Modulating bird behaviour with olfactory management

Olfaction, the most primal sense, is highly developed in most animals. Knowledge of smell is now used in feed additives that are able to modulate behaviour (to alleviate stress consequences and to stimulate appetite for example) in modern and large-scale poultry farms.

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The olfactory bulb, which is the part of the nervous system responsible for olfactive perception, is closely related to the amygdala, which processes emotion/mood and is part of the limbic system.

The sense of smell is intricately linked to the 'emotional brain' and odours are able to influence well-being and certain behaviour.

While certain odours can have a positive effect on mood, behaviour and appetite, negative odours can represent a source of stress.

Experts state that the formation of olfactive memory is unconscious and starts even before birth. Birds were traditionally thought to have a very poor sense of smell, but since 1999 and confirmed in 2004, the chicken genome sequence revealed a number of olfactive receptor genes comparable to man (Fig. 1).

The idea behind sensory stimulation and sensory feed additives is to take advantage of the important role of olfaction and olfactive memory to stimulate appetite and generate feed loyalty in animals. Not only this, but to improve well-being and reduce the impact of stress by creating a positive sensory experience. The chicken has an olfactory epithelium in the third nasal chamber, and its histological structure looks like a mammal's.

In birds, the sense of smell has been considerably underestimated, and very little is known about the effects of early sensory experience on the regulation of general behaviour (feeding and social).

Chickens as a model

The centre of olfactive perception in the brain is relatively well conserved among species. Bird chicks have thus been used as a model to evaluate olfactive responses by animals to various compounds, according to the method described by Porter et al. (1999).

The authors showed that chicks that are induced to sleep in the hand respond to olfactory stimuli in predictable ways (head shakes, beak claps and peeping) that were not observed in awake chicks, allowing the impact of odorant compounds to be assessed.

In this simple and non-invasive methodology, one-day old chicks, deprived from water and feed since birth, held in the hand under a heat lamp, become inactive and close their eyes within two minutes. Sleeping chicks are exposed to one odorant stimuli and a negative control (soya oil). The compound is rated according to chick behaviour (Table 1).

Recent research at Phode involved screening of 600 molecules and botanicals, issued from the collection of aromatic compounds authorised in Europe as feed additives. After a first selection of individual ingredients, several associations were formulated and tested at different concentrations.

Over 10,000 chicks were involved in the study: chickens, quails and pheasants. For each series of 20 chicks, two compounds were tested against the control. The same chicks were used only once. Finally, the complex which elicited the optimal response in terms of concentration and attractivity was selected: a positive response with the lowest concentration (Fig. 2).

Once formulated, this sensory complex was tested on other poultry sub-species to evaluate its anxiolytic effects (stress depression).

Table 1. Assessment of odour perception in one-day-old sleeping chicks (Porter et al, 1999).

Score	Observation	Result
0	No reaction	Neutral
1	One or more beak claps	Positively perceived
2	Head shake, silent waking	Negatively perceived
3	Sudden waking, peeping	Very negatively perceived

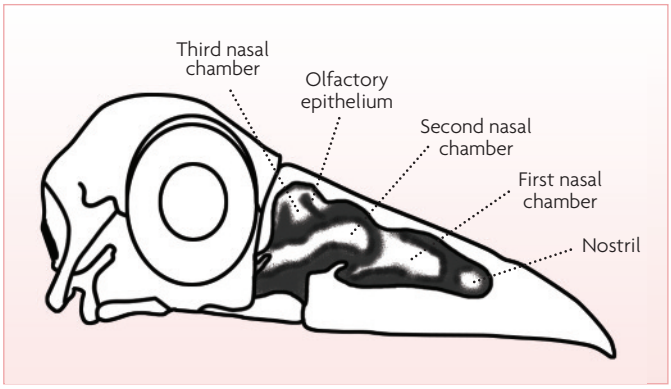

Fig. 1. Poultry olfactory structures (from Ropper, 2001).

Improved response to stress

An experiment was conducted at INRA (1999, unpublished results) to assess the effect of the functional and olfactive innovation from Phode Science on animal behaviour. This experimental model involved young Japanese quails, aged 6-8 days (n=180; 3x2x30).

Three strains of birds were used, characterised by their level of social motivation (their tendency to rejoin and stay close to peers): the high social motivated (S+), the low social motivated (S-), and neutral (ST).

For each type, two groups of 30 birds [control or with Phode Science Solution (PSS)] were individually tested for their reaction towards a group of peers using a treadmill device: the amount of time the tested subject (separated quail) spends away from a 'stimulus' group of congeners is recorded.

For the control group, each bird was tested separately without any sensorial enhancer (NO or PSS-).

In the tested group (O or PSS+), the air surrounding the bird was enriched with the Phode Science Solution (continuous release by spraying).

For the three types of quails, the PSS had a positive effect on social motivation: the quails rejoined the stimulus group earlier than in the absence of odourisation. Social motivation is negatively correlated with excitability. A decrease in excitability is synonymous with an adaptation to stress. It appears that the sensory additive developed by Phode Science (PSS) reduced the stress of the young quails when the animal is alone (Fig. 3).

Dual mode of action

Several ways of action are possible, not excluding each other, to explain the observation of stress management Firstly, olfactive perception can be associated to a specific and unique sensorial brain imprinting related to reward/motivation areas. Secondly, active ingredients can have an effect on the nervous transmission of stress.

● **Pleasure:**
Brain olfactory areas are connected to the limbic system, the brain of

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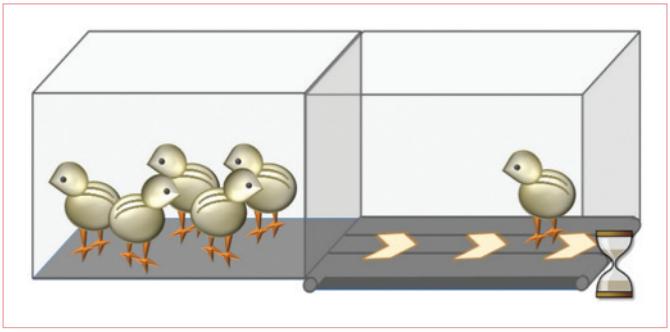

Quail anxiety measurement device (Phode and INRA private collaboration 1999). Left, quail group (stimuli). Right, a separated quail on a treadmill device.

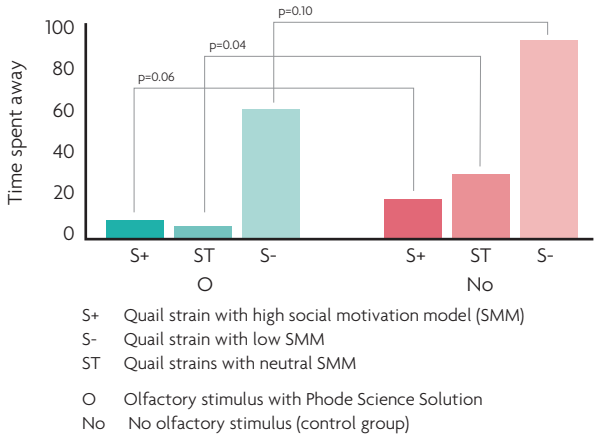

Fig. 3. Improvement of quails' social behaviour through an olfactive stress management solution developed by Phode Science.

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emotions. As a consequence, the memorisation of an odour can commonly be associated to a positive or negative state or event. Thus, specific aromatic compounds (single or complex) can also be naturally pleasant without any link with a positive condition first memorised. A pleasant odour can help adaptation to environment and then decrease stress perception.

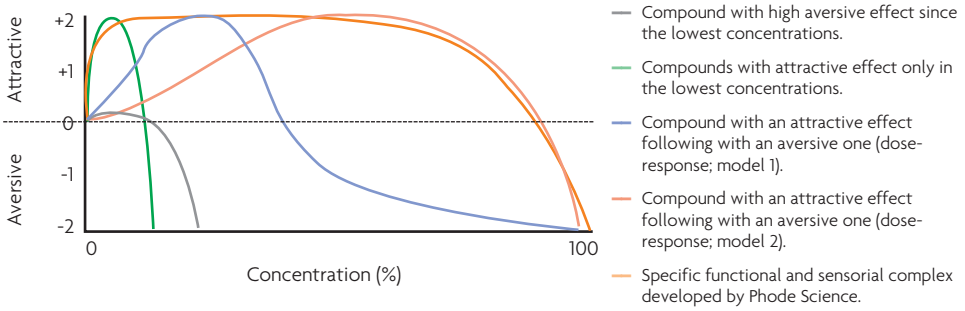
This is one of the hypotheses stated by the research team that worked on the survival rate of premature newborns suffering from apneas when the incubators were odourised with vanillin. Sensorial pleasure allows the release of dopamine, endocannabinoids and endorphins which have anti-stress properties.

● **Neurotransmission:**

The second hypothesis concerns a direct or non-direct effect on the release of neurotransmitters. Observed in the murine model, a citrus extract inhaled increases in the activity of serotonin neurons in the hippocampus and the activity of dopamine neurons in the prefrontal cortex .

The fact is that the stimulation of serotonin transmission, especially in the hippocampus, is used to treat anxiety. The increase in the activity of dopamine neurons plays a role in fear disappearance and contributes to the adaptation to an anxious situation. The endocannabinoid system is a first choice intermediary in this hypothesis: endocannabinoid CB1 receptors stimulate the release of dopamine in the prefrontal cortex and regulate the release of serotonin.

Fig. 2. Dose-response curves for various sensorial compounds (from Porter method).



Conclusion

The functional additive developed by Phode Science and based on brain-effect-selected molecules (commercially named and well-known as VeO) is one of the more efficient solutions to decrease stress in modern and large-scale farm animals. ■

References are available from the author on request