Available online at www.sciencedirect.com
ScienceDirect
ELSEVIER
Applied Animal Behaviour Science 99 (2006) 271–286
APPLIED ANIMAL BEHAVIOUR SCIENCE
www.elsevier.com/locate/applanim

Behavioural responses of broiler chickens during acute exposure to gaseous stimulation

Dorothy E.F. McKeegan [a,*], Jayne McIntyre [a], Theo G.M. Demmers [b], Christopher M. Wathes [b], R. Bryan Jones [a]

[a] *Roslin Institute (Edinburgh), Roslin, Midlothian, Scotland EH25 9PS, United Kingdom*
[b] *Silsoe Research Institute, Wrest Park, Silsoe, Bedford MK45 4HS, United Kingdom*

Accepted 10 November 2005
Available online 6 December 2005

Abstract

Controlled atmosphere (gas) stunning has potential to improve poultry welfare at slaughter but raises concerns about exposure of birds to aversive gaseous environments during the induction of unconsciousness. The aim of this study was to compare the immediate aversiveness of gas mixtures of potential use in gas stunning systems, utilising an innovative approach based on the interruption of ongoing feeding behaviour. Broiler chickens trained to feed from a dish attached to a gas delivery outlet in a custom-built apparatus were exposed to 10 s pulses of test gases whilst feeding. Test gas delivery matched a constant air flow present pre- and post-stimulation and was not associated with any other cues. Behaviour (feeding, headshaking, respiratory disruption, withdrawal and ataxia) was observed before (10 s), during (10 s) and after (20 s) gas delivery. Three identical experiments examined responses to either CO_2 in air (10, 25, 40, 55, 70%), CO_2 in nitrogen (25, 40, 55 and 40% CO_2 with 30% O_2) or argon and nitrogen (100%). Stimulation with CO_2 in air or nitrogen produced similar responses with evidence of the gas being detected at 10%. As CO_2 concentrations increased, headshaking increased monotonically while time spent feeding decreased. Respiratory disruption (apparent increased inhalation depth and duration) was exhibited at all concentrations of CO_2 tested but was not dose-dependant. Withdrawal from the food dish (assumed to indicate aversion) was observed in a small number of birds during CO_2 stimulation and was related to concentration.

* Corresponding author at: Division of Animal Production and Public Health, The Institute of Comparative Medicine, Faculty of Veterinary Medicine, University of Glasgow, Bearsden Road, Glasgow G61 1QH, United Kingdom. Tel.: +44 141 330 5712; fax: +44 141 330 5729.
E-mail address: d.mckeegan@vet.gla.ac.uk (Dorothy E.F. McKeegan).

0168-1591/$ – see front matter
doi:10.1016/j.applanim.2005.11.002

Withdrawal was transient with all birds returning to feed within 20 s of air reinstatement. The addition of 30% O_2 to the 40% CO_2 in nitrogen mix was associated with increased time spent feeding and reduced headshaking. Other than headshaking, no immediate response to delivery of the inert gases nitrogen and argon was observed, but a delayed ataxia (loss of balance, loss of posture) was exhibited by some individuals. Collectively, the results suggest mild or at most moderate immediate aversion to CO_2 as indicated by cessation of feeding and withdrawal at some concentrations. The notion that the respiratory disruption induced by CO_2 inhalation is potently aversive is not supported by our observations since this response was not associated with withdrawal or even the cessation of feeding in some cases. These results inform the welfare debate surrounding aversiveness of initial gas exposure and have implications for the levels of CO_2 to which conscious birds should be exposed during controlled atmosphere stunning.

Keywords: Gas stimulation; Carbon dioxide; Aversion; Chicken; Euthanasia; Welfare

1. Introduction

Behavioural, anatomical and physiological evidence that chickens have well developed sensory systems allowing perception of the chemical environment has been available for some time (reviewed in Jones and Roper, 1997). Only recently, however, has this knowledge been applied and extended to investigate how current husbandry practices which activate or disrupt chemosensory systems might influence poultry welfare. For example, the welfare implications of exposure to atmospheric pollutants such as ammonia have been investigated behaviourally (Kristensen et al., 2000; Kristensen and Wathes, 2000; Jones et al., 2005) and electrophysiologically (McKeegan, 2002; McKeegan et al., 2002a,b; McKeegan and Lippens, 2003).

Controlled atmosphere (or gas) stunning (CAS) is a an attractive prospect for improving the welfare of poultry at slaughter by avoiding the need for live shackling, which is a stressful and painful procedure (Gentle and Tilston, 2000). While CAS systems undoubtedly have the potential to offer welfare benefits, the extent to which conscious birds are exposed to potentially aversive gaseous environments during the induction of unconsciousness remains unclear. The use of carbon dioxide (CO_2) in gas stunning mixtures in particular raises concerns since exposure to this gas above certain levels is known to be nociceptive in humans (Kobal, 1985), eliciting painful sensations at inhaled concentrations of between 40 and 55% (Anton et al., 1992). The thresholds of hen nasal and buccal trigeminal nociceptors to CO_2 have been investigated (McKeegan, 2004; McKeegan, unpublished) and the results, though sparse, suggest thresholds of 40–50%, similar to humans. If by inhaling CO_2 above certain concentrations chickens experience pain and/or discomfort, we would expect this experience to be aversive and thus reflected in the birds' behavioural responses.

Earlier studies of the behavioural responses of poultry to CO_2 yielded conflicting data. In one study, birds were reported to spend less time in a feeding chamber when the concentration of CO_2 was raised above 5% (Raj and Gregory, 1991). However, only sub-stunning levels of CO_2 were tested (up to 7.5%) and the use of only a single group of