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Effects of embryonic corticosterone exposure and post-hatch handling on tonic immobility and willingness to compete in chicks

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Abstract

Previous experiments indicate that artificial elevation of egg corticosterone content prior to incubation may increase fear of humans, reduce the willingness to compete with conspecifics and reduce the growth rate of chicks hatching from these eggs. It can also be hypothesized that corticosterone-treated chicks might be more sensitive to the effects of stress after hatching. Accordingly, we tested the effect of embryonic corticosterone exposure (5.5 ng/ml egg) and intermittent handling after hatching on the behaviour and growth of 88 vehicle-treated (40 males and 48 females) and 88 corticosterone-treated (40 males and 48 females) chicks. The injection treatment did not have any significant effects on tonic immobility ($P \leq 0.23$), but tended to increase the male's willingness to feed in a competitive environment ($P \leq 0.10$). However, post-hatch handling increased the duration of tonic immobility in corticosterone-treated birds but not in controls ($P \leq 0.01$), as reflected in the interaction between the injection and handling treatments ($P \leq 0.01$). Intermittent handling but not corticosterone treatment reduced the willingness of male birds to eat in a competitive situation, but neither treatment affected this behaviour in females. The present results suggest that the effect of embryonic corticosterone exposure may be dependent on the hormone dosage and the environment to which birds are exposed after hatching.

Keywords: Maternal effects; Corticosterone; Chicken; Fear; Competition

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1. Introduction

Maternally derived corticosterone, androgens and oestrogens have been found in all avian eggs analysed (Groothuis and von Engelhardt, 2005; Groothuis et al., 2005), and represent a powerful mechanism for maternal influence on the phenotype of offspring. It has been demonstrated that the concentration of maternally-derived steroid hormones in eggs may vary according to their laying order within the clutch and environmental conditions of the mother such as competition, food availability, maternal parasite load, and exposure to novel or challenging surroundings (Downing and Bryden, 2002; Groothuis and von Engelhardt, 2005; Groothuis et al., 2005). The research focus of hormonally-mediated maternal effects in wild avian species has mainly been on androgens (Schwabl, 1993, 1996; Sockman and Schwabl, 2000; Sockman et al., 2001; Daisley et al., 2005), which appear to speed up embryonic development, boost muscle growth, and the begging rate (Gil, 2003). Because corticosterone is the main glucocorticoid secreted in birds in response to stress, it is hypothesized to be a mediator of maternal effects on the development of behaviour in their progeny (Eriksen et al., 2003; Hayward and Wingfield, 2004; Rubolini et al., 2005; Janczak et al., 2006). Both broiler and laying hen breeders are regularly exposed to variation in several environmental factors that might trigger corticosterone secretion leading to increased concentration of corticosterone in eggs destined for incubation. In addition to the effects of fear induced by sporadic visual contact with humans (Jones, 1996), adult laying hens may also be exposed to handling (Eskeland and Blom, 1979; Jones, 1996), social challenges such as high bird densities, unstable social relationships, competition, aggression, and 'rape' by males (Downing and Bryden, 2002), feed restriction (de Jong et al., 2003), and a restricted environment (Duncan and Wood-Gush, 1971, 1972) all of which are potential sources of stress.

Several recent studies have tested the effect of embryonic exposure to elevated levels of corticosterone in birds (Lay and Wilson, 2002; Love et al., 2005; Rubolini et al., 2005). Although the basal concentrations of corticosterone in chicken's eggs (Eriksen et al., 2003) and blood are similar (Cheng et al., 2001), the sensitivity of egg corticosterone concentrations to environmental factors is presently unclear. As studies aiming at clarifying the relationship between environmental factors and egg steroid levels are vulnerable to confounding factors, they should be supplemented by well-controlled experiments aiming at elucidating the effects of directly manipulating egg steroid content (Gil, 2003). Studies testing for the effect of injected corticosterone can be used as a model of situations in which the mother hen has been subjected to stress during the time of egg laying, causing elevated levels of corticosterone in her eggs and associated effects on progeny.

Elevated levels of predation may cause increased secretion of corticosterone in birds (Silverin, 1998; Scheuerlein et al., 2001). For chicks hatching into an environment with high levels of predation it should be adaptive to have a high level of fear, avoid potential predators, and stay close to conspecifics (Whitfield, 2003). In addition to increasing fear and the attraction to conspecifics in a novel environment (Janczak et al., 2006; Nordgreen et al., 2006), embryonic exposure to elevated levels of corticosterone has also been shown to reduce aggressiveness, competitive ability and body weight in chicks (Lay and Wilson, 2002; Janczak et al., 2006). We therefore predicted that embryonic exposure to corticosterone would increase chick's fearfulness and reduce their ability to compete with conspecifics. In addition to the hormonal environment prior to hatching, the early post-hatching environment may also affect behavioural development (Roden and Wechsler, 1998). Unpredictable or rough handling may strengthen a chicken's perception of humans as a dangerous predator and increase the strength and intensity of fear