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Group size and phenotypic appearance: Their role on the social dynamics in pullets

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ABSTRACT

Non-caged production systems offer greater freedom of movement and behavioural opportunities to pullets, which may also include the occurrence of undesired behaviours. The incidence of such behaviours may be affected by group size but also by the group membersí phenotype. This study was designed to explore the effects of group size and phenotypic appearance in the social dynamics of pullets. A total of 1050 day old Hy-line Brown was randomly assigned to 45 pens at 3 group sizes (GS), 10, 20 and 40 birds (constant density 8 hens/m^2). For all GS treatments, the phenotypic appearance (PA) of different bird proportions was modified with a black mark at the back of their head. Two types of populations were studied: homogenous (0, 100%) with all pen members presenting the same marked (M) or unmarked (U) phenotype, and heterogeneous (30, 50, and 70%) were the two phenotypes (M and U) coexisted in the same pen. All pens were observed during rearing on alternate weeks. Aggressive and affiliative social interactions performed among group members were registered together with their PA (M or U). The observed and expected mean frequencies for all phenotype combinations involved in the social interaction were calculated: MM, MU, UU and UM, where the giverís phenotype is indicated by the first letter and the receiverís phenotype by the second letter. Data were analysed with mixed model ANOVAs that included GS and PA as fixed factors for the general model, and GS, PA and type of interaction (MM, MU, UU, UM) to determine the direction of the interaction in the case of heterogeneous groups. Both aggressive (threats) and affiliative interactions (exploratory pecking and beak pecking) were more frequent in small (10) than in large (20, 40) GS ($P < 0.05$) regardless of PA (PA, $P > 0.05$; GS × PA, $P > 0.05$). Aggressive interactions however, occurred at a higher than expected frequency in heterogeneous GS 20, and were predominantly from U towards M birds (UM; $P < 0.05$), as compared to MU or UU. The significant interaction among GS × PA × Type of interaction for affiliative behaviours did not show a clear relationship. Overall, the results obtained showed that both aggressive and affiliative interactions occurred at a higher frequency in the smallest GS 10. Although the effects of PA were not as clear as expected, these results provide evidence of the directionality of the aggressive interactions from U towards M birds especially at intermediate GS 20.

1. Introduction

Non-cage production systems offer greater freedom of movements and behavioural opportunities to laying hens, thus are considered beneficial from a welfare stand point (Frölich et al., 2012). Some studies however, suggest that increasing freedom of movement may also have negative consequences for the welfare of laying hens by increasing the occurrence of undesirable behaviours such as aggression, feather pecking, and cannibalism (Sossidou and Elson, 2009), which can easily spread in the population (Cloutier et al., 2002). Even though the consequences of undesired behaviours may not be as dramatic for pullets as in adult laying hens it is important to prevent their appearance during rearing.

In addition to the greater freedom of movements, the larger group sizes (GS) generally used in non-cage systems may lead to increased social instability and aggression. When domestic fowl are kept in small groups their social behaviour appears to be similar to that of their wild ancestors, the red jungle fowl (*Gallus gallus*), establishing a dominance hierarchy that is determined by aggressive interactions (Collias et al., 1966). However, it has been suggested

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that in large GS the social hierarchy is replaced by a tolerant system characterized by low aggression (Estévez et al., 1997; Estevez et al., 2003). Pagel and Dawkins (1997) proposed that the social strategy of a group will switch when the costs of establishing and maintaining a dominance relationship outweigh the benefits. It has been suggested that this breakdown may occur at intermediate GS of around 30 individuals (Keeling et al., 2003).

Several studies suggested that phenotypic appearance (PA) may also play an important role regulating social dynamics by altering the way that individuals are perceived by their conspecifics. For instance, it has been suggested that aggressive interactions do not occur randomly within flocks of domestic fowl and that some individuals are at higher risk of being involved in aggressive encounters. It has been observed that aggression is mainly directed towards subordinates (Mc Bride, 1960; Guhl, 1968; Queiroz and Cromberg, 2006) or individuals with particular phenotypic characteristics such as low body mass, small comb size or manipulated plumage coloration (Cloutier and Newberry, 2002; Estevez et al., 2003; Dennis et al., 2008). Keeling et al. (2004) also indicated that the expression of a wild recessive allele at PMEL17 gene that controls plumage melanisation, may predispose chickens to become victims of feather pecking. Moreover, pigmented birds in their study (within a white hen population) were found to be more vulnerable to feather-pecking when they were relatively common (22–26% of the birds showing the pigmented phenotype). Frequency dependent effects were also found when manipulation of the phenotypic appearance of different bird proportions in a group (20, 50 and 100%) were applied (Dennis et al., 2008). In this study, birds with altered phenotypic appearance were the main receptors of aggressive interactions, especially when only 20% of the birds in the group were altered. The altered birds also showed lower body mass and changes in levels of stress hormones as compared to their unaltered pen mates.

It has been suggested that animals with similar PA tend to cooperate and interact in a less aggressive manner (Hamilton, 1964a,b; Lizé et al., 2006). In terms of kin selection theory it has been suggested that phenotype matching may be one of the mechanisms used by animals to discriminate between kin and non-kin (Komdeur and Hatchwell, 1999). Phenotype recognition would be expected to develop during the first few weeks of age while birds interact with each other. Thus, it is expected that PA treatment would affect to their aggressive and affiliative interactions during rearing.

Aggressive interactions and it effects in social dynamics in the domestic fowl have been studied extensively and are well defined (Estevez et al., 2002, 2003). Exploratory pecking and beak pecking may also have an important role in social bonding, thus some basal levels of feather pecking have been interpreted as a form of allopreening in young birds (Bolkhuis, 1986; Vestergaard et al., 1993). Allopreening have an important role in reducing aggression levels and in the formation and maintenance of social bonds (Harrison, 1965; Wood-Gush and Rowland, 1973), and have a positive effect on decreasing stress levels in social species (Dunbar, 1991; Lewis et al., 2007).

To the authorís knowledge no previous studies considered the effects of PA over both aggressive and affiliative interactions and no studies have been conducted in a layer strain of the domestic fowl. The aim of the present study was to investigate the effects of GS and PA on the development of affiliative and aggressive social interactions in young laying hens. We predicted that birds in larger GS will show lower levels of aggressive interactions. Birds presenting the less common phenotypes would be at higher risk of being involved in aggressive encounters while will show lower levels of affiliative interactions. The effect of PA is predicted to be less remarkable as the percentage of individuals altered increase, and in larger GS as the same proportion of altered birds involves more birds, therefore the phenotype may be encounter at a high enough frequency.

2. Material and methods

2.1. Experimental facilities

This study was performed at the experimental poultry facilities of Neiker-Tecnalia (Vitoria-Gasteiz, Spain). A large room (40 × 8 m) provided with two lines of automatic drinkers and feeders and a computerized system for light, ventilation and temperature control was used. The room was divided in 45 pens of 1.25 m^2, 2.5 m^2 and 5 m^2 (15 pens for each size) that housed groups of 10, 20 and 40 birds, respectively, at a constant density of 8 birds/m^2. The pens were built with PVC piping and plastic netting. An opaque plastic covered the lower part of the walls between pens to avoid visual contact across experimental groups. The pen floors were covered with 1.5 kg/$m^2$of wood shavings. The chicks had *ad libitum* access to food and water (4 cm round feeder space/bird and 1 nipple drinker/5 birds) and were fed a commercial diet accordingly to the rearing phase.

2.2. Animals and rearing conditions

A total of 1150 1-day-old female Hy-line Brown laser beak-trimmed chicks were obtained from a commercial hatchery (Avigán Terralta Tarragona, Spain). Upon arrival to the experimental facilities each bird was randomly assigned to a GS and PA treatment. We tested three experimental GS, 10, 20 and 40 birds per group, combined with five PA proportions of 0, 30, 50, 70 and 100% of the birds with altered phenotype in each pen. The different proportions of PA alterations were achieved by placing a black mark with a non-toxic dye on the back of the head in the corresponding number of birds in each pen (Dennis et al., 2008). All marks applied were as similar as possible, and chicks were remarked as needed according to feather growth. By this procedure we obtained: homogenous populations (0, 100%) with all members of the group presenting the same PA, unmarked (U) or marked (M), and heterogeneous populations (30, 50, and 70%) where the two phenotypes (M and U) coexisted in the same pen.

At 10 days of age all birds were marked with individual identification tags made of laminated white paper squares (3.5 × 3.5 cm). One of the numbers corresponded to the bird ID and the second to the pen number. Tags were affixed at the membrane of the wings with plastic filaments injected under the skin following the procedure described in Cornetto and Estevez (2001). Birds were retagged at 8 weeks of age in both sides of the neck with larger tags (5 × 5 cm) due to increased body weight and growing of feathers. Every bird in the pen (M or U) had identical wing tags, so the phenotype of all individuals was the same in regard to all birds carrying tags. In addition, previous investigations showed that pecking at the tags decreased to negligible levels after the first week as birds were habituated to them in all treatments (Dennis et al., 2008).

2.3. Observational methods

Observations were conducted on weeks 3, 5, 7, 9 and 13 of age, between 9:00 and 14:00. Pens were randomly allocated to an observation slot every week of observation, with around 9 pens being observed per day (45 pens per week). Each pen was observed continuously during 15 min. During this time all observed aggressive and affiliative interactions performed across group members were recorded as events, and the ID of the giver and the receiver of the interaction noted together with their PA. The definitions of the behaviours collected in the study were adapted from previous studies (Estevez et al., 2002; Newberry et al., 2007; Riedstra