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Using motivation to feed as a way to assess the importance of space for broiler chickens

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This paper describes a novel combination of feeding motivation and spatial preference testing. We used the feeding motivation test to determine a 'low' barrier height that broiler chickens, *Gallus gallus domesticus*, that were not food deprived would cross to get to food, and a 'high' barrier height that food-deprived chickens would cross to get to food. These barriers were then used to assess the chickens' spatial preferences. Birds could show their spatial preference by moving between two compartments with different stocking densities (14.7 birds/m^2 in a compartment of fixed size versus 9.3, 12.1 or 14.7 birds/m^2 in a compartment of adjustable size). The compartments were separated by either the low or the high barrier. In the density preference test, the number of birds in the adjustable compartment increased with increasing size of this compartment, indicating that birds preferred lower densities, an effect that became more pronounced with age. This effect occurred even when a barrier was used that had previously deterred 20–25% of birds from crossing to get to food after 6 h of food deprivation, suggesting that achieving a lower density was important to the broiler chickens. Since this methodology does not involve training, it could be used to evaluate the importance of spatial or other preferences in a wide range of domestic and nondomestic species.

The spacing behaviour of the red junglefowl, *Gallus gallus* (the wild ancestor of domestic fowl, *G. g. domesticus*) is hard to study in their natural habitat, because these birds are extremely timid (Collias & Collias 1996). Observations of zoo populations indicate junglefowl form groups of 6–30 individuals, which range over an area of 3000–17 000 m^2 (Collias et al. 1966). Broiler chickens (bred for meat production, and characterized by rapid growth and low behavioural activity) are housed at far more restrictive space allowances when kept commercially. Although much research has been conducted on the effects of space allowance on the health and behaviour of broiler chickens (Bessei 2006; Estevez 2007), little is known about these birds' preferences regarding space allowance. Preference testing has not been conducted previously, probably because the short life span (commercial slaughter age lies around 42 days) and the rapid decrease in spontaneous activity and walking ability with age (Hall 2001; Knowles et al. 2008) impede tests that include a long training phase. Nevertheless, as laying hens show a preference and motivation for more space (e.g. Dawkins 1981b; Faure 1986; Lagadic & Faure 1987; Weeks & Nicol 2006) there is reason to assume that broilers may be motivated similarly.

Studies of the distribution of broilers within their enclosure have been suggested as 'in situ' tests of spatial preferences (Febrer et al. 2006). When animals are less clustered or further apart than expected this indicates that space allocation is inadequate to satisfy the birds' preferences (Keeling 1995; Febrer et al. 2006). However such research has led to different conclusions. Febrer et al. (2006) reported that the distribution of broilers kept at densities between 14 and 21 birds/m^2 indicated adequate space allocation. In contrast, others observed distributions indicating inadequate space allocations for densities above 7 birds/m^2 (Leone & Estevez 2008; Leone et al. 2010). Distribution studies have the advantage of investigating the birds in the system in which they are normally kept, thus giving information that is relevant for this system. However, they do not give a clear insight into the importance of space allocation. The importance of resources can be studied by motivation tests, that is, measuring the amount of work an animal is willing to perform to acquire a certain resource. The best-known example is the number of lever presses an animal performs to get a reward (Dawkins 1983). By comparing the amount of work performed for different resources, one can determine their relative

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importance. Feeding motivation is often used as a yardstick, because of its obvious importance to all animals (Matthews & Ladewig 1994; Hovland et al. 2006; Seaman et al. 2008). Broiler chickens work for food both when fed ad libitum and when fed restrictively (Bokkers & Koene 2002; Bokkers et al. 2004). In one of these experiments, broilers had to cross obstacles to get to their reward. While for other types of work (e.g. key presses) extensive training is necessary to teach the animal that performing this work will lead to a reward, crossing an obstacle to achieve a reward does not necessitate training, when animals are able to see their reward on the other side. Because little or no training is required, such a technique is especially suitable for motivation testing in short-lived animals such as broilers.

Stocking density experiments are inevitably confounded with either group size or pen size (Frommen et al. 2009; Leone et al. 2010). However, there is evidence supporting density, rather than pen size, as the main variable motivating chickens' spatial preferences when group size is kept constant. Laying hens preferred larger (less densely stocked) pens when choices between equal group sizes were offered, but showed no preference when choosing between a large and a small empty pen (Lindberg & Nicol 1996). Preferences for increased floor space, when not confounded with density, have only been described for battery cages (Dawkins 1981; Nicol 1986), and probably result from decreased opportunity to perform certain behaviours in small cages (Nicol 1987). Broiler chickens' spatial distribution is affected when density is altered by changing either group size or pen size; but when group and pen size are altered simultaneously, thus keeping density equal, these effects are much smaller (Leone & Estevez 2008; Leone et al. 2010). Furthermore, although this is only indirect support, there are well-documented decreases in health with increasing density (Bessei 2006; Estevez 2007), but no equivalent detriments to health with decreasing pen size or increasing group size, when density is kept constant.

When pen size is altered, perimeter length changes as well, unless the shape is also changed. Broilers are attracted to walls (Newberry & Hall 1990; Newberry & Shackleton 1997; Cornetto & Estevez 2001), probably because being close to a wall reduces the chance of disturbance by conspecifics (Buijs et al. 2010). Thus, it is important to keep perimeter lengths equal when comparing different densities. Doing this means that the shape of the pen has to be altered to achieve different floor space allocations, and pen shape is also reported to influence behaviour (Stricklin et al. 1979). It is thus difficult to carry out a study in which all variables confounded with density are varied systematically. A more pragmatic approach to distinguishing between pen shape and density effects in preference experiments would be to set up the treatments such that differences in pen shape are maximized in treatments that do not differ in density, and minimized in treatments that do differ in density.

In this paper, we present a novel combination of methodologies to assess spatial preferences in broilers, taking into account the potential confounding factors described previously, as well as the difficulties of working within the commercial life span of fast-growing broiler chickens. We first carried out a feeding motivation experiment, to determine the maximum barrier height that broilers were willing to cross to get to food. By performing this feed motivation test before and after feed deprivation, we determined two barrier heights. These represented the height that moderately motivated birds would cross (predeprivation trials) and the height that highly motivated birds would cross (postdeprivation trials). We subsequently used these two barrier heights in a density preference experiment, in which birds could choose between high and low densities, but had to cross the barrier to do so. By using this combination of experiments, we were able to assess the relative importance of increased space allowance, since only birds with a moderate or high motivation would act on their density preference and cross the barrier.

METHODS

Animals and Procedures

Five hundred 1-day-old Ross 308 broiler chickens (50:50 sex ratio) were obtained from a commercial hatchery (Belgabroed, Merksplas, Belgium) and transported to the test facility. Although all birds would later be divided randomly over different experimental and replacement groups, all those of the same sex were housed together during the first 2 weeks of rearing. For this purpose, we used two 15 m^2 floor pens with a layer of woodshavings 5 cm thick as litter (17 birds/m^2; Fig. 1). Lights (approximately 70 lx) were on continuously for the first 72 h, after which a 12:4:4:4 h light:dark:light:dark schedule was used. Food was produced on-site and had a 5% lower energy content than commercial feed, to achieve a slightly lower growth, thus improving walking ability. Food and water were available ad libitum throughout rearing. During the first week, food was offered in bright red feeders, which would later be used for the feeding motivation experiment. Standard feeders were added from the second week onwards. The ambient temperature was 31 °C on the day of arrival, and subsequently lowered by 1 °C daily until a temperature of 21 °C was reached 10 days later. The barriers that would later be used in the experiment were put into the pens in the first week, to avoid novelty during the experimental phase. These were grey PVC pipes 1.88 m long and 5 cm in diameter. PVC was chosen because its smooth surface impeded perching on the barriers, which could have affected our later experiments.

At the start of the third week, 416 birds were chosen randomly and allocated to the density motivation experiment. Four groups with a 50:50 sex ratio were formed and these were moved to their new home pens (Fig. 2). These four floor pens had a layer of woodshavings 5 cm thick. Water and food were available ad libitum, and stocking density was 13.4 birds/m^2 outside the hours that

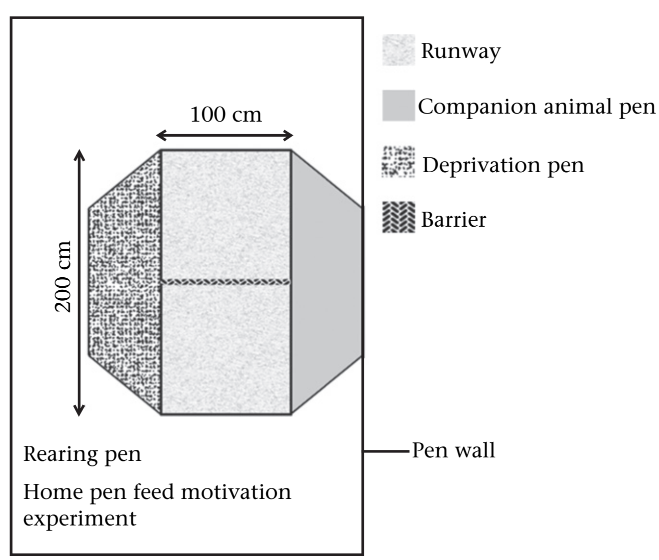

Figure 1. Rearing pen, also used as home and test pen for the broiler chickens in the feeding motivation experiment. The runway used to evaluate feeding motivation was permanently present in the home pen, from the start of week 3 on. Birds were not able to enter the runway outside their trials. The companion animal pen and the deprivation pen were removed when no trials were run.