



Short report

Looking like mother makes mallard ducklings dominant over their siblings

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ABSTRACT

Colour variation in time and space among animals may affect social relationships such as pairing and dominance interactions. For instance, some birds are naturally sensitive to leg colour, with some colours being more visible or attractive than others. The colour of the leg-rings used to mark birds may thus be related to behavioural and reproductive variables. Most studies have investigated this effect for adults during reproduction, but leg-ring colour may also affect the behaviour of young birds. We tested the potential effect of leg-ring colours on the within-brood dominance hierarchy of mallard (*Anas platyrhynchos*) ducklings while each brood formed a stable and exclusive family unit with its mother. Ducklings did not acquire a within-brood dominance rank according to the colour of their own ring. This result suggests that mallards may not have a sensory bias for a given colouration. However, ducklings wearing a ring of the same colour as one of the two rings of their mother were dominant over their siblings. We discuss the potential behavioural and methodological implications of this result.

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1. Introduction

Animals vary in colour. While some colours are condition dependent and may signal the body condition and phenotypic quality of individuals (see for examples Delhey et al., 2006; Weiss, 2006), others are genetically fixed and may signal the genetic quality of the same individuals (see Hill, 1991; and Roulin, 2004 for a review in polymorphic birds). Both these parameters may affect social relationships such as pairing and dominance interactions. For instance, snow geese (*Anser caerulescens*) and zebra finches (*Taeniopygia guttata*) pair preferentially with an individual that displays a similar colouration to their parents or siblings (Cooke et al., 1972; Cooke and McNally, 1975; Vos et al., 1993). In white-throated sparrows (*Zonotrichia albicollis*), white females dominated tan ones in the spring, with a reversal of dominance relationships being documented in the autumn (Watt et al., 1984).

Existing evidence also suggests that some birds may be naturally sensitive to leg colour, with some colours being more attractive than others (Burley et al., 1982). Several studies have suggested and demonstrated that leg-ring colour may affect behavioural and reproductive variables (Burley, 1988; Zann, 1994), including dominance relationships (Cuthill et al., 1997). Although most of these

studies dealt with the breeding behaviour of adults, mainly through mate choice and reproductive investment, leg-ring colour may also affect the behaviour of young birds (Pearson et al., 1999). Indeed, leg-ring colour seemed to affect song tutor choice in young zebra finches, with tutors ringed like the parents being more attractive to young birds (Pearson et al., 1999).

Mallard (*Anas platyrhynchos*) ducklings (typical brood size 7–14 young) and their mother form a stable family unit from hatching until the age of two months (Géroudet, 1999). These broods are organized according to a stable linear hierarchy (Poisbleau et al., 2009). However, following entire broods reared by their mother alone, our previous investigations failed to determine the individual traits explaining the within-brood hierarchy (Poisbleau et al., 2009). During this study, mallard ducklings as well as their mother were marked with coloured plastic rings for individual recognition and spent most of the time on land where leg-rings were visible. It is therefore possible that leg-ring colours influenced the behaviour of the chicks.

In the present paper, we mimicked a situation in which siblings differ in a phenotypic trait such as leg colour. We therefore test for the potential effect of leg-ring colours on within-brood hierarchical organization. If mallard ducklings were sensitive to one or several specific colours, we would expect that some colours themselves would positively or negatively affect duckling within-brood dominance ranks. However, if ducklings used the leg-ring colour of dominant relatives (here the mother) as an indication of dominance, we would hypothesize that ducklings wearing the same ring colour as their mother would be dominant over their siblings.

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2. Methods

Manipulations and observations are described in detail by Poisbleau et al. (2009). Briefly, between April and September 2002, we followed 56 mallard ducklings from hatching to the end of their growth. They came from six different broods (8, 12, 8, 9, 9 and 10 ducklings in broods 1–6, respectively, see electronic appendix) hatched between 29 April and 31 May. We recorded the hatching order within each brood. In order to simulate natural conditions, ducklings were left together with their mother, with no visual contact with other broods until 30 September. Each brood was kept in a 40 m² grass pen during the day and in a 10 m² concrete aviary at night. Mothers and ducklings were marked individually with plastic rings. For ducklings, we used a numbered green ring on the left leg and, for rapid visual recognition, a plain coloured ring on the right leg (see electronic appendix). Small rings were fitted within 24 h of hatching and replaced with larger rings of the same colour as the legs grew. Mothers wore two plain coloured rings on their right leg, but no numbered green ring (see electronic appendix). We chose 10 easily distinguished colours for the ducklings' leg-rings. These were assigned at random, except that no two chicks within a brood had the same colour. We additionally used grey and light-purple leg-rings for brood 2, which contained 12 chicks.

The determination of within-brood dominance rank for each duckling is described by Poisbleau et al. (2009). Briefly, observations were carried out between 08:00 and 10:00 during the first three months of the ducklings' lives (3 June–17 August) while the birds were in their daytime grass pen. We observed each chick for a total of 12 h during which all its aggressive encounters anywhere in the enclosure were noted. We also recorded the winner and the loser of each encounter (after Section 2 described by Poisbleau et al., 2005a,b). Interactions between birds were summarized in six sociometric matrices (one per brood) from which we obtained the most consistent within-brood hierarchy (De Vries, 1998). Each brood was organized according to a stable linear hierarchy during the period of observation (Poisbleau et al., 2009) and ducklings were ranked from 1 (most dominant) to n (most subordinate), where n is the brood size. Dominance and hatching order ranks were standardized ((individual rank – 1)/(number of ducklings in the clutch – 1), between 0 and 1) in order to make their magnitude independent of brood size. We calculated a colour matching index (CMI) which was equal to 1 if the colour of the duckling's ring matched one of its mother's (which was the case for 10 of the 56 ducklings; one or two individuals within each brood since the mothers had two colour rings) and otherwise equal to 0. Mass, size and growth rate variables (i.e. hatching body mass, hatching body size, maximum growth rate and age of maximum growth rate, see Poisbleau et al., 2009) were reduced in a Principal Components Analysis in order to analyse dominance rank independently of morphology. The first two axes (PC1 and PC2) were retained, explaining 87% of the total variance. We then performed Generalized Linear Mixed Models (GLMMs) using R 2.6.2 (R Development Core Team, 2008) with REML estimation and "brood" as a random factor on the intercept to take into account inter-brood differences. We first tested for potential effects of standardized hatching rank on the probability of being assigned the same ring colour as the mother, using a GLMM with a logit link and binomial errors. We then constructed an intercept model predicting the standardized dominance rank from the effects of sex, standardized hatching order (HO), and mass, size and growth rates (PC1 and PC2) in a GLMM with identity link and Gaussian errors. Standardized dominance rank and hatching order were arcsine transformed, i.e. $a \sin(\sqrt{Y})$, to satisfy normality. This model was considered as the null hypothesis, as it has been already shown by Poisbleau et al. (2009) that the standardized dominance rank depends on standardized HO, and mass, size

Table 1

Results of the model selection explaining standardized within-brood dominance rank. Generalized Linear Mixed Models were used with "brood" as a random intercept and compared using the Akaike Information Criterion.

| Models | d.f. | logLik | AIC | Δ AIC |
|---|------|--------|-------|--------------|
| Sex + HO + PC1 + PC2 + CMI | 8 | –16.60 | 49.21 | 0 |
| Sex + HO + PC1 + PC2 + CMI + Sex \times CMI | 9 | –16.42 | 50.85 | 1.63 |
| Sex + HO + PC1 + PC2 (null model) | 7 | –20.53 | 55.06 | 5.84 |
| Sex + HO + PC1 + PC2 + COLgrouped | 8 | –20.00 | 56.00 | 6.78 |
| Sex + HO + PC1 + PC2 + COL | 18 | –10.29 | 56.59 | 7.38 |

HO: standardized within-brood hatching order; PC1, PC2: axes 1 and 2 of a Principal Components Analysis on duckling size and growth; CMI: colour matching index; COL: colour of the chick's ring, COLgrouped: colour of the chick's ring, grouped orange/red versus others.

and growth rates (represented as PC1 and PC2). This null hypothesis model was compared using the Akaike Information Criterion with models containing an additional effect of the ring colour, of CMI, or of CMI interacting with sex (as a CMI effect could be dependent on the sex of the chick). The same model was also tested by grouping the 12 different chick ring colours for increased statistical power. As female mallards have orange legs, chick rings were categorised into orange or red versus all other colours for this additional analysis.

3. Results

No effect of hatching rank was detected on the probability that a duckling was assigned the same ring colour as its mother (General Linear Mixed Model with "brood" as a random intercept; comparison with the intercept-only model Δ AIC = 1.61, fixed effect of hatching rank $P = 0.530$).

Ducklings' within-brood dominance rank was not dependent on the colour of their own ring in itself (see Table 1). However, the ring colour matching index (CMI) explained a significant part of the variance in dominance rank (Wald test comparing models with and without CMI, $P = 0.005$, see Table 1). The model including CMI explained the observed data better than the null hypothesis model (Δ AIC = 5.84) or the model with an interaction between sex and CMI (Δ AIC = 1.63). In other words, ducklings wearing a ring of the same colour as one of the two rings of their mother were dominant over their siblings (Fig. 1).

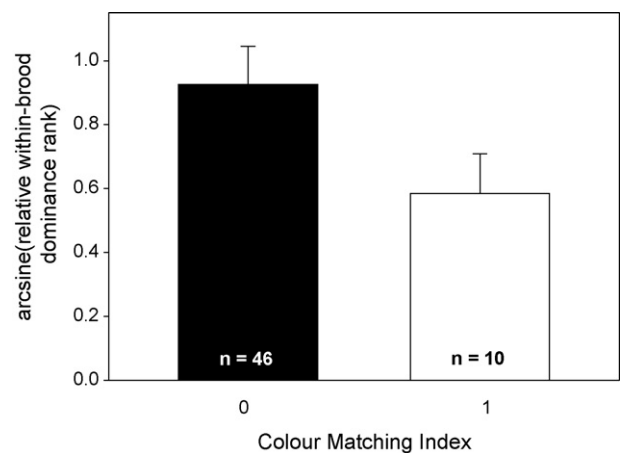


Fig. 1. Estimated effect (\pm SE) of colour matching index (CMI) on the relative dominance rank of ducklings (arcsine transformed, 0: most dominant, 1: least dominant) during the growth period, from a General Linear Mixed Model with "brood" as a random intercept. CMI refers to the colour match between a duckling's ring and its mother's rings (0: no match, 1: match). Numbers inside bars represent the sample size of each group (from six broods in total).

4. Discussion

The effect of having a ring that matched one of their mother's on the dominance rank of ducklings was significant, ducklings with the same ring colour as their mother being dominant over their siblings. To our knowledge, this is the first time this type of phenomenon has been described for a non-passerine. In domesticated zebra finches, leg-rings of certain colours affect mate selection, parental effort, reproductive success, sex ratio of offspring and survivorship; red rings were observed to be more attractive, green rings to be unattractive and other colours to have a neutral attractiveness (Burley et al., 1982; Burley, 1986, 1988; Zann, 1994). In this passerine, males with red rings are dominant over those with green rings (Cuthill et al., 1997). Because zebra finches display a preference for colours similar to those that occur naturally on the body surface of the species (i.e., red) and avoid others (i.e., green; Burley et al., 1982; Burley, 1988), these previous results could reflect selection for species identification (Burley, 1986) but also for status signalling (Zahavi, 1975; Andersson, 1986).

Because ring colour itself was not significant and no two mothers had the same two-ring colour combination, our study suggests that ducklings did not prefer a given colour. However, as interdependence between colour of the ring and dominance was evaluated using only 6 replications (broods) but 8–12 different colours, the statistical power of this test was quite low. The conclusion that ducklings did not prefer a given colour must be considered cautiously, and is a point that requires further research. Nevertheless, ducklings considered siblings with the same ring colour as their mother to be dominant. This was also observed in young male zebra finches, which often used a bird ringed with the same colour as their parents as a song tutor (Pearson et al., 1999). We never observed mothers interacting aggressively with their ducklings. We therefore assume that mothers did not actively affect dominance relationships within their brood but that the siblings used the colour of their mother's leg-rings in the establishment of their within-brood hierarchy. This suggests that ducklings use similarity in colours as a signal of individual quality, maturity and/or dominance (status badge hypothesis; Metz and Weatherhead, 1991). Since female mallards have orange legs, ducklings with orange/red rings might also have been perceived to resemble their mother, regardless of her leg-ring colours. However, the fact that particular colours (including red and orange; see [electronic appendix](#)) did not confer dominance argues against this hypothesis. Finally, our dominance observations do not allow us to distinguish whether ducklings behaved differently towards siblings who matched their mother, whether the mother-matching ducklings behaved differently themselves or whether both mechanisms occurred. Further investigations are necessary to answer these questions.

Ratcliffe and Boag (1987) concluded that any immediate advantages conferred by attractive ring colours may be masked under conditions of strong competition. In our experimental conditions, food and water were supplied ad libitum but water was spatially limited to a 2-m² bowl (see Poisbleau et al., 2009). We therefore conclude that although competition was strong enough to lead to within-brood aggressive interactions and to the establishment of a within-brood hierarchy, it was not sufficient to mask the effect of matching ring colours. Even if other factors contributed to the within-brood dominance organization, they were not strong enough in this study to avoid being masked by the ring colour effect (see Poisbleau et al., 2009). This result underlines the need to use a marking method that is neutral for the experimental design and study species, in order to avoid any unexpected interaction with the intended test parameters. This study could also stimulate

researchers studying colour polymorphic species to test whether offspring that resemble their parents the most perform better than their siblings.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.beproc.2009.08.010](https://doi.org/10.1016/j.beproc.2009.08.010).

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