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Behavioural consequences of visual deprivation occurring at hatch or in the early life of chickens

Paul M. Hocking[a,*], Kirsty-Anne Haldane[a], Emma M. Davidson[a], Peter Sandøe[b], Helle H. Kristensen[c]

[a] Roslin Institute and R(D)SVS, University of Edinburgh, Roslin, Easter Bush, Midlothian EH25 9RG, Scotland, UK
[b] Department of Large Animal Sciences and Department of Food and Resource Economics, University of Copenhagen, Rolighedsvej 25, 1958 Frederiksberg C, Denmark
[c] Department of Large Animal Sciences, University of Copenhagen, Grønnegårdsvej 8, 1870 Frederiksberg, Denmark

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ABSTRACT

The development of behaviour in a line of chickens that are born sighted (*rdd*) but turn blind after hatching was compared with a line that is blind at hatch (*beg*) and with sighted White Leghorn controls (WL) to test the hypothesis that birds that become blind later in their life will show characteristic behaviours of both blind and sighted birds. Individual behaviour, group aggregation and behavioural synchrony were compared at 1, 5 and 9 weeks of age (experiment 1) and in the parents of these chicks at 9–13 months of age (experiment 2). Responses to visual and physical isolation were assessed at 1, 5 and 9 weeks.

Analyses of home-pen behaviour showed that both *rdd* and *beg* had difficulty locating or consuming food during the first week of life. WL and *rdd* did not engage in abnormal behaviour (circle walking, air pecking, star gazing) at 1, 5 and 9 weeks whereas both *beg* and *rdd* adults did so. At 9 weeks *beg* and *rdd* birds showed decreased behavioural synchrony compared with WL, whereas group aggregation in *rdd* and WL was similar and higher than in *beg*. WL adults showed increased environmental pecking and higher rates of behavioural synchrony and group aggregation than both *beg* and *rdd*. Under visual isolation from conspecifics *rdd* chicks behaved like blind birds in some respects (e.g. decreased movement) and as sighted birds in others (e.g. peeping). The vision of *rdd* was apparently diminished compared with sighted controls (WL) even from an early age.

It was concluded that abnormal behaviours are a response to a complete loss of vision regardless of initial sight. Birds that became blind during rearing (*rdd*) may be more active as adults than birds that were blind throughout life but in general the behaviour of blind birds was similar regardless of early sight.

1. Introduction

Vision is important in poultry and their highly specialised visual systems mediate the majority of their behaviours including feeding and drinking, navigation and social behaviour including dominance and courtship (Collins et al., 2011). Chickens have particularly well developed visual abilities and vision is thought to play a crucial role in the acquisition, development and maintenance of a number of normal behaviours, including social behaviours, through the use of visual cues (Mench and Keeling, 2001; Prescott et al., 2003). Chickens naturally carry out behaviours in synchrony and there are possibly strong social facilitation and physiological effects motivating the birds to act in this way (Mench et al., 1986) and, conversely, separation and isolation from social companions has been shown to be stressful to chickens (Jones and Williams, 1992; Marx et al., 2001). Lack of vision is therefore likely to compromise the development of social and other behaviours and thereby lead to reduced welfare.

A line of chickens with the genotype *beg* (blindness, enlarged globe) are blind from hatch and show less group aggregation and behavioural synchrony than sighted controls (Collins et al., 2011). Furthermore the blind birds exhibited abnormal behaviours (circle walking, air pecking, star gazing), grew less well than sighted counterparts and tended to have greater mortality (Collins et al., 2011). However, several issues regarding the importance of sight for the development of behaviour remain to be clarified: do the differences

* Corresponding author. Tel.: +44 0 131 651 9182; fax: +44 0 131 9218.
E-mail addresses: paul.hocking@roslin.ed.ac.uk (P.M. Hocking), kirstyhaldane@hotmail.com (K.-A. Haldane), emma_marie_davidson@hotmail.co.uk (E.M. Davidson), pes@sund.ku.dk (P. Sandøe), hek@sund.ku.dk (H.H. Kristensen).

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between the lines observed in young chicks, remain in adult birds? Can the results on abnormal and social behaviour be generalized to a genotype that develops blindness later in life? Can the problems of poor growth and higher mortality be ameliorated by the possession of sight at a young age and before becoming blind later in life?

The main aim of the current study was to investigate in detail the behaviour of chickens from the retinal dysplasia and degeneration (*rdd*) genotype that were sighted at hatch and become progressively blind until there is complete loss of vision at sexual maturity (Randall et al., 1983), and to determine how their behaviour changed once they lost their sight, compared with chickens from a genotype that were blind from hatch (*beg*) and normal sighted chickens. Our hypothesis is that birds that become blind later in their life will show characteristic behaviours of both blind and sighted birds. A second objective was to extend the assessment of aspects of the welfare of blind birds by Collins et al. (2011) based on differences in social and other behaviours, body weight gain, mortality and heterophil-lymphocyte (HL) ratios.

Chicks from the three lines were reared in separate pens to compare behaviour, behavioural synchrony and group aggregation and a test of the effects of visual and physical isolation on social behaviour was also investigated. In a second experiment, the behaviour, behavioural synchrony and social aggregation of the parents of the chicks (adult females and males) were analysed to compare the behaviour of the three lines when *rdd* were unequivocally blind.

2. Materials and methods

2.1. Experiment 1: Chicks 0–9 weeks of age

2.1.1. Animals and housing

A total of 72 White Leghorn-type birds were used for the experiment consisting of 24 White Leghorn (WL), 24 *beg* and 24 *rdd*. The WL chickens have normal sight and are genetically related to both *beg* and *rdd* by back crossing WL males into the original lines. Birds were penned with those of the same genotype but the gender was not known until the completion of the experiment when the gender of the birds was determined retrospectively by visual inspection of size and colour of the comb and wattles.

The chicks were wing-banded and randomly allocated to one of 12 pens in two rooms after hatching. Each pen was 1.52 m × 2.10 m × 2.0 m (wide × length × height) with solid pen walls to 0.6 m and wire thereafter. The aisle between the two blocks of pens was 1.60 m and there were two blocks of three pens in both rooms. Each pen contained 6 birds of one of the three lines. The birds were given a unique symbol on the head and back with a black marker pen for ease of overhead identification during the observation period.

There were a number of spare birds of each line that were kept in room 1 in an extra pen, under the same conditions as the study birds, in case replacement was required. In the first 7 days, 7 *beg* chicks and 1 *rdd* chick died, and, in week 2, one WL chick died. These birds were replaced with randomly selected chicks of the same line from the stock of extra chicks.

The birds had *ad libitum* access to food and water in the home pens. They were fed a standard layer chick crumb from hatch to 6 weeks followed by a pelleted grower feed. The food was provided in large, shallow chick pans on the floor of each pen throughout the experiment to minimise the risk that feeding in the *beg* chicks might be compromised by the change to a hanging tube feeder. Water was available from bell drinkers placed on the floor and later from larger suspended drinkers. The temperature of the rooms was 29 °C at hatch and was gradually decreased to 22 °C at 4 weeks of age. Heat lamps were used to provide extra warmth until the chicks were 4 weeks of age. The photoperiod was 14 h per day from 07:00 to 21:00 h. The average light intensity at chick eye level in room 1 was 77 lx, and 50 lx in room 2.

Since it is known that newly hatched *beg* chicks often have trouble locating food (Pollock et al., 1982), for the first week, the *beg* chicks were assisted to find feed and water and some were fed and watered by hand. Curved hardboard surrounds were also placed at the back corners of the pens to encourage the chicks towards the food and water.

2.1.2. Home pen behaviour

Video cameras were positioned above each pen to record the birds' behaviour. Video recording was conducted over two days of one block in each room followed by the other block on the subsequent day at 1, 5 and 9 weeks of age. On each day, the pens were recorded for three 1-h periods from 09:00 to 10:00 h, 13:00 to 14:00 h and 17:00 to 18:00 h. Instantaneous scan sampling (Martin and Bateson, 1993, pp. 85–86) was used to record the frequency of behaviours (% of the total) at 5 min intervals during each observation period by one person who was blind to the treatment ($n = 12$) using the ethogram in Table 1. To quantify group aggregation, mean nearest neighbour distance (NND; Sibbald et al., 2009) was recorded at successive 5-minute intervals using digital callipers to measure the distance (mm) between each bird and the nearest part of its closest pen mate on the video monitor screen. Behavioural synchrony (Bs) was calculated at each interval using Simpson's Diversity Index (King and Cowlishaw, 2009) as follows for each behavioural scan:

$$\mathrm{Bs} = \frac{\sum n_i (n_i - 1)}{N(N-1)}$$

where n_i is the number of individuals exhibiting the ith behaviour and N is the total number of individuals visible in the scan. High (low) behavioural synchrony indicates a high (low) proportion of birds engaged in the same behaviour.

Since some of the behaviours were observed to be performed by the chicks very infrequently these were grouped together in one class ("other"). In total there were 9 classes of behaviours: feeding, drinking, sitting, standing, walking and running, environmental pecking, preening, abnormal (circle walking, air pecking, star gazing), and other (lie, gentle feather peck, severe feather peck, aggressive peck, dust bathe, stretch, chase and display). Mean time spent carrying out each behaviour was calculated for each pen, time period and week, and expressed as a proportion of the birds in view.

2.1.3. Social isolation

The social isolation tests were performed as described by Collins et al., (2011). Briefly, a testing arena was divided into a 'test side' and a 'companion side' by a divider that was either a wire mesh (physical isolation) or a wooden panel (visual isolation). The subject was placed in the test side, while its pen mates remained in the companion side. The test side contained a wooden 'start box' that was removed by the observer pulling on a rope to activate a pulley system. The start box was placed in the centre of the test side with one wall of wire mesh facing the companion side. The chicks could not see the experimenter at any time during the recording period and behavioural recording was conducted through a camera placed directly above the test area.

Testing occurred between 10:00 and 18:00 h. The pens were selected in a predefined random order from each block and all six birds were placed in the companion side of the arena for 1 min to habituate to the surroundings. The birds were then tested in a predefined random order. Each bird was given 1 min to habituate to the start box and the test lasted for 2 min. When all 6 birds in the pen had been tested, they were returned to the home room