded because the stimulus birds did not dustbathe during the main part of the stimulus exposure. Similarly, four observations in NODB-HEN were excluded because the stimulus birds dustbathed.

For statistical analysis, an average of the two experimental birds was calculated. Besides the separate analysis of each behavioural element, behaviours were grouped into 'agonistic behaviour' (threats + avoidance), 'frustration' (displacement preening, headshakes +

agonistic behaviour; see Duncan and Wood-Gush, 1971 and 1972b) and 'facing stimulus' (near and facing stimulus + far and facing stimulus). All results were analysed using the statistical software MINITAB. Pairwise comparisons within deprivation state were made between treatments DB-HEN and NODB-HEN, and between DB-HEN and NO-HEN, using Wilcoxon matched pairs signed rank test. Because the experiment was exploratory, no corrections for multiple comparisons were made. A post-hoc analysis compared observations in which both birds in the pair dustbathed with observations in which neither bird in the pair dustbathed. These comparisons were made on an average of the different treatments for each pair. Data are presented as medians with interquartile range.

2.3. Results

2.3.1. Behaviour of test hens during stimulus exposure

Birds spent more time near and facing the stimulus compartment in DB-HEN than in NO-HEN when the test birds were deprived and tended to face more also when they were not deprived (Fig. 1). Hens walked more in DB-HEN than in NO-HEN, both when they were deprived and when they were not deprived (Fig. 2). When hens were not deprived, they also walked more in DB-HEN than in NODB-HEN.

There was no treatment effect on agonistic behaviour, any type of non-aggressive pecking (ground pecking, gentle pecks at the plumage of the other hen and pecks at own plumage) or any other of the variables measured during stimulus exposure.

2.3.2. Behaviour of test hens when moved to the litter following stimulus exposure

In almost all cases when the test birds were deprived at least one bird in the pair, and in most cases both, dustbathed when they were given access to litter after the stimulus exposure. In the same situation very few non-deprived birds dustbathed (Table 1). There was no effect of treatment during the stimulus exposure on latency to start dustbathing or time spent dustbathing, neither when all birds were included in the analysis nor when the behaviour of only these birds that dustbathed was analysed.

We also compared the duration of dustbathing between those pairs in which both birds dustbathed and those in which only one hen dustbathed, but found no significant difference.

The post-hoc comparison between observations where both birds dustbathed and observations where neither of the birds dustbathed, revealed that the 'dustbathers-to-be' spent significantly more time facing and near and facing the stimulus side, less time preening and walked more. They also tended to show more signs of frustration (displacement preening and agonistic behaviour) during the stimulus exposure than did birds which would not dustbathe afterwards (Table 2).

Table 1
Pairs where at least one hen dustbathed when given access to litter after the stimulus exposure

	DB-HEN (*N*)	NODB-HEN (*N*)	NO-HEN (*N*)
Deprived	12 (12)	9 (9)	11 (12)
Not deprived	3 (10)	2 (11)	1 (12)

Total number of pairs are given in parenthesis.

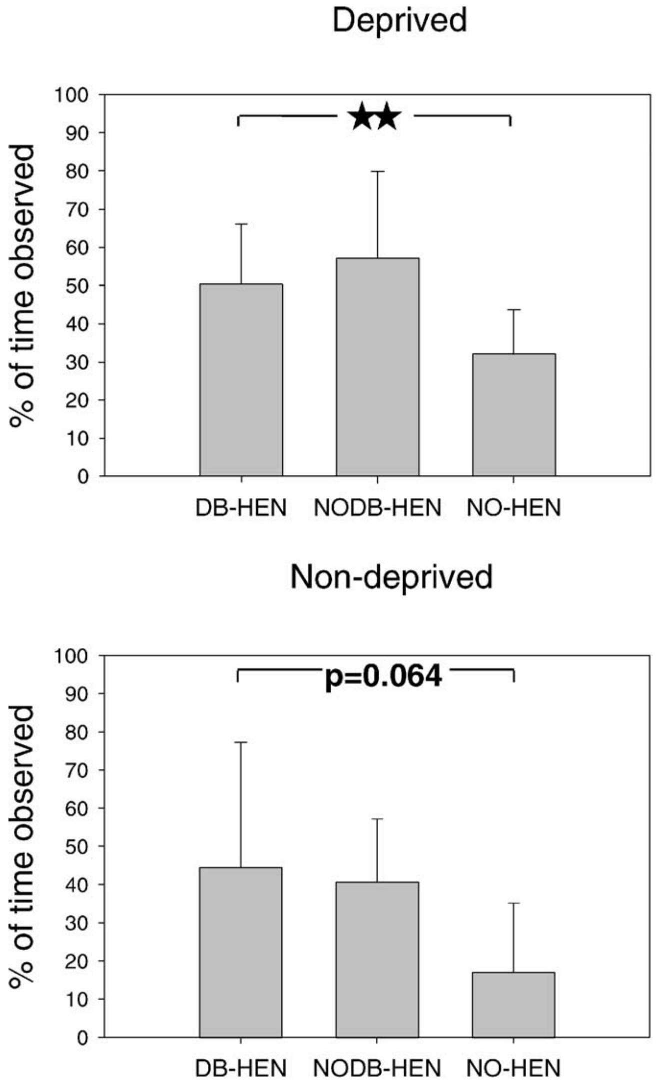

Fig. 1. Behaviour during stimulus exposure in experiment 1: time spent near and facing the stimulus (percent of time observed). Shaded bars represent median values and the error bars represent the interquartile ranges. Comparisons of results include DB-HEN vs. NODB-HEN and DB-HEN vs. NO-HEN. ★★: difference significant at $P < 0.01$.

3. Experiment 2

The second experiment was carried out taking into account a number of concerns with the first experiment. Firstly, to avoid that a long deprivation time may have masked any social effect, the hens were tested at an intermediate level of deprivation. Secondly, in order

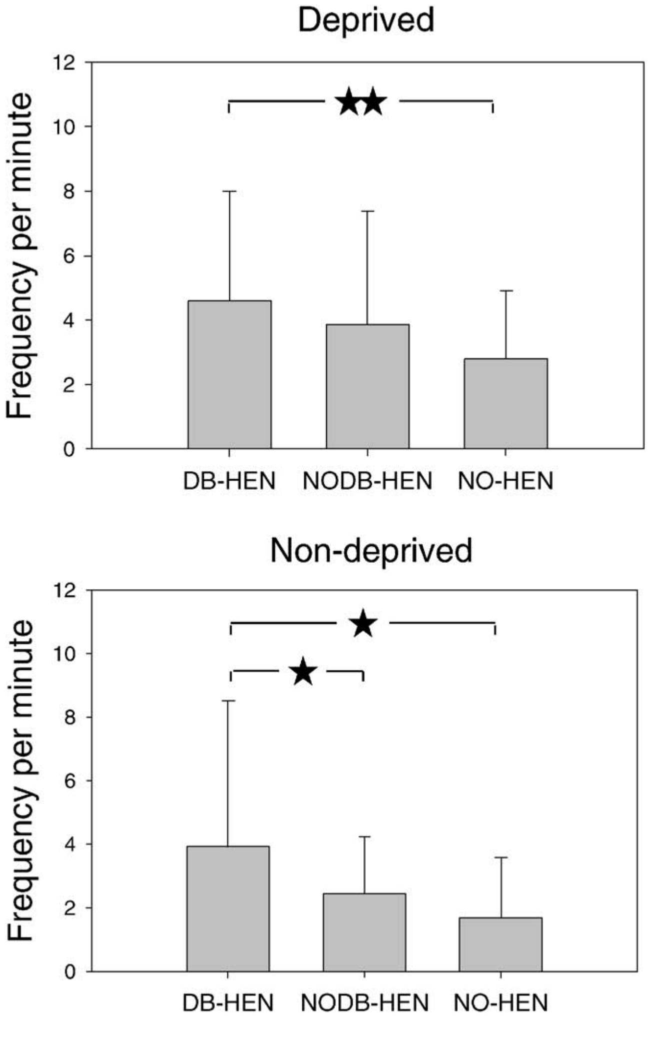

Fig. 2. Behaviour during stimulus exposure in experiment 1: number of steps (frequency per minute observed). Shaded bars represent median values and the error bars represent the interquartile ranges. Comparisons of results include DB-HEN vs. NODB-HEN and DB-HEN vs. NO-HEN. ★: difference significant at $P < 0.05$. ★★: difference significant at $P < 0.01$.

to avoid a confounding effect of the social influence within the pair of test hens, the hens were tested individually. Finally, after a short exposure to the stimulus hen, the test hen was allowed to join this hen while it was still dustbathing.

3.1. Materials and methods

After the first experiment, the hens were moved to a floor-housing system with litter, nests and perches. Half of the hens were removed from the group to be used in another

Table 2
Behaviour during stimulus exposure in birds that dustbathed and birds that did not dustbathe at subsequent access to litter

	Dustbathe	Do not dustbathe	*W* statistic	*P* value
Facing stimulus	56.1 (52.0–67.6)	40.8 (28.9–51.2)	2.0	0.004
Near and facing stimulus	47.4 (42.2–57.0)	28.3 (22.4–40.2)	1.0	0.003
Preening	6.1 (1.9–10.5)	14.5 (6.4–21.9)	67.0	0.031
Frustration	0.080 (0.046–0.129)	0.053 (0.018–0.074)	15.0	0.065
Steps	3.75 (2.78–6.38)	2.35 (0.973–3.73)	13.0	0.045

Behavioural states (facing and preening) are presented as percent of time observed and events (frustration and steps) as frequency per minute observed. Results are given as medians (interquartile ranges).

study and the 24 remaining birds were housed in one group until the start of experiment 2. The daylength was changed to 14 h (6.00–20.00 h) when the birds were 19 weeks and they remained on this schedule throughout the experiment.

Experiment 2 started when the birds were 28 weeks of age and finished at age 31 weeks. At the start of the experiment, the birds were divided into three groups of eight hens each and housed in the same type of wire-floor pens (without litter) as in experiment 1. When tested, hens had always been deprived of litter for 46 h. This was achieved by first depriving birds for so long (5–6 days) that all birds dustbathed when given 2 h access to litter. Deprivation time was thereafter counted from this 2-h access to litter. As a result, birds were tested once per week, and in the test they were always allowed to dustbathe in peat.

Hens were tested in the same test pens as in experiment 1, but now as pairs of one test and one stimulus bird. The test hens were exposed to either a stimulus hen dustbathing in peat (DB-HEN) or a stimulus hen on peat but *not* dustbathing (NODB-HEN). Since we had confirmed in the first experiment that dustbathing behaviour of the stimulus hens could be controlled by previous litter deprivation, the NO-HEN treatment was not used in this second experiment. In the DB-HEN treatment stimulus hens had been deprived of litter for 6 or 7 days, whereas in the NODB-HEN treatment stimulus hens were given access to litter for 24 h preceding testing. Four pairs of birds were tested simultaneously in parallel pens, two in each treatment. At the start of the test, the four stimulus hens were introduced into the stimulus side of the four test pens. When the two stimulus hens in the DB-HEN treatment had started dustbathing, all four test hens were introduced on the wire-floor side of the test pens. After 7 min of exposure to the stimulus, the plexiglass was lifted so that each test hen could enter the area with peat. The test hen and stimulus hen were then left together in the peat until both hens had finished dustbathing. If birds were still dustbathing after 75 min on litter, this dustbathing was interrupted and the birds were returned to the home pen.

A balanced within-subject design was used. When the test hen had been tested in both treatments, the roles were switched and the experiment repeated with the initial stimulus hen acting as test hen in both treatments and the initial test hen as stimulus hen.

Behaviour observations of the test birds on the wire-floor were performed from the video recordings as continuous observations, registering the same behaviour patterns as in experiment 1. Direct behaviour observations were made of the birds during the period on peat. All four pens were scan sampled with 1 min-intervals for dustbathing, and two focal pens were continuously observed for number of vertical wingshakes.

3.2. Statistical analysis

In the DB-HEN treatment, one test hen was excluded because the stimulus hen did not dustbathe. For the remaining 23 test birds, stimulus birds dustbathed for at least 25 min from when the test bird was first introduced on the wire side of the test pen. All results were

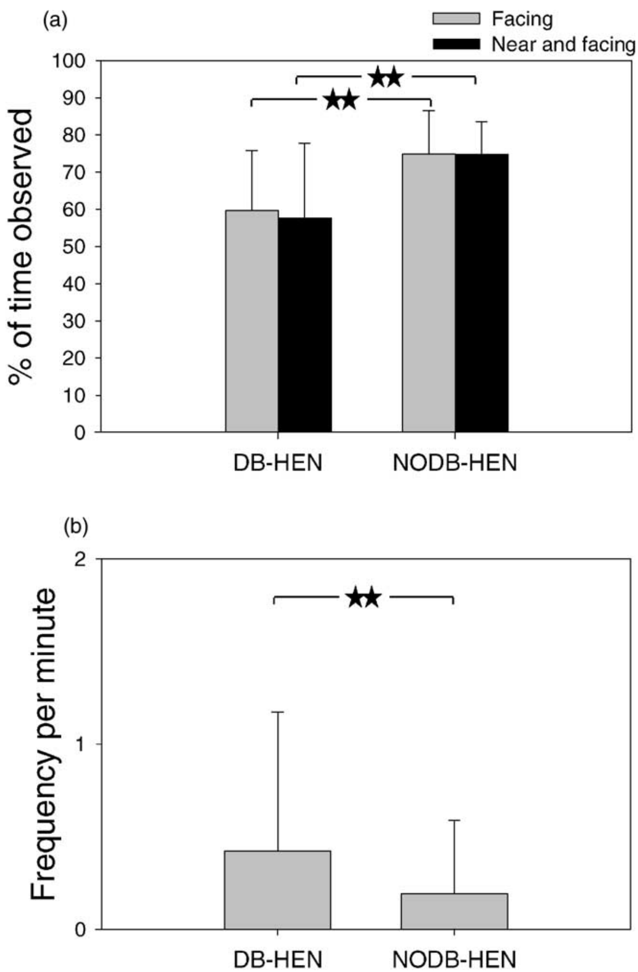

Fig. 3. Behaviour during stimulus exposure in experiment 2: (a) time spent facing and near and facing the stimulus (percent of time observed); (b) displacement preening (frequency per minute observed). Shaded bars represent median values and the error bars represent the interquartile ranges. Comparisons of results include DB-HEN vs. NODB-HEN and DB-HEN vs. NO-HEN. ★★: difference significant at $P < 0.01$.

analysed using the statistical software MINITAB and Wilcoxon matched pairs signed rank test. Data are presented as medians with interquartile range.

3.3. Results

3.3.1. Behaviour of test hens during stimulus exposure

Hens spent less time facing in total, and less time near and facing the stimulus side and showed more displacement preening in DB-HEN than in NODB-HEN (Fig. 3). No other differences between treatments were seen during the stimulus exposure.

3.3.2. Behaviour of test hens when moved to the litter following stimulus exposure

When given access to litter after the stimulus exposure, 21 test birds dustbathed in both treatments, one dustbathed only in DB-HEN, one only in NODB-HEN and one did not dustbathe at all. All deprived stimulus hens included in the analysis dustbathed. Furthermore, six non-deprived stimulus hens started to dustbathe after the test hen had been introduced on the litter.

There was no effect of treatment on any of the variables measured for the test hen during access to litter; latency to start dustbathing, time spent dustbathing or number of vertical wingshakes. Neither was there any significant difference in time spent dustbathing when observations in which the two hens dustbathed together were compared to those where only one hen dustbathed.

4. Discussion

Giving hens the opportunity to observe dustbathing hens did not result in increased dustbathing when these hens were subsequently given access to dustbathing material. Neither did hens dustbathe more when they were together with a dustbathing hen than with a hen that was not dustbathing. Although some effect on motivation was indicated by an increase in walking and displacement preening, social facilitation does not seem to act strongly on dustbathing behaviour. Consequently, the high frequency of sham dustbathing seen in furnished cages (Lindberg and Nicol, 1997; Olsson and Keeling, 2002) cannot be attributed to the influence of social facilitation in combination with competition for limited dustbathing space. Being unable to dustbathe when seeing another bird dustbathing is hence unlikely to account for the high incidence of sham dustbathing, nor is it likely to be a source of frustration in furnished cages.

The increase in walking, which was seen in the first experiment in non-deprived birds exposed to dustbathing stimulus birds, may be interpreted as birds being motivated to get access to the resource (the peat) which was not available on their side of the plexiglass (see Mather, 1981; Nicol and Guilford, 1991). In the same situation in the second experiment, the hens showed more displacement preening, a behaviour that is associated with thwarting and frustration (Duncan, 1970; Duncan and Wood-Gush, 1972a). In combination, these results indicate that the presence of dustbathing companions had an effect on the birds, possibly because it indicated a suitable dustbathing location, although the subsequent dustbathing behaviour was not affected.

Deprivation clearly affects dustbathing behaviour (Vestergaard, 1982; van Liere and Wiepkema, 1992) and previous deprivation as expected determined to a large extent whether or not test birds dustbathed in the first experiment of our study. When we reanalyzed the data on behaviour during stimulus exposure based on whether or not the birds would subsequently dustbathe, we found a clear difference between 'dustbathers-to-be' and non-dustbathers, irrespective of treatment. This difference was manifested as more time spent facing the stimulus, more walking and signs of frustration (displacement preening and agonistic behaviour) in those hens which would subsequently dustbathe. Studies of feeding behaviour have shown that the social facilitation effect is greatest when birds are moderately deprived, rather than when deprivation levels are high or when birds are not deprived at all (Tolman and Wilson, 1965). Since we only found an effect of whether or not the stimulus bird was dustbathing in the non-deprivation tests in the first experiment, it may be that the litter deprived hens were too highly motivated to dustbathe for us to detect any subtle social effects.

The second experiment was carried out reducing the duration of litter deprivation and taking into account other concerns from the first experiment. But, despite improvements in the methodology, we nevertheless again found no difference in dustbathing behaviour between when hens were paired with a dustbathing stimulus hen and when the stimulus hen was performing another activity. It is possible that although less deprived, the hens were still so motivated to dustbathe in the presence of peat, that any social effects were masked. Peat has been demonstrated to be a strong stimulus for dustbathing (Duncan et al., 1998), although it was not a strong enough stimulus on its own to elicit dustbathing in non-deprived hens in the No-Hen treatment in experiment 1.

In experiment 1, the hens paid more attention to the stimulus side of the experimental pen when it contained a pair of dustbathing hens than when it contained the dustbathing substrate alone, but there was no difference between the attention given to dustbathing and non-dustbathing stimulus hens. We would like to suggest two alternative explanations for this finding. For part of the time, the test hens faced the stimulus side since they were in fact interacting with the stimulus hens. In the first experiment, such interaction was possible only in the two treatments when there were hens on both sides of the transparent barrier. In the second experiment, with individual test hens and individual stimulus hens, such interactions were more likely to take place with non-dustbathing stimulus hens, since these paid less attention to the substrate. Hence, interaction between test and stimulus bird could also explain the unexpected finding that in the second experiment test hens spent more time facing the stimulus side when the stimulus hen was not dustbathing.

An alternative explanation for the increased attention when stimulus hens were present is that it was the mere presence of other hens and a substrate that was important, not whether or not these hens were dustbathing. With regard to drawing the attention of the test birds to the substrate, then even non-dustbathing stimulus birds were likely to be engaged with the peat, foraging, scratching and pecking in it.

In studies of social facilitation researchers can choose between using live stimulus animals, whose behaviour may vary between tests, and using video images which, while controllable, may not be perceived in the same way as would a live stimulus (see Patterson-Kane et al., 1997). We opted for the former, assuming that the dustbathing behaviour of the stimulus hens could be well controlled through deprivation. Deprivation did indeed predict the occurrence of dustbathing reasonably well (deprived stimulus hens dustbathed for most of the stimulus time in 10/12 cases and non-deprived stimulus hens refrained from dustbathing in 8/12 cases). However, we had no control over what birds did when they did not dustbathe, and we had the impression that non-dustbathing stimulus hens varied considerably in their behaviour towards the peat. Some stimulus hens scratched vigorously whereas others paid little attention to the substrate.

The finding that dustbathing behaviour in the test birds was unaffected by the presence of dustbathing stimulus hens does not support an effect of social facilitation. This is contrary to the results reported by Duncan et al. (1998) although it may, in part, be explained by difficulties in distinguishing between the different ways in which social factors affect motivation, e.g. social inhibition, solitary inhibition and social facilitation (see Lundberg and Keeling, 2002, for a summary of social effects). In the experiment by Duncan et al. (1998), the hens were either alone or in the company of dustbathing hens, and the possible effect of solitary inhibition in the control situation cannot be separated from that of social facilitation in the experimental treatment. Similarly, the findings by Lundberg and Keeling, 2002 that high-ranked hens had a shorter latency to dustbathe while shown a video with a dustbathing hen than a standing hen, suggest that it is the sight of a standing hen that inhibits rather than the sight of a dustbathing hen that facilitates dustbathing behaviour. Thus, although a synthesis of the results of the three above-mentioned experiments gives clear evidence for an effect of social factors on dustbathing behaviour, it is not clear whether this effect is actually brought about by social facilitation.

Acknowledgements

Thanks to Megan Brown for help with taking care of the hens and analyzing videos. The work was funded by The Swedish Council for Forestry and Agricultural Research, SJFR. Anna Olsson's stay at the University of Guelph was funded by grants from the Swedish University of Agricultural Sciences and C.F. Lundströms fond.

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