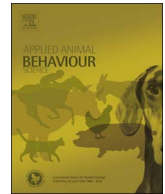




Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

Some like it varied: Individual differences in preference for feed variety in dairy heifers

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ARTICLE INFO

Keywords:

Foraging behaviour
Individual differences
Neophobia
Curiosity
Animal welfare
Preference

ABSTRACT

Motivation to explore is believed to be widespread among animals, but exploratory behaviour varies within populations. Offering variety in feed is one simple way of allowing intensively housed dairy cattle to express exploratory foraging behaviour. Individuals' exploration of different feed types, as with other new stimuli, likely reflects a balance between exploratory motivation and fear of novelty. We tested the degree to which Holstein heifers ($n = 10$) preferred variety in feed vs. a constant, high quality mixed ration, by first providing varying types of forages and then varying flavours of mixed feed. We also investigated individual differences in exploratory behaviour by measuring switching between feed bins. Individual consistency in preferences was assessed between tests, and longer-term consistency was evaluated by comparing these results with behaviour in novel object and novel feed tests before weaning. On average, the heifers preferred the constant, familiar feed (spending on average just 20% of their time at varied feed bins), but this preference varied among individuals (from 0 to 46% of time eating in the forage trial, and 0–93% in the flavour trial). Preference for varied forages correlated positively with intake of novel feed as calves ($r_s = 0.72$, $n = 9$). Preference for varied flavours showed a negative correlation with latency to approach a novel object ($r_s = -0.65$). It thus appears that preference for variety and exploratory foraging behaviour reflect consistent personality traits. These results suggest that offering novel feeds on a rotating schedule as a supplement to the regular diet may be an effective form of enrichment for at least some individuals within a herd.

1. Introduction

Animals are often motivated to explore (Berlyne 1960; Hughes 1997; Špinková and Wemelsfelder, 2011). It has been demonstrated, for example, that opportunities to explore can be used as reinforcers for learning tasks (: rhesus macaques; : rats), and that rats will sometimes choose to explore new locations over visiting known reward locations (Franks et al., 2013). Motivation to explore is presumed to be common across species because it enables gathering of information about resource availability and proximity of potential threats or mates (see e.g. Inglis et al., 1997). Although the tendency to explore varies between species and taxa, with generalist species hypothesized to be more exploratory (see Glickman and Sroges 1966; Mench 1998), some exploration when feeding is expected in all species (e.g. moving between locations to try different feed types). Not only is it useful to find higher quality food patches in the wild, but herbivores must consume more than one type of plant to meet dietary requirements (Villalba et al., 2010).

Modern dairy farms provide few opportunities to perform feed-

related exploratory behaviour; they commonly feed an unvarying diet consisting of a mixture of forage and grains to all animals of a given age or production stage, provided in a constant location. Environments with few and unvarying stimuli may be monotonous for the animals and thus potentially reduce welfare (Wood-Gush and Vestergaard, 1989; Meagher and Mason 2012). Some evidence suggests that variation in feed is preferred to such uniform diets by other ruminants (e.g. Scott and Provenza 1998). Lambs fed a uniform diet with no opportunity for choice had slower feed intakes than did those allowed to choose between feeds that varied over time, as well as higher cortisol levels and neutrophil to lymphocyte ratios, suggesting that they might have been experiencing stress (Catanese et al., 2013). Consistent with the hypothesis that cattle prefer variety, all beef heifers tested consumed more than one type of feed when they are offered a choice (Ginane et al., 2002), and calves select different dietary ingredients day to day and at different times of day (Atwood et al., 2001). Cows have approximately 20,000 taste receptors on their tongues, compared to less than 7000 for humans and 1700 for dogs (reviewed by Roura et al., 2008), suggesting they may be highly attuned to distinctions in flavour, and perhaps

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<http://dx.doi.org/10.1016/j.applanim.2017.06.006>

Received 8 March 2017; Received in revised form 2 June 2017; Accepted 6 June 2017
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prone to boredom when fed monotonous diets. The first aim of our experiment was therefore to determine whether heifers prefer varied feeds to a nutritionally balanced but unchanging feed.

Exploratory behaviour varies within as well as between species. The expression of this behaviour in response to novelty likely reflects a balance of two competing motivations (reviewed by Russell 1973): fear of novelty (neophobia) and motivation to gain information and/or stimulation (i.e. motivation to explore, sometimes called 'curiosity'; see e.g. Hughes (1997) and Litman (2005) for discussions of different theories of the motivation underlying exploration). Understanding individual differences in such traits is important because it can influence response to experimental treatments, susceptibility to stress, and perhaps health (see e.g. Carere and Eens 2005; Cavigelli 2005). However, little experimental work has been done on this topic in ruminants, and research on feed preferences has typically focused on the group rather than individuals. Our second aim was therefore to determine whether individual differences in preference for varied feed were stable across tests, and the extent to which these differences could be predicted by behaviours associated with fearfulness and curiosity.

2. Methods

2.1. Animal housing and care

This research was approved by the University of British Columbia Animal Care Committee (Protocol A15-0117). The subjects were 10 female Holsteins, housed at the University of British Columbia Dairy Education and Research Centre (Agassiz, BC, Canada). These animals were exposed to behavioural tests as calves and as weaned heifers. As calves, animals were housed individually from birth to 48 ± 3 days of age, in sawdust-bedded pens (1.2×2 m). Calves had ad libitum access to water and grain (Hi-Pro Medicated Calf Starter, Chilliwack BC, Canada). For the first 26 d of life, they were fed 8 L of milk per day by bottle, split between two feedings. The amount per feeding was then reduced over two days to a total of 4 L per day. They were then weaned at the time they were moved to a group pen (48 ± 3 d).

As weaned heifers, the animals were housed as a group in a free-stall pen that was deep-bedded with sand, containing 13 lying stalls and 13 headlocks at the feed bunk. All animals had ad libitum access to water. Their regular diet was a total mixed ration (TMR) of corn silage, local fescue and orchardgrass hay, grain, and grass silage (35%, 25%, 22%, and 19% of dry matter, respectively; the overall mixture had an average of 44% dry matter, 17.5% crude protein, 43% neutral detergent fibre, and 0.93 Mcal/kg net energy for gain).

2.2. Feeding behaviour tests

Preference for variety and expression of exploratory foraging behaviour were tested when the heifers were aged 41–49 weeks old. During the habituation phase, heifers were introduced to the new feeds to be included in the experiment. Timothy and alfalfa hays, a local tall fescue/orchardgrass hay mixture and chopped rye straw were placed in four different bins at the feed bunk simultaneously. Two heifers at a time were provided access for 20 min each for two days, with feed locations rearranged on the second day. Over the next four days, the same procedure was followed but with access to only one forage type per day. The heifers had no access to their regular TMR during these habituation trials. Heifers were paired during this stage to reduce stress associated with isolation and encourage feeding while the test conditions and feeds were novel.

In the next phase (i.e. the Forage trial), heifers could choose between a feed bin containing the regular TMR and a bin containing one of these four forage types, with the forage varying day-to-day in a pseudorandom order (each forage being presented an equal number of times once all heifers were eating). Tests were conducted following the protocol of Huzzey et al. (2013), in which heifers were allowed to

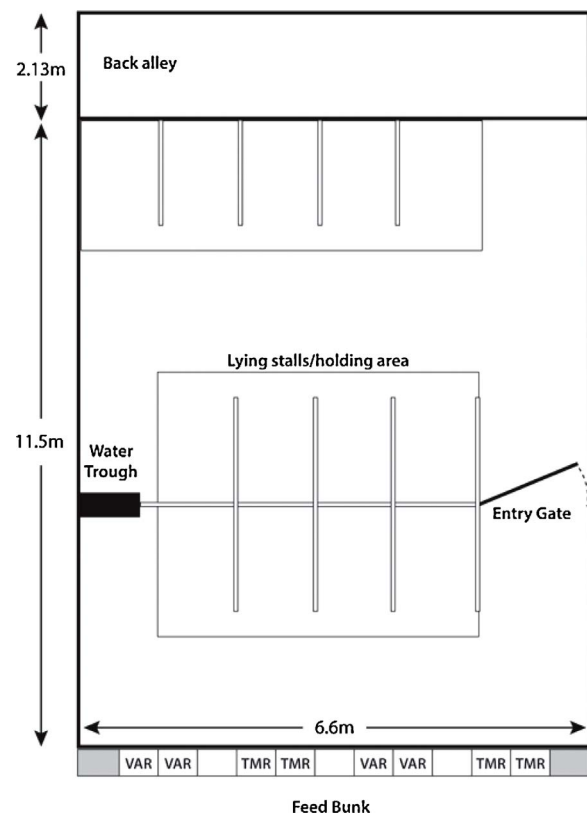


Fig. 1. Pen layout for varied forage preference trial. VAR = bins containing a forage that varied day-to-day; TMR = bins containing regular total mixed ration.

approach the feed bunk one at a time in daily tests, while the other heifers were held in another section of the pen. The heifers were allowed to enter in the order in which they chose to approach the gate. Tests were 10 min long, and began at the typical feed delivery time (approximately 7:30 a.m.) to ensure that the heifers were motivated to eat. Bins were partially covered by a lid to prevent the animals from seeing the contents before they approached, but were always in the same locations (see Fig. 1). Bins were refilled between heifers as needed to maintain equal fill. The heifer's first choice of bin (defined by the heifer putting her head in the bin and interacting with the feed) and time spent interacting with the feed at each bin were recorded within each trial. Additionally, number of switches between bins was recorded in each trial, reflecting sampling behaviour (cf. Huzzey et al., 2013; Nielsen et al., 1996), which is a form of exploration (see e.g. Eliassen et al., 2007), and latency to feed on the first day of the habituation phase was recorded as a measure of feed neophobia. These tests were continued for 14 days. The first two days of the Forage trial were excluded from analyses of feed preferences because some heifers were not yet consistently eating; the remaining 12 days of data included three presentations of each of the four forage types.

The Forage preference test provides a naturalistic treatment, but can be criticized because the different forages also varied nutritionally. Thus, in a second test (the Flavour trial), we used the standard TMR but varied flavour using non-nutritive powdered flavours (Essentials Inc., Abbotsford, BC, Canada) added to this mixed ration. Heifers were habituated to the new flavours and a new feeding location over two days in which they only had access to the flavoured TMR (three flavours on Day 1 and two on Day 2), as in the Forage trial. On the following day, all five flavours were presented simultaneously to assess preferences, with heifers tested one at a time. Preferences were again assessed based on time spent at each bin. Starting the next day, heifers were given the choice among three bins: one containing the regular (unflavoured) TMR, one that varied between four flavours (Power Punch [berry

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