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Chicks from a high and low feather pecking line of laying hens differ in apomorphine sensitivity

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Abstract

Proactive rodents show a larger behavioral response to apomorphine (APO) than reactive copers, suggesting a more sensitive DA system in proactive individuals. Previously, chicks from a high feather pecking (HFP) and low feather pecking line (LFP) have been suggested to display a proactive and reactive coping strategy, respectively. Therefore, at approximately 4 weeks of age, the behavior of 48 LFP and 48 HFP chicks in response to an APO injection was studied using an open field. Another objective of the present study was to determine whether behavioral variation (in an open field) between HFP and LFP birds, after APO injection, is also reflected by variation of D_1 and D_2 receptor densities in the brain. Receptor binding capacities were assessed by measuring specific binding of tritiated D_1 and D_2 receptor ligands in different regions of the brain of control HFP and LFP chicks.

In the present study, it is shown that indeed HFP chicks display a more enhanced behavioral response to acute APO treatment (0.5 mg/kg BW) than LFP birds in an open field. This difference was not reflected by variation of D_1 and D_2 receptor densities in the brain between both lines.

Keywords: Coping strategy; Dopamine; Apomorphine; Open field; Feather pecking

1. Introduction

Feather pecking behavior in laying strains of domestic fowl is a long-standing welfare problem in the layer industry. It is characterised by rather stereotypic pecking [18] and compulsive pulling [26] at feathers of conspecifics, ultimately leading to injury and death. Despite years of research, its complex aetiology remains hard to fathom. Feather pecking is usually performed by a limited number of individuals in a flock [15]. Specific interaction between a genetic predisposition for the development of feather pecking and environmental challenges is believed to underlie this behavioral pathology [3,18].

Previously [43], we reported that birds from a high (HFP) and low feather pecking (LFP) line of laying hens displayed different physiological and neurobiological response patterns when challenged. More specifically, it was shown that in response to acute stress induced by manual restraint, HFP chicks had lower plasma corticosterone levels and lower dopamine (DA) and serotonin (5-HT) turnover levels in the forebrain than LFP chicks. The results from the study supported earlier findings [20,21] that the (physiological) characteristics of HFP and LFP birds show considerable analogy to the characteristics of, respectively, the proactive and reactive coping strategy, known to exist in other species like rodents and pigs. From this study [43] we also

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postulated that the difference in feather pecking behavior between both lines might be causally related to a difference in the functioning of the 5-HT and DA system.

Recently [41,42], we found evidence for a causal role of the 5-HT system in the development and performance of feather pecking. In the present study we investigate a possible role of the DA system in feather pecking behavior.

It has been suggested that the neurobiological characteristics of 'proactive' individuals make them more vulnerable to develop (behavioral) pathologies than 'reactive' individuals [5,8,19,37,39]. A difference in the functioning or sensitivity of the DA (receptor) system has been suggested to (partly) account for this difference in vulnerability [6]. Apomorphine (APO), a full agonist of the dopaminergic D_1 and D_2 receptors, with similar intrinsic activity as DA, is often used to predict individual differences in the sensitivity of the (receptor) DA system [23,38]. By stimulation of the postsynaptic D_1 and D_2 receptors, APO, dose-dependently, induces an increase of locomotor activity and stereotyped behavior [2], like stereotypic pecking in chickens [31,44]. Proactive copers show a larger behavioral response to injection with APO than reactive copers [1,4], suggesting a more sensitive DA (receptor) system in proactive individuals.

From the above we postulate that birds from the (proactive) HFP line have a higher sensitivity of the DA (receptor) system, and will therefore show an enhanced behavioral response to acute APO treatment compared to (reactive) LFP birds. To test this hypothesis, the behavior of LFP and HFP chicks in response to an APO injection was studied using an open field. Another objective of the present study was to determine whether behavioral variation (in an open field) between HFP and LFP birds, after APO injection, is also reflected by variation of D_1 and D_2 receptor densities in the brain. Therefore, receptor binding capacities were assessed by measuring specific binding of tritiated D_1 and D_2 receptor ligands in different regions of the brain of control HFP and LFP chicks.

2. Methods

2.1. Birds and housing

In this study 96 White Leghorn chicks were used: 48 LFP and 48 HFP chicks (for line specifications see Ref. [20]). All birds were female and non-beaktrimmed. Chicks arrived on the day of hatching and were kept in groups of 4 animals per line (12 groups per line) and housed in pens (0.75×1.0 m) with wood shavings. The pens were placed in a climate controlled room. Individual pens were visually isolated by hardboard partitions. Chicks were individually marked on the back with waterproof markers (black, purple, blue and green) before housing.

The environmental temperature was gradually lowered from 34 °C on day 1 to 22 °C at 5 weeks of age. On days 1 and 2 of age the chicks received 24 h of light. From 3 days to 5 weeks of age the light regime gradually decreased from an 18 h to a 10 h light period. All birds had access to three drinking cups and one square feeding trough placed along one of the walls of the pen. Water and commercial feed (mash) were provided ad libitum.

2.2. APO injection and open field test

Apomorphine hydrochloride (Sigma RBI, the Netherlands) was freshly dissolved in distilled water (vehicle) every day. APO was injected into the breast muscle at a dose of 0.5 mg/kg BW in a volume of 1 ml/kg BW. A pilot study showed that this dose was the most effective in eliciting a change in behavior of the chicks (data not shown). This finding is in agreement with previous studies [31,44]. The control chicks were injected (i.m.) with a volume of 1 ml distilled water/kg BW.

At either 29, 30 or 31 days of age each chick was individually tested in an open field. Two identical test rooms, with two identical open fields were used, to allow simultaneous testing of birds. During the test birds did not have visual or auditory contact with birds in adjacent rooms.

A chick was captured individually, taken to the test room and injected into the breast muscle with either APO or distilled water (control). In each pen two APO and two control chicks were randomly chosen. The open field was situated in a separate room, to ensure auditory isolation, and the ambient temperature and humidity were maintained at a similar level to that of the home environment. The open field consisted of a wooden box, measuring 1.5×1.5×1.5 m (L×W×H), with white solid walls and wood shavings on the floor.

Immediately following APO or vehicle injection, the chick was placed in the middle of the open field. The behavior of the chicks was videotaped for 30 min using an overhead camera and scored afterwards using Ethovision® 2.1 software programme (Noldus, Wageningen, The Netherlands). For the analysis of the open field behavior, the 30-min observation period was divided into 6 periods of 5 min. Furthermore, the behavior of the birds was divided into the states 'moving' and 'not moving' (i.e. 'velocity'=0.5 cm/s in Ethovision). The statistical analysis was performed only on the 'moving' state. For the 'moving' state the mean and maximum velocity (cm/s), total distance moved (cm) and the total time spent 'moving' (% of time) were calculated.

2.3. Dopamine D_1 and D_2 receptor binding

For analysis of D_1 and D_2 receptor binding in LFP and HFP chicks, only the control birds were used. At the age of 35 days the two control birds were captured from their home cage and killed by rapid decapitation. Their brains were removed immediately and dissected into 4 brain regions; telencephalic pallium, basal telencephalon, diencephalon and the mesencephalon (for details see Refs. [3,22]).