



## Disrupting motivational sequences in chicks: Are there affective consequences?



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### ABSTRACT

The 'reward cycle' conceptualises reward acquisition as a cyclic phenomenon divided into three motivational stages with related emotional or affective states. For feeding behaviour such a cycle consists of an appetitive stage characterised by foraging and exploration linked to emotions such as wanting and anticipation, a consummatory stage with eating behaviour linked to liking and pleasure, and a post-consummatory stage linked to satiety and relaxation with behaviour like resting and preening. In this study we investigated whether disturbing the feed reward cycle in laying hen chicks, by denying access to parts of a pen designed to accommodate the stages of the cycle (litter area 'appetitive'; feed area 'consummatory'; perches and dark area 'post-consummatory'), resulted in a more negative affective state. To test this, we used a spatial cognitive bias task in which a bowl in one location in the test arena was associated with a positive outcome (mealworm), and in a different location with a negative outcome (unpalatable puffed rice soaked in quinine sulphate). Three ambiguous probe locations were presented during the test. Chicks ( $n = 22$ ) discriminated between the positive and negative location as evidenced by a significant difference in times to reach these locations (mean difference variable-feed treatment  $22.1 \pm 8.8$  s; closed-litter treatment  $23.3 \pm 6.5$  s; closed-dark treatment  $24.4 \pm 4.9$  s and baseline mean difference  $22.3 \pm 6.4$  s). Chicks denied access to the litter area was significantly quicker to reach the probe near the negative location than when denied access to the feed area (mean  $8.9 \pm 1.7$  vs.  $18.6 \pm 1.7$ ) – an 'optimistic' judgement of ambiguity indicative of a less negative affective state when denied litter compared to when denied feed. Relative to the initial baseline cognitive bias tests, all treatments resulted in slower times to reach the negative location (closed-dark:  $14.9 \pm 1.9$ ; variable-feed:  $12.6 \pm 1.9$ ; closed-litter:  $13.7 \pm 1.9$ ) and shorter times to the positive location (closed-dark:  $-7.3 \pm 1.7$ ; variable-feed:  $-7.2 \pm 1.7$ ; closed-litter:  $-7.3 \pm 1.7$ ). Continuing improvement in learning of the positive versus negative location discrimination following baseline tests, or a change in perception of the incentive value of the positive and negative outcomes, may explain this finding. There was no evidence that variations in fearfulness or sociality (measured in tonic immobility and social reinstatement tests) affected the outcome of the cognitive bias tests. There seems to be different reactions to disrupting different parts of a reward cycle and further investigations into the links between affect and motivational sequences may provide a better understanding of the affective importance of different resources.

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## 1. Introduction

Conceptually, resource acquisition can be divided into three motivational stages with each motivational stage being linked to different affective states: an appetitive motivational stage linked to emotions such as wanting, excitement and anticipation; a consummatory motivational stage linked to liking and pleasure and a post-consummatory motivational state linked to satiety, satisfaction and relaxation. Behaviourally, these stages can be characterised by for instance exploration and searching; ingestion of feed particles or eating and maintenance or relaxation behaviour respectively. This model of the linkage between motivation and affect has recently been referred to as the 'reward cycle' (Burman et al., 2011; Keeling et al., 2008; Seehuus et al., 2012). In an earlier study (Seehuus et al., 2012) we designed a pen that separated behaviour, such as foraging, eating and maintenance and relaxation behaviour, linked to the three parts of a possible feed reward cycle in the laying hen chick. The pen consisted of three equally sized areas that were specifically designed to accommodate the behaviour linked to the three stages and the chicks performed these behaviour predominantly in those specific areas of the pen. This experimental set-up allows us to manipulate the behaviour of the different stages by for example blocking access to a particular area and studying related effects on affective states to substantiate further the idea of a feed reward cycle in the laying hen chick.

One implication of the reward cycle is that animals have evolved motivational and associated affective processes which result in an animal 'cycling' through appetitive, consummatory and post-consummatory phases in sequence. Commercial husbandry conditions may interfere with such sequences. For example, in commercial practice laying hens are kept in large flocks and crowding, resource placement or scarcity may make it difficult for them to perform the behaviour in the reward cycle sequence at the desired time. This may have effects for their affective state, especially if one function of affective states is to provide feedback on the integrity of motivated sequences of actions (Berridge, 2004; Cabanac, 1971).

In this study we wanted to investigate how the chicks' affective state would be influenced by being denied access to parts of a pen designed to accommodate the stages of a possible reward cycle. We chose to use a cognitive bias task to assess affective state. Humans that suffer from anxiety disorders or are depressed have a tendency to interpret ambiguous stimuli in a more negative way than people with low levels of anxiety or depression (Eysenck et al., 1991). Likewise, whether people pay attention to negative or positive aspects of the environment is associated with their current mood (Mathews and MacLeod, 2002). These findings have recently been extended to non-human animals using tests designed to assess optimistic or pessimistic decision-making when confronted with ambiguous stimuli (Paul et al., 2005). Affect-induced cognitive or judgement biases have been observed in a wide range of species (reviewed in Mendl et al., 2009). Environmental manipulations of affective state have often

been used and several studies have shown that removal of environmental enrichments or moving animals to a more barren or unpredictable environment leads to a pessimistic judgement bias in a cognitive bias test (Asher et al., 2009; Bateson and Matheson, 2007; Burman et al., 2008a; Harding et al., 2004). Environmental enrichments have been shown to induce optimistic cognitive biases in pigs (Douglas et al., 2012) and starlings (Matheson et al., 2008).

In this study we chose to use a spatial cognitive bias task, adapted from Burman et al. (2008a) to assess affective state, as this approach has also been used in recent studies with poultry (Wichman et al., 2012). Animals are trained that a bowl placed at one location in an arena is associated with a positive stimulus (e.g. palatable food) and at another location with a null or negative stimulus (e.g. unpalatable food). Subjects respond by running fast to the positive location and slower to the negative location. Once they have learnt this spatial discrimination, test trials involve bowls being placed at ambiguous locations between the positive and negative locations. The hypothesis is that animals in a more negative state are more likely to judge these ambiguous stimuli negatively (a 'pessimistic' judgement bias), and hence run more slowly to them than animals in a more positive state. This hypothesis has been supported in previous studies across species (see above). In this study, we hypothesised that disruption of the feed reward cycle by removing access to a part of the pen designed to facilitate a particular stage of the cycle, would lead to a more negative affective state; the chicks would show longer running times to ambiguous probes. The aim of our study was to compare the effects of blocking access to the different parts of the pen and in such a way investigate whether disruption of some stages of the reward cycle had a greater effect on affective state than disrupting other stages.

Even though laying hen hybrids are highly selected and thus often quite similar genetically, there is individual variation in traits such as fearfulness and sociality. The chicks were trained and tested on their own and the individual differences in fearfulness and sociality may have affected how the test situation was perceived by the individual and thus affect the test outcome. So in addition to the cognitive bias test we added two other tests that allowed us to measure individual variation in these two traits and their possible effects on cognitive bias test outcomes. Fearfulness of the chicks was tested in a tonic immobility test. This is a well validated test that is often used to measure fearfulness in chicks (Jones, 1986) and relies on variation in a catatonic-like state induced by manual restraint. Sociality was tested using a social reinstatement test modified after Pelhaire et al. (2012) using pen-mates as social stimuli. Our hypotheses were that chicks with a shorter duration of tonic immobility, i.e. less fearful chicks, would run faster to ambiguous probes in the cognitive bias test and that chicks with a shorter latency to reach the pen in the modified social reinstatement test, i.e. more social chicks, would have longer running times to the ambiguous probes in the cognitive bias test.

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