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The Old School, Brewhouse Hill, Wheathampstead,
Hertfordshire AL4 8AN, UK

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Environmental enrichment for ostrich, Struthio camelus, *chicks*

JW Christensen and BL Nielsen*

Department of Animal Health and Welfare, Danish Institute of Agricultural Sciences, Research Centre Foulum, PO Box 50, DK-8830 Tjele, Denmark
* Contact for correspondence and requests for reprints: JanneWinther.Christensen@agrsci.dk

Abstract

*Commercially reared ostrich chicks are typically kept in barren, indoor environments. This experiment investigated the effects of environmental enrichment on the pecking behaviour, exploration, food consumption and novelty responses of ostrich chicks aged 10 to 21 days. Four groups of 20 randomly selected ostrich chicks were housed in heated huts at one day of age (Day 1), and at Day 10 were allowed access to sand-covered areas (30 m²) that were either barren (control: n = 2 groups) or enriched with cabbage, coniferous cones and sticks (enriched: n = 2 groups). Pecking behaviour was recorded by focal sampling the behaviour of five chicks per group for four 5 min periods per day on Day 10 and Day 13. All enriched chicks pecked at the cabbage, of which they consumed considerable amounts (26 ± 3 g/chick/day). The enriched chicks did not have higher overall pecking frequencies but tended to peck less at fixtures in the pen, compared to control chicks. Additionally, the enriched chicks showed increased exploration in terms of the percentage of chicks observed outside the heated huts. In a novel object test, enriched chicks stayed closer to and delivered more pecks at sorrel (*Rumex acetosa*) than did control chicks, whereas there was no difference between the treatment groups in their response to adult ostrich feathers. Enriched chicks consumed more food (79 ± 0.4 g/chick/day) than did control chicks (67 ± 0.9 g/chick/day) during the experimental period. We suggest that environmental enrichment improves the welfare of ostrich chicks in terms of increasing exploration and reducing pecking at fixtures in the pen, without compromising food consumption.*

Keywords: *animal welfare, environmental enrichment, exploration, ostrich, pecking behaviour,* Struthio camelus

Introduction

The commercial production of ostriches in captivity has resulted in a large number of ostrich chicks being reared under conditions that differ considerably from natural rearing conditions. This is especially true in Europe and North America where ambient temperatures make it necessary to rear ostrich chicks (without parental care) in indoor environments that provide very few stimuli compared to outdoor environments. Under natural conditions, less than half of hatched ostrich chicks will reach maturity (Holtzhausen & Kotzé 1990), and chick mortality is also a problem in ostrich farming (Verwoerd *et al* 1999). Chicks are very vulnerable and easily succumb to various diseases and compaction of the digestive system, and, as a consequence, chicks are typically reared in barren production environments and fed concentrate rations.

Under natural conditions, ostrich chicks are able to leave the nest 24 h after hatching, and during their first days they live on the yolk-sac — the remaining egg yolk drawn into the abdomen through the navel-opening prior to hatching. After 4–5 days the chicks start pecking at the fresh dung of their parents, which serves as a convenient first source of nutrition since the nest is usually far from water and food (Holtzhausen & Kotzé 1990). Wild ostriches feed on grass, berries, succulents, seeds and the leaves of trees and bushes. These food items tend to be widely spaced and a lot of time is required to search for food; thus ostriches in the wild spend a large part of their day walking and foraging (Holtzhausen & Kotzé 1990; Williams *et al* 1993; Sambraus 1995; Bubier *et al* 1996; Deeming & Bubier 1999). Sambraus (1995) studied abnormal behaviour in captive adult ostriches and described, among other behaviours, pecking sand, pecking wire, and pecking air. He related these abnormal behaviours to the fact that the animals were fed exclusively on pellets, meaning that food consumption was completed within a very short time. He recommended that food for ostriches should not only supply the animals with sufficient energy and nutrition, but also be of a consistency that ensures that food intake will be of an appropriate and satisfactory duration. Likewise, Bubier *et al* (1996) indicated that some captive ostrich chicks performed highly habitual repetitive pecking behaviours. The authors found that the type of pecking that was directed at non-food items tended to be highly repetitive within bouts, and that there was a tendency for chicks performing these behaviours to feed less. Thus, repetitive pecking is suggested to be an indication of poor welfare in captive ostrich chicks (Bubier *et al* 1996; Deeming & Bubier 1999).

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Enrichment experiments with other avian species have been reported to improve welfare in terms of reducing fear responses (chickens [Jones & Waddington 1992]; laying hens [Reed *et al* 1993]; parrots [Meehan & Mench 2002]), and decreasing stereotypic/abnormal behaviours (chickens [Huber-Eicher & Wechsler 1997, 1998]; parrots [Meehan *et al* 2003]). However, in young ostrich chicks, pecking at non-food items can interfere with efficient feeding (Paxton *et al* 1997). Environmental enrichment may therefore lead to decreased food consumption as a result of increased pecking at the enrichment, because fewer pecks may be targeted at food. The present study is a preliminary investigation into the effects of enrichment on the pecking behaviour, exploration, novelty responses and food consumption of ostrich chicks. We provided edible enrichment (cabbage) to facilitate foraging behaviour, along with inedible enrichment (coniferous cones and sticks) to increase the complexity of the environment. Our hypothesis was that the chicks would direct a proportion of their pecking behaviour to the enrichment and less repetitive pecking to fixtures in the pen.

Methods

Animals and housing

Four groups of 20 randomly selected ostrich chicks (*Struthio camelus*) were housed in a commercial greenhouse (12 m × 90 m) at one day of age (Day 1, see Table 1). During Days 1 and 2, the chicks were kept in heated huts (3 m × 3 m × 0.5 m high) with chipboard floors, and at an ambient temperature of 29°C, which was gradually reduced to 19°C during the experimental period. Wood shavings were scattered on approximately half of the floor area of each hut. On Day 3 the chicks were allowed access to a chipboard-floored area (3.0 m × 1.8 m) just outside the huts. A yellow food container holding commercial starter ration (200 g protein/kg) and a red water trough were placed on the chipboard. The huts' door openings (0.5 m × 0.5 m) were fitted with bubble wrap curtains, which were cut into 2 cm vertical strips, in order to maintain a dark and temperature-stable environment inside the huts. The treatment period commenced on Day 10 (see Table 1) when the chicks were given access to additional 30 m^2 sand-covered areas containing three extra food containers and enclosed by 40 cm high boundary walls (ie there was no visual contact between the four groups). For half of the chicks (control: n = 2 groups of 20 birds) the additional sand area was barren, whereas for the remaining chicks (enriched: n = 2 groups of 20 birds) the sand area was enriched with cabbage (1 head cut into two halves), coniferous cones (10 Spruce [*Picea abies*], 5 Pine [*Pinus sylvestris*] and 5 Larch [*Larix deciduas*]) and sticks of Willow (*Salix* sp; 10 of 15 cm and 5 of 30 cm). Cabbage was replaced each day to ensure that fresh cabbage was always available, and the removed cabbage was weighed in order to estimate the intake of cabbage in the two enriched groups. Likewise, the daily amount of commercial feed offered to the chicks was weighed in order to estimate the food intake of control and enriched groups. On Day 18, all chicks were allowed free access to outdoor grass-covered areas (20 m^2) just outside the greenhouse, through door openings (0.5 m × 1.5 m). Prior to the treatment period, group sizes were adjusted to account for mortality, and five chicks from each group were randomly selected as focal animals and dye-marked with red or blue colours on the neck or back for individual recognition. The experiment was carried out in June 2002, during which time the average outside day temperature was 20–25°C.

Data collection

Indoor recordings

Behavioural recordings began on Day 10. Each observation period involved the observation of each of the five focal animals in each of the four groups for 5 mins, starting with Chick 1 in Group 1, followed by Chick 1 in Group 2, and so forth. In cases where a chick was not visible (ie was inside the hut), the next chick in its group was observed and the missing chick was returned to on the next occasion. Observations were carried out in the morning (0900–1100 h), around midday (1130–1330 h), in the afternoon (1400–1600 h) and in the evening (1630–1830 h) for the first 24 h after the chicks had been given access to the sand areas, and again three days later. Each focal animal was recorded as being either active, passive (sitting or lying) or not visible (ie within the hut), using a hand-held computer (Workabout, PSION PLC, UK). Also, all pecks of the focal animal and their target (ie chipboard, sand, food, water, wall, other chicks, and, for the enriched groups, cabbage, coniferous cones and sticks) were recorded. Additionally, each group was scanned every 20 mins to determine the total number of chicks out of the heated hut and the percentage of these chicks occupying the sand area, in order to measure exploration.

Novel object tests

After one week's access to the sand areas (Day 17, see Table 1), two novel object tests were carried out at group level in order to test the effect of enrichment on the chicks' responses to novel stimuli. The chicks were held in the chipboard-floored area while the stimuli — Test 1: Sorrel (*Rumex acetosa*), 4–5 stems, 30–40 cm high, and Test 2: feathers from adult ostriches, 2 white, 30–40 cm long — were placed in the middle of the sand area. The test began when the chicks were allowed access to and full view of their home environment with the novel object, and lasted for 30 mins. Latency to the first peck at the novel object by any chick in the group was recorded, as was the total number of pecks by each focal animal. Additionally, the number of chicks that were within 0.25 m of the novel object was recorded each minute.

Outdoor recordings

Immediately after being allowed access to the grass-covered outdoor areas on the morning of Day 18, the latency for the first chick of each group to enter the outdoor area was recorded, and, for the subsequent 30 mins, the number of

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Table 1 Details of experimental design and data collection.

Day	Event	Observations / tests	
1	Day-old chicks housed in four groups of 20 chicks		
3	Chicks allowed access to chipboard-floored areas		
5	Group sizes adjusted and focal chicks dye-marked		
10	Onset of treatment: chicks allowed access to barren (n = 2 groups) or enriched (n = 2 groups) sand areas	Focal observations (pecking behaviour)	Scans (chicks outside huts)
13		Focal observations (pecking behaviour)	Scans (chicks outside huts)
17		Novel object tests	
18	Chicks allowed access to outdoor grass-covered areas		Scans (chicks in outdoor areas)
21			Scans (chicks in outdoor areas)

chicks observed in the outdoor area was recorded each minute. In addition, the number of chicks observed outside and the number of active/passive chicks in each group were recorded every 30 mins during the remainder of Day 18, and again three days later (Day 21).

Data analysis

Data on the pecking behaviour of the focal animals were adjusted for the total number of seconds that the chick was visible and active. Although chicks may peck when sitting or lying, they do so less frequently than when they are active, which was the reason for using only active data for analysing pecking behaviour. Pecking data were analysed using mixed models in SAS (Littell *et al* 1996), with treatment (n = 2) and observation day (n = 2) and their interaction as fixed effects, and with chick within group within treatment as a random effect. The response variables were the total number of pecks, and the number of pecks at sand, chipboard, other chicks, walls, food pellets and water. Likewise, data from the novel object tests were analysed using mixed models, with treatment as a fixed effect, chick within group within treatment as a random effect, and the total number of pecks to the objects by the focal animals as the response variable.

Data regarding the number of chicks that were recorded within 0.25 m of the novel objects were converted to percentages of the total number of chicks in each group and, due to skewed distributions, were analysed for treatment effects using Mann-Whitney *U*-tests. The number of chicks outside the hut and the number of chicks in the outdoor grass-covered area were likewise converted to percentages, and were analysed for effects of treatment and observation day separately by analysis of variance (ANOVA), or, for data with a skewed distribution, by Mann-Whitney *U*-tests, using the computer software SigmaStat (SPSS 1997). The food consumption of control and enriched chicks was compared using a Student's *t*-test. A significance level of $P < 0.05$ was applied throughout.

Results

Indoor recordings

The mean number and direction of pecks performed by chicks in each treatment are illustrated in Figure 1. The mean number of pecks per chick did not differ significantly between the treatments (enriched [mean ± standard error] = 12.1 ± 1.27 versus control = 13.5 ± 1.66 pecks/chick/min). Enriched chicks directed a large proportion of their pecking behaviour to the cabbage (22.2% of all pecks), whereas only a minor amount was directed to the coniferous cones and sticks (0.2% of all pecks). Control chicks directed a large proportion of their pecking behaviour to the chipboards in front of their heated huts (control = 7.63 ± 1.43 versus enriched = 3.77 ± 0.61 pecks/chick/min), but, since the increased pecking was shown mainly by chicks in just one of the control groups, the difference between control and enriched chicks showed only a trend towards significance ($F_{1,18} = 3.97$; $P = 0.062$). There were no significant differences in the number of pecks directed at any other object, and there was no effect of observation day on pecking behaviour, except for a significant increase in the number of pecks at food pellets on Day 13 compared to Day 10 (Day 13 = 2.11 ± 0.6 versus Day 10 = 0.64 ± 0.2 pecks/chick/min; $F_{1,36} = 6.15$; $P = 0.018$).

Although the treatment groups did not differ in the amount of pecks they directed at food pellets and water (enriched = 18.6% versus control = 16.5% of all pecks), food consumption within the test period (10 to 21 days of age) varied between the two treatments (enriched = 79 ± 0.4 versus control = 67 ± 0.9 g/chick/day; $t = 12.08$; $P = 0.007$). Chicks of the two enriched groups did not, however, consume equal amounts of cabbage (23 and 29 g/chick/day).

Five of the 10 focal control chicks (4 of the 5 chicks in one control group and 1 chick in the other control group) developed a characteristic manipulation of the hut curtain in which they grabbed a strip of the curtain in their beak, pulled it as far as they could, and, upon dropping it, returned

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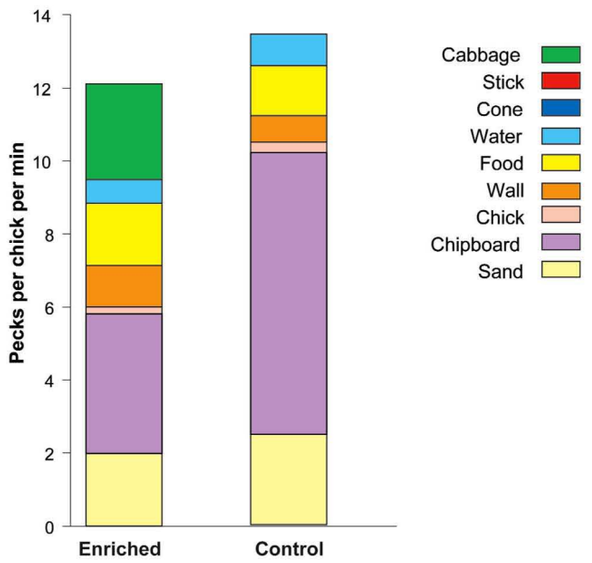
Figure 1



Mean number and target of pecks performed by enriched and control ostrich chicks.

to pick it up again in a uniform movement. This abnormal behaviour was recorded only if the chick repeated the movement more than three times. Of the total observation time of 40 mins (2400 s) per chick, the five chicks spent between 10 and 295 s performing this behaviour, which was never observed in the enriched groups.

There was a significant effect of treatment on the percentage of chicks observed outside the hut (enriched [median (25, 75% quartiles)] = 93.3 (87, 100) versus control = 87.5 (81, 94); $Z_{80,80} = 2.10$; $P = 0.036$), whereas there was no effect of observation day. However, on Day 13 a higher proportion of the control chicks that were outside the hut stayed on the chipboard (control = 57.4 ± 3.2 versus enriched = 41.3 ± 2.8; $F_1 = 14.38$; $P < 0.001$).

Novel object tests

Latencies to the first peck at the novel objects (sorrel and feathers) by any chick in the group, ranged between 2–665 s in the enriched groups and between 2–316 s in the control groups. The percentage of chicks that were within 0.25 m of the novel object during the 30 min tests differed between the treatments in the first novel object test (sorrel: enriched = 26.7 (15, 33) versus control = 0 (0, 13); $Z_{50,56} = 6.16$; $P < 0.001$). However, in the second test (feathers), there was no difference between the treatment groups. Accordingly, focal chicks of the enriched groups delivered more pecks than did control chicks to the sorrel in the first novel object test (enriched = 2.26 ± 0.4 versus control = 0.98 ± 0.5 pecks/chick/min; $F_{1,18} = 4.38$; $P = 0.051$), but did not differ from control birds in the number of pecks directed at the adult ostrich feathers in the second novel object test (enriched = 3.71 ± 1.2 versus control = 4.77 ± 1.7 pecks/chick/min; $F_{1,18} = 0.25$; ns).

Outdoor recordings

The time between the first chick appearing in the doorway and the first chick entering the grass-covered outdoor area ranged between 5–20 s in the enriched groups and between 30–35 s in the control groups. Significantly more chicks from the enriched groups were recorded outside within the first 30 mins after the opening of the door (enriched = 76.9 (67, 100) versus control = 56.3 (38, 75); $Z_{53,58} = 4.75$; $P < 0.001$). This pattern was repeated during the rest of the outdoor recordings since a significantly greater number of enriched birds stayed outside compared to control birds (enriched = 64.8 ± 4.4 versus control = 47.9 ± 4.8; $F_1 = 8.18$; $P = 0.005$). The percentage of birds outside decreased between Day 18, the first day of access to the area, and Day 21 (all birds combined: Day 18 = 69.7 ± 4.7 versus Day 21 = 43.0 ± 3.9; $F_1 = 20.43$; $P < 0.001$).

Six chicks (3 enriched and 3 control) died of various ailments during the experimental period, ie there was no difference in mortality between the treatment groups.

Discussion

Chicks in the enriched groups directed a large proportion of their pecking behaviour to the cabbage without increasing their overall mean number of pecks compared to control chicks. The cabbage increased foraging opportunities for the enriched chicks, and considerable amounts of it were consumed; thus it served as a food supplement. The chicks showed hardly any interest in the coniferous cones and sticks, which may indicate a preference for edible items or may relate to the shape, size, colour, and/or lack of contrast between these objects and the sand substrate. Increased contrast has previously been reported to encourage pecking activity in ostrich chicks (Paxton *et al* 1997).

Despite the small sample size, there was a strong tendency for enriched chicks to peck less at fixtures in the pen (chipboard). Repetitive pecking at the chipboard occurred mainly in one of the control groups, whereas all but one of the focal chicks in the other control group were observed to manipulate the hut curtain. Social facilitation of behaviours has previously been shown in ostrich chicks (Paxton *et al* 1997), and abnormal behaviours may spread throughout a group by social facilitation so that once developed in one animal, all sensitive individuals within a group develop the same behaviour. Repetitive pecking and manipulation of the hut curtains were performed only by chicks in the control groups, indicating that enrichment, in terms of increased foraging opportunities, might be useful in avoiding repetitive pecking behaviour directed at fixtures in the pen as well as in avoiding other abnormal behaviours. This result is in agreement with studies on other avian species in which foraging enrichment reduced the development of behavioural problems (feather pecking [Huber-Eicher & Wechsler 1997; Meehan *et al* 2003]). Bubier *et al* (1996) studied the time budgets of ostrich chicks and found that they spent more than 50% of their time walking and foraging on the ground, and showed a strong preference for feeding on pellets scattered on the floor rather than presented in a dish. These observations appear to reflect this species' natural

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feeding behaviour in the wild, where food items are widely spaced and a lot of time is required to walk between them. A lack of appropriate foraging opportunities is likely to be a major contributor to behavioural problems, and the provision of appropriate foraging opportunities through enrichment appears to be an important factor in modifying both the development and the performance of such behaviours (Newberry 1995; Meehan *et al* 2003).

Surprisingly, consumption of pelleted food was higher in the enriched groups than the control groups, even though they consumed cabbage as a supplement. It has been shown that the colour green produces the greatest pecking response in ostrich chicks, which has been related to wild ostriches' preference for green foliage as food items (Bubier *et al* 1996). The authors suggest that poor feeding performance in captive ostriches may be a symptom of practical problems of locating, identifying and ingesting the food, and adding roughage (green plants) to the feed is generally accepted as a way of encouraging foraging activity in ostriches (Cooper 2000). Our results indicate that the provision of cabbage encourages foraging activity and feeding behaviour even without being offered with the food. Additionally, some studies have shown negative correlations between pecking at non-food items and growth rates (Lambert *et al* 1995; Deeming & Bubier 1999). Unfortunately, growth was not measured in the present experiment as the experimental period of 12 days was expected to be too short to affect growth rates. The unexpected difference in food consumption between the treatment groups does, however, indicate that growth rates might be affected by environmental enrichment. More controlled studies are needed in order to relate the effects of enrichment to food consumption and growth.

Paxton *et al* (1997) found significant pen effects on behaviour, and found that pecks to the floor were associated with fewer pecks targeted at food in chicks aged 26–33 days, whereas the relationship was non-significant in younger chicks. The authors suggest that the pecking behaviour of young chicks is directed towards a broad variety of objects and stimuli, and that non-food pecking interferes with efficient feeding in young chicks, affecting survival and growth. Accordingly, in the present study there was a tendency for control chicks to peck more at fixtures in the pen, and these chicks also consumed less food, ie there seemed to be a negative relationship between repetitive pecking at fixtures in the pen and food consumption.

In general, the enriched chicks showed increased exploration in terms of the percentage of chicks that were observed outside their heated huts on Days 10 and 13 and in their outdoor areas on Days 18 and 21. The latency to contact the novel objects varied considerably between the groups, with no effect of treatment. Once a chick started to peck at an object, other chicks in the group were stimulated to peck as well. Interestingly, the treatment affected the chicks' response to sorrel in the first novel object test, but not their response to the adult ostrich feathers in the second test. This result may be ascribed to the fact that the enriched chicks were accustomed to consuming considerable amounts of fresh green cabbage and may have associated the green colour of the sorrel with cabbage. This result is consistent with the finding from the outdoor recordings that enriched chicks entered the grass-covered areas sooner than did control chicks, and that a greater number of enriched chicks were observed outside on the first and third day after outdoor access. During the second novel object test, all chicks showed playful responses to the adult feathers: picking them up and carrying them around. Adult ostrich feathers could therefore serve as appropriate inedible enrichments that encourage playful activity.

Animal welfare implications

The enrichment affected general pecking behaviour as well as behaviours such as exploration, abnormal behaviour, response to novel objects and food consumption. We suggest that environmental enrichment improves the welfare of ostrich chicks in terms of increasing exploration and reducing pecking directed at fixtures in the pen, without compromising food consumption.

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