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T-maze behaviour in broiler chicks is not sensitive to right–left preferences, test order or time-of-day

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Abstract

There is substantial individual variation in the time taken by broiler chicks to traverse a T-maze and thereby reinstate visual contact with their companions. Chicks completing this task quickly (high performance, HP) subsequently grew faster in the laboratory and on farm, exhibited greater sociality, and showed less pronounced adrenocortical responses to a partial water immersion stressor than did their slower (low performance, LP) counterparts [Marin, R.H., Jones, R.B., 1999. Latency to traverse a T-maze at 2 days of age and later adrenocortical responses to an acute stressor in domestic chicks. Physiol. Behav. 66, 809–813.; Marin, R.H., Arce, A., Martijena, I.D., 1997. T-maze performance and body weight relationship in broiler chicks. Appl. Anim. Behav. Sci. 54, 197–205.; Jones, R.B., Marín, R.H., García, D.A., Arce, A., 1999. T-maze behaviour in domestic chicks: a search for underlying variables. Anim. Behav. 58, 211–217.]. Given its simplicity, rapidity and non-invasiveness, the T-maze test might represent a commercially attractive selection criterion for future breeding programmes if this behavioural trait exhibits sufficient genetic variability. However, it is first necessary to ensure that performance in the T-maze is not sensitive to potentially confounding variables, such as existing preferences to turn right or left at the junction of the maze, the order of testing, or the time of day. In the present study, 240 newly hatched, mixed-sex broiler chicks (Cobb) were randomly allocated to 12 groups of 20 upon receipt. When they were 2 days of age a group of 20 chicks was placed in the brood area of each of two T-mazes at 0830 h; the brood areas were positioned on either the right or the left sides of the mazes. After acclimatisation, one chick from each group was placed in the isolation chamber of the T-maze and we recorded the time it took to traverse the maze. This procedure was repeated until all 20 chicks and all 12 groups had been tested. The locations of the brood areas were rotated after each block of 20 tests. Testing was completed in the same day and

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two groups were tested at each of the following times: 0900, 1030, 1200, 1330. 1500, and 1630 h. Analyses of variance (ANOVA) revealed no detectable effects of: positioning the brood area on the right or the left side of the T-maze ($F_{1,200} = 0.06$, $P < 0.80$), test order ($F_{19,200} = 0.48$; $P < 0.96$), or time-of-day ($F_{5,234} = 0.44$; $P < 0.81$). These findings strongly suggest that the future classification and possible selection of broiler chicks according to their T-maze responses are unlikely to be confounded by right–left preferences, test order, or the time of day.

Keywords: Chicken-genetics; T-maze behaviour

1. Introduction

Genetic selection is probably the quickest and most reliable method of promoting desirable characteristics and eliminating harmful ones in poultry and other farm animals (Craig and Swanson, 1994; Jones, 1996; Jones and Hocking, 1999). The substantial variation in behavioural characteristics that exists within as well as between populations of poultry provides considerable scope for selective breeding. For example, selection programmes based on simple behavioural tests have already yielded significant and rapid divergence in underlying fearfulness and social motivation in chickens and Japanese quail (Jones, 1997; Jones and Hocking, 1999; Jones et al., 1991; Faure and Mills, 1998). Substantial individual variation has also been reported in the behaviour of individually tested, 2-day-old broiler (meat-type) chicks in a T-maze (Marin and Arce, 1996; Marin et al., 1997; Jones et al., 1999). By leaving an isolation chamber and then traversing a short corridor and a perpendicular arm, chicks could reinstate visual contact with their companions. Chicks fell into three categories: those that performed this task in less than 25 s, between 25 and 75 s, or over 75 s were classified as high (HP), medium (MP) or low (LP) performance birds, respectively. Though there were no differences in body weight at 3 days of age, we then found that HP chicks put on significantly more weight than did LP ones when they were housed in small groups in the laboratory (Marin et al., 1997) or in large flocks at a commercial farm (Marin et al., 1999). Home-cage activity levels were similar in HP and LP chicks but underlying sociality (motivation to be near conspecifics) was significantly greater in the HP broilers (Jones et al., 1999). Our finding that plasma corticosterone responses to a partial water immersion stressor were lower in HP than LP chicks (Marin and Jones, 1999) indicated differential susceptibility to stressful stimulation. Because corticosterone has catabolic effects (Hemsworth and Coleman, 1998; Jones, 1999), we might hypothesize that the better growth rates found in the more sociable HP birds (Marin et al., 1997, 1999) reflected the fact that they could devote more of their bodily resources to growth rather than for responding to social or other stressors.

Clearly, these findings have important strategic implications. However, before we can recommend the T-maze test as a commercially viable selection criterion for future breeding programmes, we must establish that the chicks' responses are not sensitive to potentially confounding variables, such as the ones described below.

The order in which the chicks are tested might be influential for at least two reasons. Firstly, because fear exerts an inhibitory effect on all other behaviour systems, including sociality (Jones, 1996), sequential disturbance of the group might elicit mounting levels of fear-induced immobility. This could, in turn, lead to an increase in the times taken to traverse the T-maze with test order. Secondly, the order in which the chicks were captured and, hence, tested might be influenced by previously existing differences in underlying fearfulness. For example, Japanese quail that had been genetically selected for short tonic immobility (TI) reactions (low fear) were caught earlier from mixed-line groups than their long TI (high fear) counterparts (Faure and Mills, 1998). However, the relationship is not straightforward because other quail from a high fear line (Jones et al., 1982), selected on the basis of low activity in a test cage, were more easily caught from mixed-line groups than were their active, low fear counterparts (Bessei et al., 1983).

Chicks show hemispheric specialization and they use their right and left eyes, ears and nostrils differentially to attend to cues of strong or lesser affect, e.g., familiar versus unfamiliar or non-threatening versus threatening stimuli (Vallortigara and Andrew, 1994; Milklósi et al., 1996; McKenzie et al., 1998). Lateralized motor behaviour is also present in domestic chicks. For instance, feeding chicks showed a right-foot preference for scratching at the ground (Rogers, 1995) and hens chose the left arm of a Y-maze faster than the right (Petherick et al., 1993), though the latter finding may have reflected the position of the experimenter. Therefore, it is conceivable that hemispheric specialization and/or pre-existing right–left preferences might decelerate running or confound choice at the junction of the T-maze.

The expression of several behaviour patterns, including feeding, drinking, mating, and anti-predator responses, is known to vary with the time of day in chickens (Wood-Gush, 1970; Rovee et al., 1977; Savory, 1979). Therefore, it is important to establish whether or not there is diurnal rhythmicity in T-maze performance.

The potential effects of positioning the brood area on the right or left sides of the maze, of test order, and of time-of-day on the T-maze behaviour of 2-day-old broiler chicks were examined here.

2. Material and methods

2.1. Animals and husbandry

Two hundred and forty newly hatched, mixed-sex broiler chicks (Cobb) were obtained from a commercial supplier (INDACOR, Argentina). Upon receipt, they were randomly allocated to 12 groups of 20 and housed in wooden boxes painted white and measuring $85 \times 45 \times 50$ cm (length $\times$ width $\times$ height). The wire-mesh floor (1-cm grid) was raised 2 cm to allow the passage of excreta. Ambient temperature was maintained between 28°C and 32°C and lighting was provided by fluorescent lamps from 0700 to 1900 h. Food (Cargill, broiler BB, 20% min crude protein, 2950 kcal/kg) and water were supplied ad libitum.

2.2. T-maze test

At 2 days of age, each chick was tested individually and once only in one of two similar T-mazes. This apparatus is fully described, with line diagrams, elsewhere

(Gilbert et al., 1989; Marin et al., 1997). To summarise, it consists of a 21 × 21 cm isolation chamber leading via a 21 cm long × 7 cm wide corridor to two perpendicular, open-ended arms, each measuring 7 × 7 cm. A mirror (10 × 10 cm) placed at the junction of the T corridor promoted movement of the chick towards this point. Each T-maze was situated in a 35 × 60 cm section of one of two 95 × 60 cm wooden communal brooders painted white. This section was separated with chicken wire from the remaining 60 × 60 cm ‘‘brood’’ area that contained 19 conspecifics (see below). One of the perpendicular arms allowed direct visual contact with the chick's cagemates when it reached the junction while the other faced the blank wall of the outer communal brooder and led into a narrow alley between it and the T maze. Exit through the former arm enabled the test chick to closely approach its companions in the brood area. Food and water were freely available in the brood areas. Each test apparatus was situated in a separate room and the temperature and illumination were maintained at similar levels to those in the rearing room.

Two experimenters tested two groups of chicks simultaneously. Thus, 20 chicks were placed in the brood area of each of the two T-mazes and allowed 30 min to acclimatise before testing began at 0900 h. At test, one chick was removed from the brood area and placed in the centre of the isolation chamber facing away from the entrance to the T corridor. The latency from its placement in the chamber until it exited from the perpendicular arm closest to the stimulus birds (latency to traverse the T-maze) was then recorded. A test ceiling of 90 s was employed. All chicks that exited the maze or reached the test ceiling were immediately removed, marked on the head with ink to avoid subsequent re-capture, and returned to the brood area. The floor of the T-maze was wiped clean after each test. This procedure was repeated until all 20 chicks in the brood area had been tested; this took 20–25 min depending on the distribution of latencies within that group. The chicks were then returned to their home cage and 20 previously untested ones were placed in the brood area and allowed the standard 30-min acclimatisation period before testing recommenced. The experimenters moved slowly and steadily when returning a tested chick to the brood area and removing another.

The brood areas were initially positioned on the right side of one of the T-mazes and on the left side of the other but their locations were then rotated between batches. Thus, of the 12 groups of 20 chicks, six were tested with the brood area on the right and six with it on the left side of the maze (3 right and 3 left in each room). All testing was completed by 1730 h on the same day.

2.3. Statistical analysis

The latencies to traverse the T-maze were examined using two separate analyses of variance (ANOVA). A two-way ANOVA examined the effects of positioning the brood area on the right or left side of the T-maze and of the order in which chicks were tested within batches of 20 (1, 2, 3, . . . 20), as well as their interaction. The fact that there were no replicates precluded the inclusion of time of day as a factor in the above ANOVA. Here, the results from simultaneously tested groups were pooled and thereby provided six time points (0900, 1030, 1200, 1330, 1500 and 1630 h), each representing 40 chicks. A one-way ANOVA was then performed in order to determine if T-maze behaviour

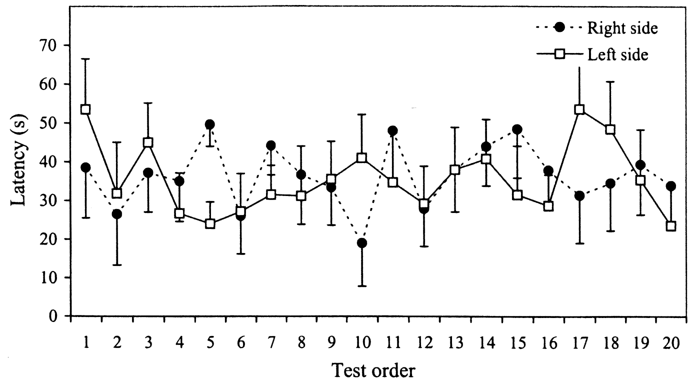

Fig. 1. Means and standard errors of the latencies to traverse a T-maze by 2-day-old broiler chicks according to the order of testing within groups and to whether the brood area was positioned on the right or the left side of the maze ($n = 6$). (s) = seconds.

showed diurnal rhythmicity; this approach was also justified by the absence of detectable right–left or test-order effects.

3. Results

Two-way analysis of variance revealed no significant effects of positioning the brood area on the right or the left side of the T-maze ($F_{1,200} = 0.06$, $P = 0.8.$) or of test order ($F_{19,200} = 0.48$, $P = 0.96$) on the chicks' latencies to traverse the maze (Fig. 1). Neither was there a significant interaction between location and test order ($F_{19,200} = 0.60$, $P = 0.90$). A one-way ANOVA also revealed that the time of day at which the chicks were tested exerted no detectable effect ($F_{5,234} = 0.44$, $P = 0.81$) on their behaviour in the T-maze (Fig. 2).

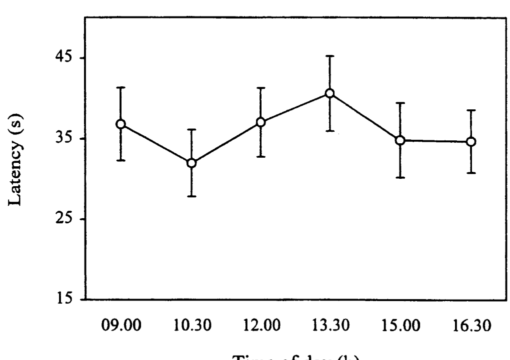

Fig. 2. Means and standard errors of the latencies to traverse a T-maze by 2-day-old broiler chicks as a function of the time of day ($n = 40$). (s) = seconds; (h) = hours.

4. Discussion

The times taken to traverse the T-maze by the chicks tested in the present study ranged from a minimum of 4 s to the test ceiling of 90 s. This finding is consistent with those of our previous studies (Jones et al., 1999; Marin and Jones, 1999; Marin et al., 1997, 1999) and again demonstrates the considerable phenotypic variation in this behaviour. If this phenotypic variation translates to genetic variability, there should be considerable scope for manipulation of this behavioural trait through selective breeding.

The repeated human contact and disturbance associated with the sequential removal of chicks from the brood area for testing and their subsequent replacement may have caused progressively greater distress (Beuving and Vonder, 1978) and elicited fear-induced behavioural inhibition (Jones, 1996). If so, we might have expected latencies to traverse the maze to increase with the order of testing within groups. However, there were no detectable effects of this variable on T-maze performance here. This result was not unexpected in view of three previous reports. Firstly, test order had no effect on plasma corticosterone levels when ducklings were returned to the group after blood withdrawal (Harvey et al., 1980). Secondly, witnessing other birds bled failed to elicit adrenocortical activation in laying hens (Culbert and Wells, 1975). Thirdly, the sequential capture and temporary removal of domestic chicks from an established group elicited no apparent behavioural or adrenocortical effects in their uncaptured companions (Jones and Harvey, 1987).

Domestic chicks exhibit visual, auditory, olfactory and motor lateralizations (Vallortigara and Andrew, 1994; Rogers, 1995; Milklósi et al., 1996; McKenzie et al., 1998) and adult hens were thought to prefer one arm of a Y-maze to the other (Petherick et al., 1993). However, the T-maze behaviour of broiler chicks was unaffected by positioning the brood area on the right or the left sides of the maze in the present study. This finding confirmed a preliminary observation attained using a smaller sample size and referred to elsewhere (Jones et al., 1999). Therefore, even if chicks do have pre-existing preferences for turning right or left at a T junction, the location of the brood area is considered unlikely to be an influential factor in T-maze tests, at least in 2–3-day-old broilers.

Although chickens show diurnal rhythms in many behaviour patterns (see Introduction), the present study revealed no detectable effects of time-of-day on the T-maze responses of young broiler chicks. Individual variation in underlying sociality is thought to be a particularly influential variable underpinning contrasting T-maze performance (Jones et al., 1999) and social proximity in the home cage is thought to be a useful measure of this behavioural characteristic (Vallortigara, 1992; Jones et al., 1999). Therefore, our previous observation that social proximity measures in both HP and LP chicks were unaffected by time of day (Jones et al., 1999) supports the present finding. Similarly, an argument for differential T-maze performance based on periodicity in general activity levels is weakened by the absence of differences between measures of ambulation, resting and pecking recorded in HP and LP broilers in the morning and afternoon (Jones et al., 1999).

In conclusion, the T-maze test may represent a particularly useful selection criterion for future breeding programmes if this behavioural trait exhibits sufficient genetic variability. The present findings strongly suggest that the assessment of T-maze performance is unlikely to be confounded by any pre-existing right–left preferences, by the order in which the chicks are tested, or by the time of day.

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