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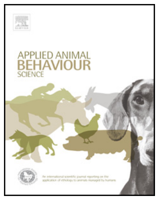

Does temperament affect learning in calves?

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A B S T R A C T

The aim of the study was to investigate how temperament affects learning ability in calves.

Nine two-month-old Holstein-Friesian bull calves were subjected to four challenge tests: novel object (NOT), novel environment (NET), social isolation (SIT), and social isolation with a novel environmental cue (SI/E). During these tests, hypothesised temperament variables were recorded. Hypothesised learning variables were recorded during training on an operant task.

Principal component analysis (PCA) was conducted on temperament variables and learning variables separately. Principal components (PCs) hypothesised to reflect underlying temperament and learning traits were extracted from these two PCAs using the Kaiser rule. Spearman's rank correlations were carried out to determine relationships between temperament and learning PC scores.

Four temperament PCs were extracted from the PCA on temperament variables, and these were proposed to reflect fearfulness, activity, exploration, and attention towards the environment. These hypothesised underlying temperamental traits were consistent with findings of previous studies using larger numbers of calves. Two learning PCs were extracted from the PCA on learning variables, and these were proposed to reflect feed motivation and working speed. A single correlation was found between temperament and learning PC scores: high activity was associated with low feed motivation. This preliminary exploratory study suggests that temperament, as assessed during challenge tests, may affect learning an operant conditioning task in calves. Understanding how temperament affects learning in calves can help with the training of calves on novel automated feeding apparatuses or on novel feed components, and can thus help improve calf health and welfare.

1. Introduction

Individuals vary in their ability to learn, and learning ability may be related to behavioural responses to novel or challenging situations. Differences between individuals in terms of their behavioural response to challenging situations have been studied not only in humans but also in various non-human animal species (e.g. Kagan et al., 1988; Fujita et al., 1994; van Reenen et al., 2004; Bolhuis et al., 2005). Applied ethologists have aggregated correlated behavioural responses into temperamental traits; namely, stable, consistent underlying phenotypes, or causal factors, mediating distinct behavioural reactions in threatening situations (Boissy, 1995; Jensen, 1995; Koolhaas et al., 2007; van Reenen et al., 2013). Research in rodents, pigs and cattle has exposed the multidimensional nature of these underlying traits, with responses typically being characterised along two main

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axes: fearfulness or emotional reactivity and activity or coping style (Courvoisier et al., 1996; Ramos et al., 1997; Andersen et al., 2000; van Reenen et al., 2004; Koolhaas et al., 2007). Fearfulness is an individual's propensity to respond to threatening circumstances (Boissy, 1995), whereas coping styles are alternative behavioural patterns in response to threatening circumstances, and include proactive (active or bold) and reactive (passive or shy) coping (Koolhaas et al., 2007). Proactive animals are thought to be less flexible in their behaviour, take less notice of environmental change and be more likely to respond to threatening circumstances with active behaviour, compared with reactive animals (Benus et al., 1987; Benus et al., 1990; Benus et al., 1991).

Understanding the relationship between temperament and learning in animals is of fundamental interest, but also has practical implications for captive animals. Intensively raised calves often have to learn how to access milk or solid feed, e.g. from an automated dispenser, and sometimes need to learn about new diet components. Poor or slow learning may have negative health consequences and negatively impact calf welfare. It is, therefore, important to understand how temperament relates to learning ability in calves. The effect of temperament on learning has mainly been studied in rodents (Benus et al., 1987; Benus et al., 1990; Fujita et al., 1994; Teskey et al., 1998), horses (Haag et al., 1980; Heird et al., 1981; Heird et al., 1986; Marinier and Alexander, 1994; LeScolan et al., 1997; Visser et al., 2003a), and pigs (Bolhuis et al., 2004; Melotti et al., 2013). These studies suggest that underlying fearfulness or coping style may affect learning (Benus et al., 1987; Benus et al., 1990; Teskey et al., 1998; Bolhuis et al., 2004).

While studying animal preferences, usually in the context of improving captive animal welfare, cross point analysis of double demand functions is a comprehensive method (Sørensen et al., 2004). This method involves presenting animals with the opportunity to work for two resources simultaneously. Double demand functions circumvent interpretation problems relating to animals working for a resource simply because there is no alternative: e.g. the resource is essential to the animal or pressing the panel is rewarding in itself (Sørensen et al., 2004; Holm and Ladewig, 2007). The assumption is that animals will work more for the more valued resource, even if the workload is higher for this resource compared to the less valued resource. However, a double demand task appears rather complex to learn and 'non-performers', i.e. animals that seem to fail to learn a task (Teskey et al., 1998; Visser et al., 2003a), with potentially specific preferences, may require additional training time (and past studies may have excluded these animals altogether). It may, therefore, be valuable to study the effect of temperament on learning ability in calves in a double demand operant setup.

This short paper presents a preliminary explorative study on how temperament in calves relates to learning ability in a double demand operant setup. Here, learning ability refers to the speed of response and progression in the training schedule as well as response precision at the end of training.

2. Materials and methods

2.1. Animals

A detailed description of husbandry can be found in Webb et al. (2014). In brief, seven-week-old Holstein-Friesian bull calves ($N = 9$; 84.6 ± 1.3 kg) were housed together in one pen (9.40 m × 2.45 m) with wooden slatted floors, two brushes (for self-grooming) and a plastic ball hanging from a chain (for object playing). The calves received milk replacer (MR) in buckets with floating teats, twice a day (07:30 and 16:30 h), and concentrate once a day (16:45 h). MR allowance per calf and per day gradually increased from 1225 g DM at 7 weeks to 1544 g DM at 15 weeks of age. Concentrate allowance per calf and day gradually increased from 300 g DM at 7 weeks to 1363 g DM at 15 weeks of age. Feeding times and methods were chosen to control feed intake before calves were tested. The first 2 weeks after arrival, calves were offered ad libitum access to roughage (one type at a time): chopped Lucerne hay mixed with 8% cane molasses and linseed oil (molashine, Gedizo Trading Int., the Netherlands), barley straw or hay. Thereafter, roughage was only offered in the home pen during weekends, i.e. when no training took place. Water was offered ad libitum via drinking nipples. Artificial lighting was provided between 07:00 and 22:00 h. Temperature and relative humidity ranges were 16.5–23.9 °C and 50.6–97.1%. Between 07:30 and 17:00 h, constant background noise was sustained via a radio.

2.2. Test pen

The test pen (2.35 m × 2.45 m) had a wooden slatted floor and 1.45 m high black opaque walls (Fig. 1). The wall adjacent to the home pen was only 1.10 m high and had a door leading to the home pen that was made of the same opaque material as the walls (Fig. 1). On the wall opposite to the door were two panels and corresponding buckets (see Webb et al. (2014) for a more detailed description of the test pen). Cylindrical feed delivery systems were positioned over the buckets. The panels and feed delivery systems were connected to a computer. When the system was active, the correct number of muzzle presses to a panel would result in the automatic delivery of a feed reward into the corresponding bucket. Successful muzzle presses were signalled by a bell sound and the delivery of a reward was signalled by an alarm sound.

2.3. Assessing temperamental traits

'Challenge' tests were done to measure temperament variables. Theses tests included a novel object test (NOT), novel environment test (NET), social isolation test (SIT), and social isolation test with a novel environmental cue (SI/E). These tests were performed in this order. The calves were randomly allocated to a group of three calves, and then randomly given a testing order within this group. The same order was maintained throughout the experiment. Throughout the experiment, a test group was gently herded into the waiting pen (Fig. 1), then the door separating the waiting pen and home pen was closed to isolate the test