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Applied Animal Behaviour Science 54 (1997) 335–343

APPLIED ANIMAL BEHAVIOUR SCIENCE

The effect of cover on the behaviour of Japanese quail (*Coturnix japonica*)

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Accepted 14 January 1997

Abstract

Flying up vertically, a typical flight behaviour of Japanese quail (*Coturnix japonica*), may result in head injuries and mortality caused by head-banging in caged quails. Given the fact that wild Japanese quail are usually found in dense vegetation, two experiments were carried out to quantify the use of different types of cover and to measure the effect of cover on the incidence of flight behaviour. In Experiment 1, 16 groups of ten female quails were provided with two qualitatively different types of cover in four successive preference tests. It was found that the quails preferred to stay in cover types that were partially or fully open to the sides compared with cover types that were partially or fully open to the top. For egg laying they preferentially used cover types with a small entrance but no other openings to the sides or on the top. In Experiment 2, 160 female quails were individually confronted with a flight inducing stimulus in an experimental pen. The birds showed flight behaviour significantly less often if they were in cover when exposed to the stimulus. Moreover, there were significantly more flight responses when the stimulus was presented above the pen than at the side. The results suggest that the welfare of Japanese quail could be improved by incorporating cover and nest boxes into alternatives to conventional battery cages. © 1997 Elsevier Science B.V.

Keywords: Japanese quail; Use of cover; Preference test; Flight behaviour; Egg laying

1. Introduction

The Japanese quail (*Coturnix japonica*) is a ground-living species with a marked preference to stay in cover in dense vegetation. In the wild, it is usually found in grasslands, in the bushes along the rivers and in fields planted with rice, oats or barley

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PII S0168-1591(97)00031-2

(Taka-Tsukasa, 1967). The quails' preference to stay in cover has probably evolved to minimise the risk of predation. When a quail is approached by a human being in its natural habitat it first lays still on the ground but then suddenly rises and flies for a few yards, drops into the grass and takes cover (Taka-Tsukasa, 1967).

The Japanese quail has been domesticated since at least the twelfth century AD as a song bird in Japan (Kovach, 1974). Nowadays the domestic quail is used for egg and meat production (Yamashina, 1961, Gerken and Mills, 1993, Baumgartner, 1994) and as a laboratory animal (Kovach, 1974, Ratnamohan, 1985, Cooper, 1987). Both for egg production and in laboratory research quails are usually group-housed in cages that are arranged in batteries with several tiers (Yamashina, 1961, Cooper, 1987, Gerken and Mills, 1993).

Flying up vertically, the typical flight response of wild Japanese quail, is also shown by the domestic quail. As a consequence, there may be serious welfare problems due to head-banging in caged quails (Gerken and Mills, 1993). In order to avoid head injuries and mortality caused by such behaviour it is recommended that birds are provided with cage heights of less than 25 cm (Gerken and Mills, 1993). This preventive measure takes the negative consequences of flight behaviour into account. However, with respect to animal welfare it is also of importance to consider the quails' tendency to show flight behaviour. The occurrence of head-banging could possibly be reduced by providing the quails with adequate cover in their housing system.

The present study is part of a research project that aims at developing alternatives to battery cages for Japanese quail (Schmid and Wechsler, 1997a,b). The experiments described here were designed to quantify the effect of cover on the behaviour of domestic quails. In a first experiment, we provided group-housed quails with different types of cover and measured their preferences with regard to staying, resting and egg laying in cover. In a second experiment, quails were individually confronted with a stimulus that elicited flight behaviour. The stimulus was presented either above the bird or from the side. Whether the quail was in cover or not when exposed to the flight inducing stimulus was varied as a second factor.

2. Methods

2.1. Animals and housing conditions

Sixteen groups of ten female quails were kept in pens with a floor area of 100 cm × 50 cm and a height of 50 cm. The birds had been reared in cages on a commercial farm and were introduced into the pens when they were 8 weeks old. They stemmed from a strain that was used for both egg and meat production. All quails were individually marked with coloured leg rings.

The pens were made of wood. They had solid walls on three sides and a solid floor that was covered with a mixture of wood-shavings and chaff. Both the front and the top were made of wire mesh and could be opened to collect eggs, to renew the litter or to catch a quail. On the right side of each pen there was a feeder and a drinker. The floor of the pens was 60 cm above ground.

The pens were arranged in four rows in a room with two windows on opposite walls. There were six fluorescent tubes (36 W) fixed to the ceiling that illuminated the pens for 15 h day^{-1}. Lights came on at 05:30 h, and light intensity in the pens was between 40 and 60 lux. Temperature varied between 12 and 32°C. Ventilation was controlled by temperature.

2.2. Experiment 1

Four successive preference tests were carried out with 16 groups of ten female quails in order to quantify the use of different types of cover. In each test the quails were simultaneously provided with two types of cover in their home pens. At the beginning of the experiment the birds were 3 months old and had been kept in the pens for 4 weeks. A standard cover type was used in all preference tests and combined with one of four alternative cover types (Fig. 1) that differed in the quality of the top or the sides but not in size (40 cm × 20 cm, height 20 cm). This experimental design was chosen to quantify the quails' relative preferences regarding the quality of the top and the sides of the cover. Each alternative cover type thus differed in only one respect from the standard cover type.

With the standard cover type all sides and the top were made of green plastic tablecloth (outside green, inside white). There was a small entrance (10 cm × 13 cm) on one narrow side. Due to this opening and as the tablecloth was to some extent translucent, it was not completely dark in this type of cover. The other four cover types differed from the standard type in that there was no tablecloth on the top (Type A) or at the sides (Type B), or in that the tablecloth was perforated (square openings of 2 cm × 2 cm) on the top (Type C) or at the sides (Type D). Because the cover types had no floor of their own, the same quality of litter was found within and around them.

The sequence of the four preference tests was varied between the pens. The two cover types were placed at the back wall of the pens, and the position of the standard cover type was systematically varied between right and left over the four tests in each pen. The two cover types were put into the pens 4 days before the start of data collection to allow the quails to become familiar with them.

Data collection included behavioural observations and records of egg laying places. Each quail group was observed four times for 14 min in each preference test. A given

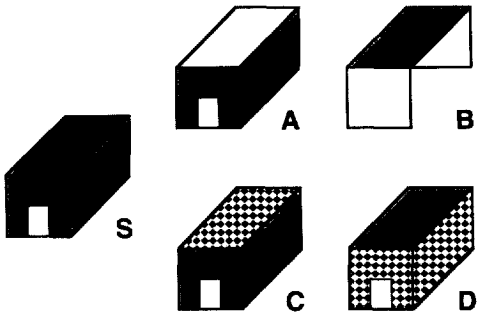

Fig. 1. The standard cover type (S) and the four alternative cover types (A, B, C, D) used in the preference tests.

group was observed on 4 different days, once in each of four periods of 80 min distributed between 09:00 and 15:10 h. Before the start of a protocol the observer quietly sat in front of the pen for 5 min. During the protocol the number of quails staying in the two types of cover was recorded every 2 min (scan sampling; Altmann, 1974). It was differentiated whether a quail was active or resting (lying on belly or on side) in cover. On the 4 days of behavioural observations the total number of eggs laid in a pen and the number of eggs laid in each type of cover were recorded in the morning. The whole experiment lasted for 6 weeks.

In the analysis, the percentage of quails staying in cover, the percentage of the quails staying in cover that were resting and the percentage of eggs laid in cover were calculated for each cover type in each preference test. These data were subjected to two statistical tests. First, pairwise comparisons were made between the standard and the alternative cover type for each preference test ($n = 16$ pens, Wilcoxon matched-pairs signed-ranks test; Siegel and Castellan, 1988). Second, data on the use of the alternative cover types in all four preference tests were included into an analysis of variance with the location (top or sides) and the quality (square openings or no tablecloth at all) of the opening used as main factors. As four different preference tests were carried out in each pen, the pen number was used as a third factor. Data were transformed (arcsine, square root transformation) to achieve a normal distribution of the residuals (Lilliefors test; Lilliefors, 1967). However, non-transformed means and standard errors are presented in the results. The analyses were performed using Systat (Wilkinson, 1992). All significance tests were two-tailed.

2.3. Experiment 2

This experiment was carried out to quantify the quails' behavioural response to a flight inducing stimulus. The quails ($n = 160$) were tested individually in an experimental pen. Before and after the test they were housed in groups of ten in the home pens described above. All home pens contained one standard type of cover as used in Experiment 1. At the beginning of Experiment 2 the quails were 6.5 months old.

The experimental pen was identical to the home pens with respect to size, construction and litter quality, but contained no feeder and drinker. Instead of a wire mesh, a plastic net was fixed at the front and on the top of the pen to avoid injuries due to head-banging. The experimental pen was surrounded by white linen cloth, and behavioural observations were made through a hole in this cloth to avoid disturbance caused by cues other than the flight inducing stimulus.

A red plastic hat filled with pebbles (weight 370 g) was used to frighten the quails. The hat was suspended by a string fixed at the ceiling above the experimental pen. When the quail was transferred from the home pen to the experimental pen the hat was fixed behind the linen cloth on a narrow side of the pen. During the experiment the observer could suddenly release the hat. By changing the length of the string and the point of the fixation of the string at the ceiling it could be varied whether the hat swung a few centimetres above the experimental pen after being released or at the height of the quail's head along the front side of the pen. The size of the hat was the same when viewed from below or from the side. Whether the quail was in cover or not when

exposed to the frightening stimulus was varied as a second factor. Half of the birds tested were provided with cover by fixing two frames covered with a mesh made of black threads of wool in front of and 20 cm above the floor of the pen. The distance between the threads varied between 1 and 2 cm. This allowed good observation of the behaviour of the quails.

The experiment was carried out with 40 female quails in each of the four experimental conditions (2×2 factorial design). The quails were randomly assigned to the conditions, and the sequence of the conditions was randomly varied within groups of four tests (one of each condition). The whole experiment lasted for 2 weeks.

After transfer from the home pen to the experimental pen the quail was allowed to become accustomed to the situation for 15 min. The behaviour of the quail was recorded during 20 s before and 20 s after the release of the red hat. For both periods it was noted whether the quail showed the following behavioural elements or not (one-zero sampling; Altmann, 1974):

1. Resting: a quail is lying on the belly or on the side.
2. Standing: a quail is in a standing position with open eyes.
3. Dozing: a quail is in a standing position with closed or blinking eyes.
4. Stretching: a quail is in a standing position with the head raised towards the top of the pen.
5. Walking: a quail is slowly moving on the floor.
6. Freezing: a quail is standing motionless with the head stretched horizontally.
7. Creeping: a quail is slowly moving on the floor with the head stretched horizontally.
8. Running: a quail is quickly moving on the floor.
9. Hopping: a quail's feet are between 5 and 10 cm above the floor.
10. Flying up: a quail's feet are more than 10 cm above the floor.

With the exception of 'hopping' and 'flying up' a behaviour was only recorded if it lasted for 3 s without interruption.

In order to check whether the provision of cover had an influence on the time it took for the quail to notice the red hat, the time from the release of the hat to the first reaction of the quail (sudden head movement; running; sudden movement after standing, dozing or resting; freezing after moving; follow the hat's movement with the eyes) was measured with a stop-watch. In 27 quails with cover and 24 quails without cover no such reaction could be observed.

The sign test (Siegel and Castellan, 1988) was used to compare the occurrence of the defined behavioural elements before and after the release of the red hat. The significance of the effects of the experimental conditions on flight behaviour was assessed by the G-test of goodness of fit (Sokal and Rohlf, 1981). All significance tests were two-tailed.

3. Results

3.1. Experiment 1

The results of Experiment 1 are given in Fig. 2. With respect to staying in cover pairwise comparisons between the standard cover type and the alternative cover types

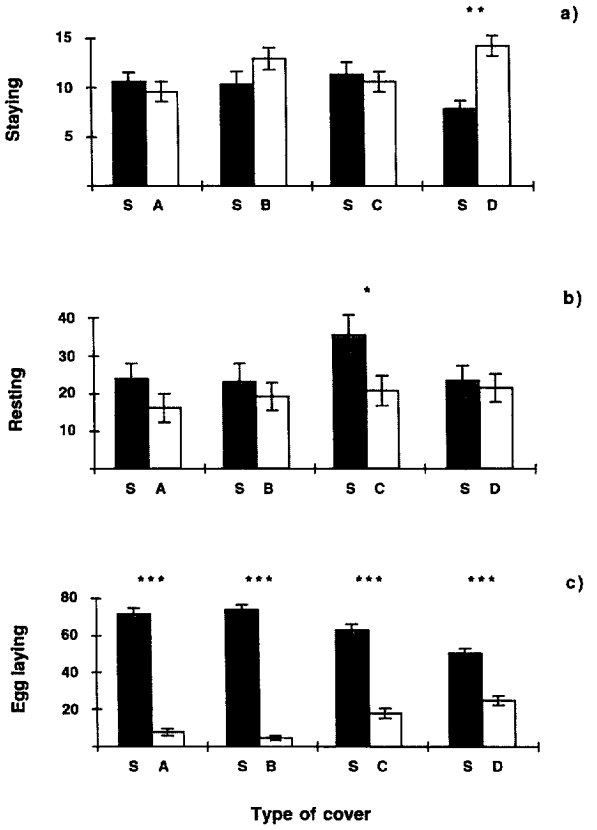

Fig. 2. Percentage (means ± SE, $n = 16$ pens) of (a) quails staying in cover, (b) quails staying in cover that were resting and (c) eggs laid in cover in four preference tests. In each test the quails were provided with two qualitatively different types of cover (S: standard cover type; A, B, C, D: alternative cover types). $^{*}P < 0.02$; $^{**}P < 0.002$; $^{***}P < 0.001$.

showed a statistically significant difference in the preference test where the alternative cover type had square openings to the sides (Type D). The analysis of variance revealed that the location of the opening had a significant effect on the percentage of quails that stayed in the alternative cover types ($F_{(1,45)} = 13.3$, $P = 0.001$). Cover types that were (partially or fully) open to the sides were preferred over types that were open on the top. The quality of the opening (square openings or no tablecloth at all) had no significant effect ($F_{(1,45)} = 1.37$, $P = 0.25$). There was also no significant interaction between these two factors ($F_{(1,45)} = 0.02$, $P = 0.9$). The effect of the pen was not statistically significant ($F_{(15,45)} = 1.85$, $P = 0.06$).

In all four preference tests, the percentage of the quails staying in cover that were resting was higher in the standard cover type than in the alternative cover type (Fig. 2(b)). The difference was, however, only significant when the alternative cover type had square openings on the top (Type C). Neither the location ($F_{(1,45)} = 0.67$, $P = 0.42$) nor

the quality ($F_{(1,45)} = 1.34$, $P = 0.25$) of the openings had a significant effect on the percentage of quails resting in the alternative cover types. The interaction between these two factors ($F_{(1,45)} = 0.06$, $P = 0.8$) and the effect of the pen ($F_{(15,45)} = 0.69$, $P = 0.78$) were also not statistically significant.

During Experiment 1 the quails laid 79.9% of all eggs ($n = 2221$) in one of the cover types. In each preference test the standard cover type was significantly more attractive for egg laying than the alternative cover type (Fig. 2(c)). The analysis of variance revealed that both the quality of the opening ($F_{(1,45)} = 57.39$, $P < 0.0001$) and the interaction between the quality and the location of the opening ($F_{(1,45)} = 5.65$, $P = 0.022$) had a significant effect on the percentage of eggs laid in the alternative cover types. Cover types with square openings to the sides or on the top were more often used for egg laying than cover types which had a full opening. The effects of the location of the opening ($F_{(1,45)} = 0.29$, $P = 0.6$) and the pen ($F_{(15,45)} = 1.76$, $P = 0.07$) were not statistically significant.

3.2. Experiment 2

Quails that were provided with cover in the experimental pen showed a first reaction (for definition, see methods) on average ($\pm$ SD) 1.2 ± 0.7 s ($n = 53$) after the release of the red hat. In quails tested without such cover the average duration of this period was 1.1 ± 0.5 s ($n = 56$). The difference between the two samples was not significant (Mann–Whitney U test, $U = 1594$, $P > 0.5$).

As can be seen in Table 1 resting, standing, dozing, stretching and walking were observed significantly more often before than after the appearance of the red hat. On the other hand, the occurrence of freezing, creeping, running, hopping and flying up was significantly increased after exposure to the frightening stimulus. For the following analysis the latter five behavioural elements were categorised as 'flight behaviour'.

Table 1
Number of quails in which defined behavioural elements were observed both before and after, only before or only after exposure to a frightening stimulus. The experiment was repeated with 160 quails

Behaviour	Occurrence			P^a
	Before and after	Only before	Only after	
Resting	1	9	1	< 0.03
Standing	58	69	6	< 0.001
Dozing	1	12	0	< 0.001
Stretching	2	31	6	< 0.001
Walking	40	50	17	< 0.001
Freezing	12	1	97	< 0.001
Creeping	0	4	23	< 0.001
Running	2	1	80	< 0.001
Hopping	1	1	38	< 0.001
Flying up	1	1	8	< 0.04

[a]Comparison between 'only before' and 'only after'; sign test.

The quails showed flight behaviour significantly more often when the red hat was presented above the pen than when it appeared at the side of the pen (G-test, $G = 78.51$, d.f. = 1, $P < 0.001$). Moreover, there was a significantly lower incidence of flight behaviour if the quails were in cover when exposed to the red hat (G-test, $G = 10.05$, d.f. = 1, $P < 0.01$).

4. Discussion

The main result of Experiment 1 was that domestic Japanese quail prefer to stay in cover that has no opening to the top. In addition, the quails preferentially laid their eggs in the standard cover type which had a small entrance but no other openings. The use of more pronounced cover for egg laying probably reflects an increased risk of predation during incubation in wild quails. Several authors have reported that Japanese quail typically choose a nest site in dense vegetation (Stevens, 1961, Taka-Tsukasa, 1967, Orcutt and Orcutt, 1976). Taking into account that fewer eggs were laid in Type B cover than in Type D cover, the former cover type seems to be preferable for alternative housing systems that also contain nest boxes, as the proportion of eggs laid outside the nests would probably be increased with use of the latter cover type.

The quails' preference for cover types without openings to the top has possibly evolved to reduce risk of predation by birds of prey. In accordance with this supposition we found that the presentation of a frightening stimulus above the experimental pen elicited flight behaviour significantly more often than the presentation of the same stimulus at the side of the pen (Experiment 2). However, it is also possible that the quails were better habituated to disturbing stimuli appearing at the side of the pen, as they had experience of people passing along the side of their home pen. The influence of previous experience on flight behaviour could be further investigated by keeping some of the experimental birds in home pens with a solid instead of a wire-meshed front side.

The quails showed flight behaviour significantly less often if they were in cover when exposed to a frightening stimulus (Experiment 2). As there was no difference in the time between the release of the red hat and the onset of a first reaction to the stimulus, this result cannot be explained by an impaired perception of the red hat in the birds with cover. The quails thus seemed to be less motivated to show flight behaviour when tested in cover. On an emotional level this could mean that they felt more secure in cover. With respect to animal welfare it may therefore be important to incorporate cover into alternative housing systems for Japanese quail. As a next step, it should be tested experimentally whether the provision of adequate cover has an influence on the incidence of injuries and mortality due to head-banging in such housing systems.

The fact that the quails laid most of their eggs in cover may also be of relevance for animal welfare. Gerken and Mills (1993) reported that caged quails show symptoms of pre-laying restlessness. In caged laying hens such behaviour is interpreted as indicating frustration caused by the lack of an adequate nest site (Wood-Gush, 1972, Brantas, 1980). The inability to perform normal pre-laying behaviour is therefore considered as one of the most important problems for the welfare of hens in cages (Appleby and Hughes, 1991). In our study, the quails laid 79.9% of the eggs in one of the cover types.

This result indicates that it may be possible to design nest boxes that can be incorporated into housing systems for Japanese quail. The use by quails of different types of nest boxes has been further investigated in our research project (Schmid and Wechsler, 1997b), but we have not yet compared the incidence of pre-laying restlessness between conventional battery cages and alternative housing systems containing nest boxes.

Acknowledgements

We are grateful to the Federal Veterinary Office of Switzerland, the Kanton Zürich and the Meta und Willi Eichelsbacher Stiftung for their financial support of the research project (No. 014.93.3). David Nash made valuable comments on the manuscript.

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