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The effect of experience of ramps at rear on the subsequent ability of layer pullets to negotiate a ramp transition

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Abstract

In commercial situations, laying hens must negotiate levels to reach resources such as food, water and litter. Providing ramps in aviary systems reduces collisions and resultant keel bone fractures in adults. We investigated whether providing ramps during rear improved the ability of birds to transition between levels.

Chicks were reared commercially in two flocks both of which provided access to raised structures from three weeks of age. One flock had no ramps, but the other flock was provided with additional access to two types of ramp (wooden ladders, and grids formed from commercial poultry slats placed at an angle). At 8 weeks of age, 64 birds (32 from each rearing condition) were transferred to an experimental facility. At 10 weeks of age, 32 pullets from each group were trained to run to a food reward. During testing at 12-14 weeks of age the pullets accessed the food reward by moving up or down a ramp. The pullets' behaviours and time taken to complete the task were recorded. Ramp use over three days was also observed in a room replicating a small-scale single-tier system. Four groups of 16 birds aged 12-14 weeks were housed for three days and the number of transitions between the raised tier and litter were recorded.

For upward transitions, more ramp-reared birds than control birds succeeded in reaching the food reward for both ladder (52 % vs 13%) and grid (74% vs 42%). Birds from the ramp-reared group took significantly less time to complete an upwards transition (68.8s±49.3) than the control group (100s±37.6) ($p=0.001$). In addition, the control group showed more behaviours indicative of hesitancy (moving away, head orientations, ground pecking and crouching) before transitioning, and signs of difficulty when making upward transitions (crouched walks, pauses, turning, returning and escape attempts). In the group housing observations, the ramp reared groups had almost double the number of transitions between the slats and litter on day one compared to the control group. This difference was reduced by day three.

In summary, this suggests there are positive effects of providing ramp experience during rear shown by increased mobility and apparent confidence in older pullets. It is not known whether these benefits persist through to the laying period, but no detrimental effects were noted so we suggest that ramps should be included from the early rearing period onwards.

Key words

Animal Welfare, Behaviour, Laying hens, Rearing, Ramps, Keel fractures.

1 Introduction

In commercial loose housed laying systems, ramps are increasingly provided to help birds with level changes in their environment. There are two principal loose housing systems for laying hens: single tier (flat deck) and multi-tier (aviary) systems. Single tier systems comprise a raised slatted area containing food, water and nest boxes with a drop down to reach the litter and range. Multi-tier (aviary) systems contain multiple tiers stacked on top of each other with food, water and nest boxes. There can be vertical drops of up to 90cm between tiers, including to the ground level litter.

In loose housed systems, increased collisions have been observed when a level change is included (Harlander-Matauschek et al., 2015). Collisions and falls from heights can lead to injuries such as keel bone fractures (Stratmann et al., 2015). Birds with keel fractures show restricted movements and reduced willingness to jump down from perches (Nasr et al., 2012a; 2012b). Experimental work has shown that mobility is partially restored if analgesic drugs are administered (Nasr et al., 2015) suggesting that untreated keel bone fractures are painful. In commercial systems fracture rates can be as high as 80% of the flock at end of lay in more complex housing with aerial perches (Wilkins et al., 2005; 2011). The addition of ramps in the laying house has been shown to reduce falls and collisions by 45% and 59% respectively, along with 44% of birds showing more controlled movements if provided with ramps (Stratmann et al., 2015). When negotiating a level change fewer hesitancy behaviours have been recorded in laying flocks provided with ramps spanning the full width of the lower tier (Pettersson et al., 2017a), suggesting that ramps can aid transitions between levels. Birds' ability to negotiate ramps of different design has also been trialled, showing easier transitions on a grid ramp and a preference for a grid ramp over a ladder ramp (Pettersson et al., 2017b).

Before transfer to the laying system at 16 weeks of age, pullets destined for loose-housing systems are commonly reared in large areas with litter covered floors and some perches and raised structures to give them experience of navigating in three dimensions. Rearing in complex environments, such as aviaries, which provide opportunities for exercise, can reduce the proportion of keel bone fractures measured during lay. For example, Casey-Trott et al. (2017) found a fracture rate of 41.5% in aviary reared birds compared with 60.3% for cage reared birds.

The cognitive effects accruing from perch or tier provision also seem to be enhanced when birds are reared with these structures, rather than encountering them for the first time when moved to the laying system. For example, Gunnarsson et al. (2000) found that rearing birds with perches to 8 weeks of age, improved their ability to negotiate a series of raised platforms to reach a food reward.

Because the difference in performance between the two rearing groups increased with task difficulty, the authors argued that the rearing conditions may have influenced spatial navigational ability, and that the results could not easily be explained only by differences in physical strength. This was tested more directly by Tahamtani et al. (2015) who compared the influence of cage versus aviary rearing on spatial cognition using a two-dimensional hole board task thereby eliminating the confounding factor of physical ability. These authors reported that birds reared in the more barren cage environment had poorer working memory. Further, Colson et al. (2008) showed that birds reared with vertical structures, similar to those later encountered in the laying shed, performed more long distance flights (100cm to 300cm), accounting for 40% of all flights compared to 35% for floor reared birds. Generally, indirect effects due to improved spatial navigation are likely to be complemented by direct effects of additional exercise. Overall it seems that rearing birds with vertical structures has both physical and cognitive benefits and the provision of ramps for adult laying hens aids smooth transitions between levels.

There is less evidence for the effects of ramp provision during the early rearing period. In a review Harlander-Matauschek et al. (2015) suggested that the provision of ramps at a young age may promote wing-assisted inclined running, which could affect the development of the keel bone and muscles and improve balancing abilities. Kozak et al. (2016) reared chicks in complex aviaries with ramps, low level platforms and perches. Ramp use peaked at 2 weeks of age when chicks started to use the upper levels. In this study the effect of ramps and low-level perches were confounded, and it was not clear if chicks utilised the ramps to gain access to the upper levels. LeBlanc et al. (2017) looked at the effect of ramp angle and found that from 2 weeks of age all birds were successful on inclines up to 40° which continued to 36 weeks of age. We have shown that providing ramps during the first week of age can increase the use of other raised structures in commercial systems (Norman et al., 2017).

Improving the mobility and confidence of young birds could have beneficial effects during the stressful transfer to the laying system. With resources spread throughout the house, birds must navigate the system effectively as soon as possible, to avoid welfare problems (Pettersson et al., 2016). Given that ramps appear to encourage better access and use of perches, tiers and vertical structures during the laying period, and that there are some indications of beneficial effects of ramp provision during rear, it is important to consider at what stage ramps should be provided during the rearing period. The aim of this study was to determine whether experience of inclined ramps during the early rearing period would improve birds' subsequent ability to negotiate similar ramps towards the end of rear.

The specific objectives were to compare the effects of rearing birds from 3 to 8 weeks of age with or without ramp access to elevated platforms on:

i. Individual latency to move up or down a ramp at 12-14 weeks of age.
ii. Individual behaviour at 12-14 weeks of age when traversing a ramp for a food reward.
iii. The number of ramp transitions made by groups of birds aged 12-14 weeks over a period of three days.

2 Materials and Methods

2.1 Animals and housing

For this study, British Black Tail pullets (*Gallus gallus domesticus*) from the same parent flock were reared to 8 weeks of age in two flocks of 2,000 pullets in adjacent sheds (12.5m by 8m) on a commercial rearing farm. Housing comprised a fully littered floor, gas brooders, track feeders and bell drinkers. At three weeks of age both flocks were provided with four A frame perches (L:2m, H:0.5m) and two elevated platforms (L:360cm, W:60cm, H:50cm) to encourage vertical movement in preparation for the laying house. Platforms consisted of metal frames with white plastic stats on top. One flock (ramp-reared) was additionally provided with two grid ramps (GR) and two ladder ramps (LR) that were attached to the platforms at an angle of 61 degrees (to fit between the drinker lines in the rearing sheds), with the other flock used as a control. Each GR consisted of a white plastic poultry slat (Jansen) attached to a sheet of medium density fibreboard (MDF) for support. Each LR was constructed from hardwood timber with three rungs (4.4cm square) 30cm apart.

At 8 weeks of age, 32 birds from each flock (ramp reared or control) were collected and transported to a research facility at the University of Bristol. Upon arrival birds were weighed and keel palpated using the method of Wilkins et al. (2004). The birds were kept in their rearing groups and were housed separately in two similar rooms (3.66m by 3.05m) each with floors covered in wood shaving litter, two feed hoppers (30cm diameter) and two bell drinkers (30cm diameter). Birds were fed *ad libitum* on chick crumb and gradually moved onto a layer mash. Lighting was on a 12h dark:12h light cycle, with room temperature maintained around 19-22^{o}C and fan ventilation. Each room contained one identical raised platform (L:120cm, W:60cm, H:50cm). The ramp reared group was provided with a GR and LR (identical to those provided in the commercial rearing system) leading up to the platform at an angle of 61^{o} (Figure 1).

2.2 Negotiation of a ramp by individuals

The aim of the individual bird tests was to measure whether there was a difference between ramp reared and control birds in the individual latency to transition a ramp and to compare behaviour before and during a transition down or up a ramp.

A separate room was used for individual testing, which used a narrow pen (3.02m by 0.65m) set up at the side of the room with one long side fenced off with a wooden frame covered in chicken wire. During the first stage of habituation and training a white plastic slat was positioned on the floor at one end of the pen (figure 2, section A) with shavings covering the concrete flooring (figure 2, section B). During testing the ground level slat was replaced with a raised structure (90cm high) with the plastic slat fixed on top. Either a GR or a LR (L:120cm by W:57cm) were attached (angle 45°) (See figure 2). The LR had three central rungs 30cm apart. For downward transitions hens were placed via a cardboard door in the wire framework onto the raised slatted platform. For upward transitions birds were lifted over a wire barrier onto the shavings (figure 3). A CCTV camera was installed at a raised position on the wall facing the ramp to record behaviour during up and down transitions. The birds' preference for ramp type (GR or LR) has been reported (Pettersson et al. (2017b).

Habituation took place over the first 14 days (8 to 10 weeks of age) where birds were introduced to handling and a food reward (tinned sweetcorn). Over the first 7 days birds were fed *ad libitum* sweetcorn from two ceramic bowls (black outside with white inside) in the home rooms. Once all birds were eating sweetcorn from the bowls, the birds were introduced to the individual testing room (days 8-14). Two birds were carried to the individual testing room and were fed *ad libitum* sweetcorn from the bowls placed on the ground. This progressed to feeding inside the test pen in pairs, then feeding individual birds in the test pen. Habituation to the testing room was complete when all birds were eating calmly from the bowl when alone in the testing pen.

Training took place over 14 days (10-12 weeks of age). Following habituation to the testing room, each bird was carried to the testing room and placed at one end of the testing pen. The starting position (litter or a ground level slat) was balanced across individuals. A bowl containing 5 pieces of sweet corn was already in position at the other end of the testing pen where a researcher tapped on the bowl twice with a pencil to attract the bird's attention. Once the bird reached the bowl and had eaten the sweetcorn, the procedure was repeated in the other direction. Each bird received this training once a day from days 15-25. The starting direction was alternated for each bird. During the last three days 26-28 whether the bird succeeded in reaching the bowl within two minutes was recorded. To meet the training criteria birds had to be successful in 5 out of 6 of these tests (3 in each direction).

2.3 Individual Testing protocol

All birds experienced a recap day and two days of testing. The recap day involved all hens experiencing the training protocol (no raised levels) in both directions, as there was a break between training and testing for most birds.

Testing took place during days 30-44 when birds were 12-14 weeks old. 16 birds from the same rearing group were tested over three days, this was repeated four times so all birds could be tested. The testing pen was set up with the raised slatted area and a ramp attached with cable ties. Each bird experienced four tests GR-DOWN, GR-UP, LR-DOWN and LR-UP. Testing order of ramp type and direction was systematically balanced to account for first experiences. See Figure 4 for example testing procedure for an up transition.

Videos of the testing days for each bird were watched using VLC media Player (VideoLAN, France). The pre-transition period was recorded from the start of the trial until a transition was started. Behaviours indicative of hesitancy were recorded (as used in Lambe et al. (1997); Pettersson et al. (2017a)) such as head orientations, crouches, steps, pacing. The transition period was recorded from when the bird had started a transition to reaching the bowl. Behaviours whilst transitioning were also recorded such as moving straight down, jumping, half jumping, crouch walk, running etc. Table 1 lists the behaviours recorded.

2.4 Use of ramps in a group setting over three days

The aim of the group test was to compare the effect of early rearing experience on the number of successful transitions birds made going up and down ramps and whether this changed over time.

Group testing took place in a room (3.66m by 3.05m) identical to the home pens. Six wooden frames each designed to support 6 plastic slats (L:120cm by W:57cm) were joined together to create a raised slatted area (W:366cm x D:120cm and H:90cm). Chicken wire was used to block access to underneath the frames. The floor area (366cm x 185cm) was covered with wood shavings. A LR and GR (L:120cm x W:171cm) were attached to the wooden frames of the raised area by cable ties at a height of 85cm, resulting in an angle of 45°. The LR had three central rungs 30cm apart. There was a small gap between the ladder ramp and the wall of 24cm, present in both positions. A feed hopper (right) and bell drinker (left) were installed above the slatted area. Two CCTV cameras were attached to the walls, to provide a full view of each ramp (figure 5).

2.5 Group testing protocol

Group testing commenced with the first group of 16 birds after they had completed the individual tests. Between 8.30am and 9.00am the following day 16 birds were placed on the raised slatted area of the group testing room. The birds were left in the group testing room for three days, during which the next group of 16 was run through individual testing. Videos were recorded from 9.00am to 5.00pm for the three consecutive days that each group was housed in the testing room, as this was a time period when the birds would be undisturbed. To minimise any side bias, each day the birds were removed from the group testing room and put into crates whilst the ramp positions were swapped. The side that the ladder ramp and grid ramp started on were balanced for the two groups. Birds were always replaced on the raised slatted area. Once the birds were replaced by 9.00am the rooms were not disturbed until 8.30am the next morning. Throughout the day birds could be inspected through a small peep hole so as not to disturb them. On the fourth day birds were removed, the ramps reset, and the next group was placed in the group testing room. This was repeated until all four groups had completed three consecutive days in the testing room.

From video recordings, the total number of successful up and down transitions completed within a minute was recorded for each ramp type. Recording periods were from 9:00 h to 17:00 h. A transition began when a bird placed both feet on the ramp or on one of the ladder rungs and ended when both feet were either on the litter or on the raised area. Every bird that started a transition was tracked and it was recorded whether it completed a transition or returned to the starting area within the minute. A 1-minute time period was chosen to exclude birds that stopped/perched on a ramp. If the bird was still on the ramp after one minute the observation was terminated. Further records such as number of jumps or collisions were taken. Additional scan sample recordings were taken at ten-minute intervals between 9:00 h and 17:00 h to count the number of birds' stationary on each ramp type to determine the extent to which blocking might influence ramp use.

2.6 Statistical analysis

All data were analysed using SPSS 23 (IBM). Data were analysed separately for up and down transitions. Two birds were removed from analysis, one for not completing the training criterion and the other as it was tested incorrectly. For pre-transition behaviours, all 62 birds were included in the analysis. For transition behaviours, only birds that attempted a transition were included (N=58) for analysis. Some birds had to be removed from analysis for certain variables, for example, if they completed the transition by jumping they could not perform certain behaviours on the ramps such as pausing or returning. All variables were tested for normality and square root and log transformations were made to try and meet the assumptions, but these were not achieved. Therefore, a non-parametric alternative to an independent t-test was used, Mann-Whitney U test, to perform exploratory statistics. Mean and standard deviation will be reported in this analysis. Some of the data were nominal so they could not be analysed on an individual level such as successful transitions and jumps. Percentages and graphs are reported to indicate any trends in the results. Statistical analysis could not be performed for the group tests as N=2, so simple summary statistics are presented.

2.7 Ethical approval

The University of Bristol's Animal Welfare and Ethical review body approved this study under UIN: UB/17/046.

3 Results

3.1 Individual testing results

For the results, upwards and downwards transitions will be reported separately. Both ramp types were analysed together unless there was a difference between the two. See Table 2 for detailed results. When considering the time taken to start a transition (start latency) the control group took longer when faced with the Ladder ramp but there was no significant difference for the grid ramp. The time taken to transition when negotiating a ramp (transition latency) was significantly longer in the control group compared to the ramp reared group with both ramp types combined. When looking at the total latency to start and complete a transition of a ramp, the control group took significantly longer than the ramp reared group for upward transitions. For the downwards ramp transitions there was no significant difference in latency between the rearing groups.

When comparing pre-transitions behaviours (i.e. orientation, foot raise, step, pace, crouch, move away, ground peck), the number of head orientations per bird was greater in the control group compared to the ramp group when transitioning up a ramp. Significantly more control birds moved away from the bottom of the ramp before attempting an upwards transition. There was no significant difference between groups for foot raises, steps, pacing, crouching and ground pecking for upwards transitions. There was no significant difference between rearing groups for pre-transitions behaviours during downwards transitions. See Table 2 for statistical results.

The time taken before transitioning and the number of behaviours birds showed, allowed the rate to be calculated for pre-transitions. For the LR-UP there was a significant difference in the rate of ground pecks being greater in the control group compared to the ramp group. When considering the rate of pre-transition behaviours occurring when moving down ramps, differences between the rearing groups appeared when tested with the LR. For LR-DOWN there was a greater rate of head orientations in the control compared to the ramp reared group. This was opposite for the rate of crouching which was lower in the control group compared to the ramp group. See Table 2 for results.

For the behaviours recorded (see Table 1) during the upward transitions, the ramp reared group displayed significantly more crouch walks than the control group. More pauses, returning to the starting position and turning around on the ramps were recorded in the control group compared to the ramp reared group. For the LR the number of rung steps and rung jumps were recorded. There was a significant difference between the groups, with the ramp reared group showing more rung jumps compared to the control group. A difference in the number of birds showing escape behaviours in the control group compared to the ramp reared group was found. Ramp reared birds had a greater mean number of attempts compared to the control group for LR-UP transitions. No significant difference in the behaviours when transitioning down the ramps was found between rearing groups. See Table 2 for the significant results.

When comparing the rearing groups, of the 62 birds tested, 23 birds (74%) in the ramp reared group and 13 birds (42%) in the control group had successful transitions for the GR-UP. For the LR-UP, in the ramp reared group 16 birds (52%) were successful compared to 4 birds (13%) in the control group. Irrespective of prior ramp experience 70-80% of birds successfully negotiated down the ramps, however 38% of birds without ramp experience collided upon landing compared to 10% in the ramp reared group. See figure 6 for a graph of results.

3.2 Group Testing Results

Owing to the nature of the data, some could only be obtained at a group level so with only 2 groups per treatment the data are presented descriptively. On their first day in the group testing room there were more up and down transitions on the ramps in the ramp reared groups (14.72 ± 9.95) compared to the control groups (7.22 ± 9.304). The mean number of up transitions was greater in the ramp reared groups (15.69 ± 11.79) compared to the control groups (6.34 ± 5.597) on day 1. This difference reduced by day 3 with the control groups having a mean of 12.31 ± 9.282 and the ramp reared group having a mean of 11.81 ± 6.855 for down transitions. For up transitions the control group had a mean of 10.50 ± 6.520 and the ramp group had a mean of 13.31 ± 8.495 (see Fig. 7). In total, 17 jumps in the control groups and 39 in the ramp groups were recorded. Two collisions in the control group and 9 in the ramp group were also observed.

4 Discussion

4.1 Individual Differences in latency

The first aim of the study was to determine whether individuals with different experience of ramps during 3 – 8 weeks of age had an altered latency to move up or down two types of ramp.

For upward transitions, there was a significant difference between individuals from the two rearing conditions. Latency to start moving up a ladder ramp was significantly longer in the individuals with no ramp experience compared to the ramp reared individuals. This difference in latency suggests that birds without previous experience may be more cautious in starting a transition. Scott et al. (1999) looked at birds jumping to perches for a food reward and found birds that were successful in jumping tended to jump within the first 20 seconds. This suggests hesitant birds may take longer in starting a transition.

Birds without rearing experience of ramps took longer to transition a ramp than birds with previous ramp experience. A greater number of ramp reared birds completing a transition than non-ramp reared birds, suggests that birds without previous experience of ramps had difficulty transitioning up both types of ramps. An increased latency to transition may cause blocking on ramps in commercial systems which could also prevent other birds from transitioning. There were no clear differences between individuals in the latency for down transitions, suggesting no effect of rearing conditions.

In summary, early rearing experience with ramps reduced transition latency on ramps. In a commercial laying house, it is important for birds to easily access the litter and to be able to move up to food and water on the raised areas. If birds are hesitant in moving between levels, this could cause crowding and blocking on ramp areas which will limit access for other birds. Crowding on raised areas of the shed can increase the risk of collisions or pushing from conspecifics which could lead to keel bone fractures (Stratmann et al., 2015). If blocking or difficulty in negotiating a level change restricts access to resources, this could reduce bird welfare and lead to unwanted behaviours such as feather pecking (Nicol et al., 2013; Alm et al., 2015).

One factor to consider is that food was used as a motivator in individual bird testing. This may have influenced their level of caution in negotiating down the ramps, as many birds were observed to have a collision on a downwards descent of a ramp. Individual differences in levels of food motivation were not tested in this study. There is evidence of individual differences in motivation for a food reward (Scott et al., 1999) which may have a confounding effect on the results.

4.2 Individual pre-transition behaviours

For upward transitions there were higher numbers of head orientations and moving away in the control individuals. Multiple head orientations have been shown to indicate hesitancy when transitioning ramps (Pettersson et al., 2017a). Head orientations were found to be precursors for jumping down from perches by Scott et al. (1999). A greater number of head orientations may be indicative that the control group took time looking at the food reward before attempting the transition. The greater number of birds that moved away from the bottom of the ramp in the control group could possibly indicate that they were less willing to transition and looked for a different route up or lost interest in the reward (Lambe et al., 1997; Scott et al., 1999). As with the latency, there was no difference between individuals from the two rearing conditions in behaviours prior to moving down either ramp type.

4.3 Individual rates of pre-transition behaviours

The rate of head orientations was greater in the control groups when transitioning down the LR. This suggests that the control group perform more head orientations over time than the ramp reared group. Corroborated by Lambe et al. (1997), where the rate of head movements was positively correlated with the time taken to jump down from a perch. The rate of crouching was greater in the ramp reared group. Crouching tends to indicate a transition will be made, therefore a higher rate of crouching suggests birds are more likely to make a transition (Lambe et al., 1997; Scott et al., 1999), and indeed more ramp reared birds made the transitions down onto the litter.

For LR-UP there was a greater rate of ground pecks in the control group. Ground pecking has been identified as a redirected behaviour when a goal is not achieved (Kuhne et al., 2011). Therefore, it could have been a redirected behaviour from not obtaining a food reward. It was more likely to occur in the upwards transition owing to the litter covered floor. Birds that abandoned transitioning were more likely to ground peck and only 13% successfully transitioned the LR-UP in the control group compared to 52% in the ramp reared group. As the control group seemed to have more difficulty with the upwards transition than the downwards one, it could be reflective of this increased difficulty.

4.4 Behaviours recorded whilst transitioning a ramp

Birds seemed to express similar behaviours whether reared with or without ramps when transitioning down. When moving up the ramps birds without prior ramp experience showed a higher number of crouched walks. A crouched walk was recorded when birds' bodies were held low to the structure; it appeared to the observers that these birds lacked confidence when transitioning. The control birds also paused, turned and returned to the litter more frequently than the ramp reared group. This suggests they were unsure of making an upward transition. Confirmed by the fact that more birds in the ramp reared group successfully completed an upwards transition. The individuals in the control group showed a higher number of escape attempts. This suggests that they struggled with transitioning the ramp and looked for alternative routes to leave the testing pen. These behavioural recordings suggest that control birds are less confident in using the ramps when making the first transition upwards. Few studies have looked at upward transitions on ramps in laying hens. LeBlanc et al. (2017) observed chicks use ramps from 1 week of age, and training and testing may help with bone and muscle development. When looking at rearing experience with inclined structures Kozak et al. (2016) reared chicks in a complex environment, and found chicks used the inclined surfaces from 2 weeks of age. However, no previous studies have considered the consequences of previous experience of ramps during rearing.

4.5 Other behaviours

When looking at the nominal data, the ramp reared group showed a greater percentage of successful and attempted transitions compared to the control group. This suggests that previous experience with ramps may encourage use of ramps when first exposed to them. With the downward transitions, there was a greater percentage of collisions in the control group compared to the ramp reared group. This suggests that birds with no previous ramp experience may be at more risk of colliding with the floor when transitioning down the ladder ramp. Studies have found with more ramps in a system there is a reduction in the number of falls, collisions and keel bone fractures (Stratmann et al., 2015). By introducing ramps at an early age birds may be more likely to use these structures as a route for level changes.

4.6 Group recordings

When tested in groups, the ramp reared groups transitioned more than the control groups. However, the number of successful transitions in control groups increased over the three days to almost the same as the ramp reared group (Figure 7). This suggests that, despite having exposure to ramps during individual testing, the control group were less confident in using the ramps to begin with, but as they gained experience they were more able to move between the slats and litter. This is important in a laying shed as movement between the litter and raised areas is essential for birds to forage and reach food and water. If thwarted this can have negative consequences such as feather pecking (Nicol et al., 2003; 2013).

5. Conclusion

Overall increased mobility and apparent confidence was seen in older pullets with previous ramp experience, shown by differences in pre-transition, transition behaviours and latency. We have found that early experience of ramps influences pullets up to 14 weeks of age. From the group observations the difference in transitions appears to reduce over three days, so it is possible that non-ramp reared birds can learn to use ramps relatively quickly. But the time this may take in a more complex commercial system with older birds in unknown. In all, only positive effects were noted with early ramp experience, so we suggest that ramps should be included form the early rearing period onwards.

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8. Figure captions

Figure 1. Photograph of the platform (L:120cm, W:60cm, H:50cm) with the ladder ramp (right) and grid ramp (left) attached in the ramp reared group home pen.

Figure 2. A side view diagram of Individual testing pen. The black boxes represent the bowls at starting position A for up transitions and B for down transitions. The dashed line represents the barrier used to shorten the starting box for up transitions.

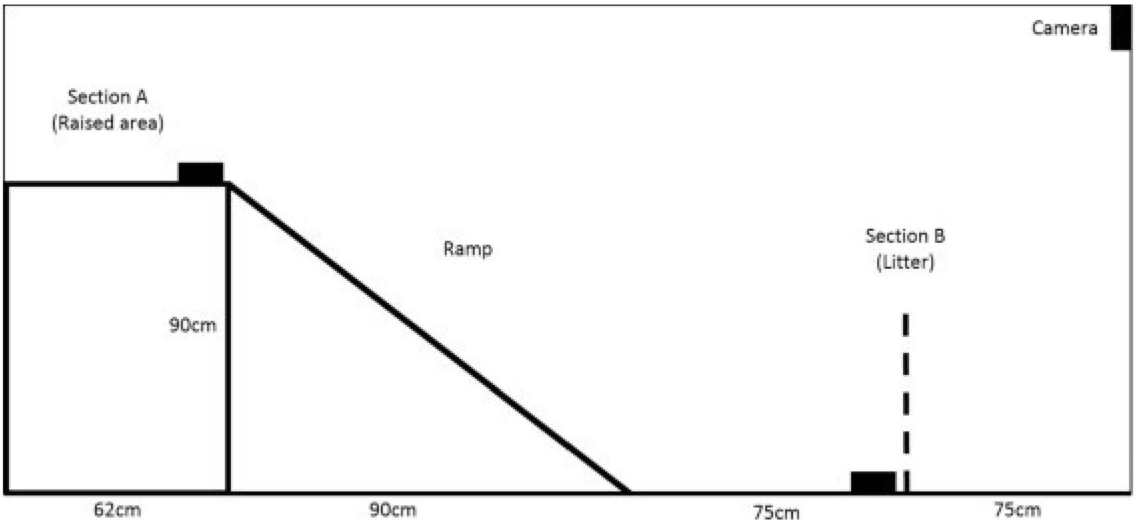


Figure 3. Photograph of individual testing pen with both ramp types. (A) Ladder ramp (LR) and (B) grid ramp (GR).

Figure 4. Flow chart of the testing procedure for an upwards transition in the individual tests.

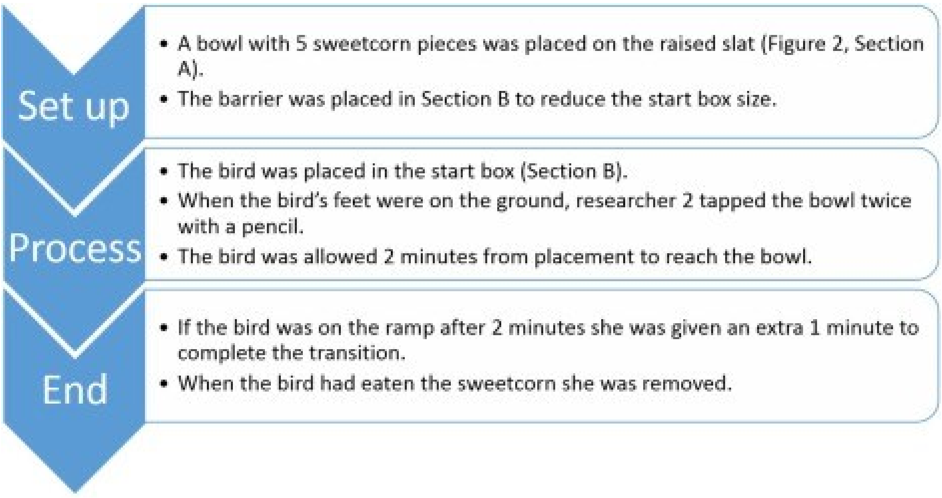


Figure 5. The raised area in the group testing room. Grid ramp (GR) on the left and ladder ramp (LR) on the right. Raised slatted area 90cm high with ramp angles of 45°.

Figure 6. Graphs comparing the percentage of birds performing behaviours during different transitions. (A) Grid ramp transitions down (GR-D), (B) Grid ramp transition up (GR-U), (C) Ladder ramp transitions down (LR-D) and (D) Ladder ramp transitions up (LR-U).

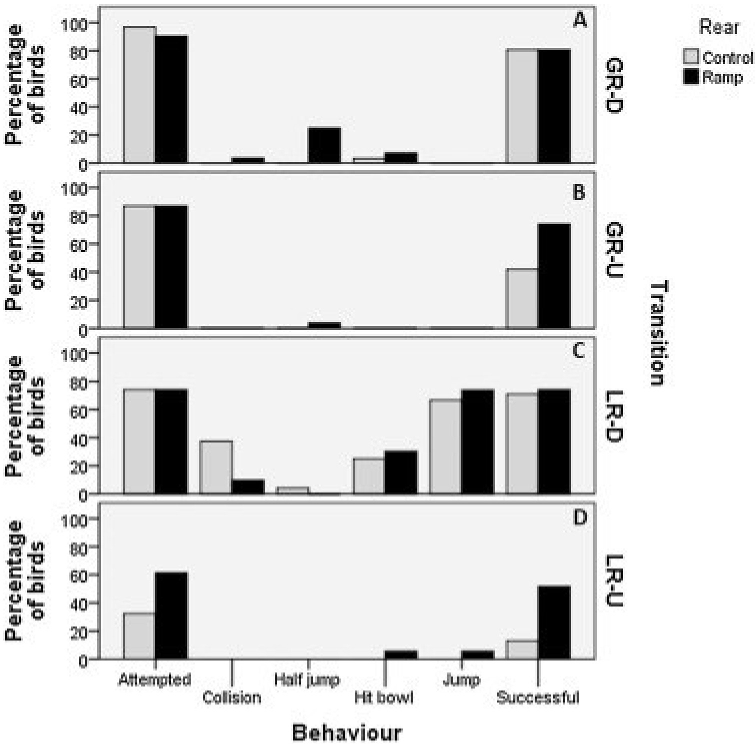
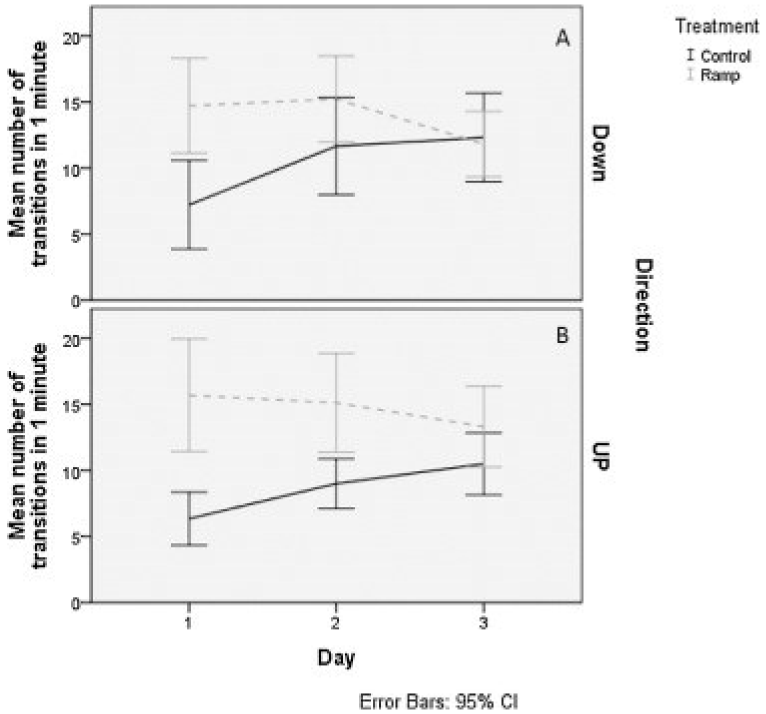


Figure 7. Graphs showing the difference in the mean number of transitions per day for ramp-reared and control birds in the group tests over three days. (A) Downwards transitions, (B) upwards transitions.



9. Table Captions

Table 1. Ethogram of the behaviours recorded in the individual tests.

Behaviour	**Description**
Pre-transition behaviours	
Start	Release of the bird, both feet placed on slat/floor
Orientation	Rotates head in the direction of movement
Foot raise	Raising foot to initiate movement
Step on the spot	Raising foot and replacing on the same spot
Pace	Walking along the top of the slat, looking down the structure
Crouch	Lowering body to the ground, preparing for a jump
Move away	Bird turns away from ramp for more than 3 s
Ground peck	Bird pecks ground (bouts separated by 3 s)
Transition behaviours	
Transition start	One foot placed on ramp
Straight	Smooth transition on the ramp
Rung step	Stepping between rungs on the ladder ramp
Rung Jump	Jumping between rungs on the ladder ramp
Zig zag	Moving across the ramp
Side step walk	Moving in a straight line with the wing side facing down
Crouch walk	Moving with body low to the ramp
Wing flap	Wing extended and flapping
Balance	Wings slightly away from the body
Half jump	Moving half way down the ramp then jumping
Jump	Jumping from the top of the structure
Run	Fast paced movement on the structure
Pause	Stops mid transition
Turn	Turns on ramp
Return	Goes back to the start position without completing transition
Structure collision	Collides with structure impacting movement
Landing Collision	Collides at the end of the transition movement
Hit bowl	Collide into bowl
No attempts	Does not attempt a transition on the ramp
Escape	Bird orientates head looking to escape (hand needed to stop escape)
End	Bird reaches bowl and starts eating

Table 2. A table listing the significant results for latency, pre-transition behaviours and transition behaviours separated for direction. Results that were analysed separately for ramp type are noted with LR or GR.

	Mean ± SD	Mean ± SD	Test result and Significance level
	Control	Ramp reared	
Upwards transitions			
Total Latency	100s ± 37.6	68.8s ± 49.3	U = 1182, n1 = 62 n2 = 62, p = 0.001
Transition latency	30.24 ± 26.66	14.10 ± 14.78	U = 207.5, n1 = 17 n2 = 39, p = 0.027
Start latency (LR)	66.80s ± 35.40	30.10s ± 23.54	U = 32.00, n1 = 10 n2 = 17, p = 0.008
Head orientations	2.98 ± 1.42	2.29 ± 1.63	U = 1265, n1 = 62 n2 = 62, p = 0.001
Move away	0.94 ± 0.903	0.42 ± 0.560	U = 1302, n1 = 62 n2 = 62, p = 0.001
Rate of Ground pecks (LR)	0.0107 ± 0.0122	0.0035 ± 0.011	U = 47, n1 = 10 n2 = 17, p = 0.018
Crouched walks	0.56 ± 0.698	0.26 ± 0.447	U = 232.5, n1 = 27 n2 = 27, p = 0.009
Pauses	0.97 ± 0.928	0.27 ± 0.447	U = 460.5, n1 = 37 n2 = 45, p = 0.001
Returns	0.57 ± 0.647	0.11 ± 0.318	U = 512.5, n1 = 37 n2 = 45, p = 0.001
Turns	0.57 ± 0.647	0.13 ± 0.344	U = 529.5, n1 = 37 n2 = 45, p = 0.001
Rung jumps (LR)	0.2000 ± 0.42164	1.4706 ± 1.1245	U = 25.00, n1 = 10 n2 = 17, p = 0.001
Escapes	0.19 ± 0.568	0.03 ± 0.254	U = 1707, n1 = 62 n2 = 62, p = 0.017
Attempts (LR)	0.35 ± 0.551	0.61 ± 0.495	U = 350.5, n1 = 31 n2 = 31 p = 0.035
Downwards transitions			
Rate of head orientations (LR)	1.01 ± 0.799	0.588 ± 0.418	U = 136.5, n1 = 22 n2 = 19, p = 0.039
Rate of crouching (LR)	0.284 ± 0.681	0.345 ± 0.404	U = 137, n1 = 22 n2 = 19, p = 0.047