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Identification and development of measures suitable as potential breeding traits regarding dairy cows' reactivity towards humans

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ABSTRACT

Behavioural indicators of the human-animal relationship (HAR) are predominantly used in animal welfare science. However, the reactivity of dairy cows – as part of the HAR – is also of interest in the context of dairy breeding, due to its estimated moderate heritability. The avoidance distance (AD) towards an unfamiliar experimenter in a standardized test is regarded an established behavioural indicator of the HAR, but for breeding purposes more feasible measures would be advantageous.

The aim of the present pilot study was to identify and develop potential measures of the cow's reactivity towards humans, which are promising as breeding traits with regard to feasibility, reliability and criterion validity.

On three German dairy farms with loose housing and herd sizes of 45–195 cows of the Holstein-Friesian and German Black Pied Cattle breed, AD at the feeding place and AD in the barn as well as four alternative HAR measures were recorded and tested for inter-observer reliability (IOR) and inter-test associations for the assessment of criterion validity. Alternative measures were (1) tolerance to standardised tactile interaction (TTI), (2) release behaviour after restraint (RB), (3) qualitative behaviour assessment (QBA) of the cow during the TTI and RB test, and (4) facial hair whorl position and form (HW). TTI, RB and QBA were additionally tested for intra-observer reliability using video recordings of 31 cows. IOR was assessed based on Spearman rank or Kendall W correlation coefficients (in case of QBA with three observers) for metric and ordinal data and based on PABAK coefficients in case of nominal data (HW). Intra-observer reliability was assessed based on Spearman rank correlation coefficients. Inter-test associations between AD at the feeding place and HW were analysed using a General Linear Model and between all other measures using Spearman rank correlation.

IOR was good to very good for all measures: AD feeding place $r_s = 0.79$ ($n = 84$, $p < 0.01$); AD barn $r_s = 0.83$ ($n = 36$, $p < 0.01$); TTI $r_s = 0.93$ ($n = 55$, $p < 0.01$); RB $r_s = 0.90$ ($n = 54$, $p < 0.01$); QBA $W = 0.95$ ($n = 32$, $N = 3$, $p < 0.01$); HW PABAK = 0.77–0.83 ($n = 58$). Intra-observer reliability of the alternative behavioural measures was also very good: TTI $r_s = 0.94$ ($n = 31$, $p < 0.01$), RB $r_s = 0.89$ ($n = 31$, $p < 0.01$); QBA $r_s = 0.93$ ($n = 31$, $p < 0.01$).

High inter-test correlations were found between AD feeding place and AD barn ($r_s = 0.77$, $n = 44$, $p < 0.01$), between TTI and RB ($r_s = 0.78$, $n = 52$, $p < 0.01$) as well as between QBA and RB ($r_s = 0.76$, $n = 18$, $p < 0.01$). Moderately correlated were QBA and TTI ($r_s = 0.68$, $n = 18$, $p < 0.01$), AD feeding place and TTI ($r_s = 0.50$, $n = 44$, $p < 0.01$), and AD feeding place and RB ($r_s = 0.45$, $n = 43$, $p < 0,01$). No significant associations were found between HW and AD.

The present results suggest that TTI, RB and QBA alongside the established AD measures are suitable reactivity measures. They partly reflect similar and partly different aspects of the HAR, with an apparent clustering into distance and handling measures.

1. Introduction

Close interactions between stockpeople and cows are a regular part of dairy farming. In this situation, the quality of the human-animal relationship (HAR) is especially important. Effects of the HAR on work safety and quality for the human as well as on the welfare and productivity of the animals were found in numerous

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Table 1
Selected measures of the reactivity towards humans.

Measure	Method	Reference
ADfeed	Distance measurement at the feeding place	e.g. Welfare Quality® (2009) and Windschnurer et al. (2008)
ADbarn	Distance measurement in the barn	e.g. Ivemeyer et al. (2011) and Waiblinger et al. (2002, 2003)
Chute test[a]	Categorical behaviour assessment on a scale from very quiet to very nervous, when the animal is handled in a squeeze chute	e.g. Curley et al. (2006), Grandin (1993) and Hoppe et al. (2010)
Flight-speed/exit behaviour test [1)]	Categorical behaviour assessment on a scale from quiet to very fast/jumping, when the animal is released from restraint	e.g. Hoppe et al. (2010) and Lanier and Grandin (2002)
QBA	Qualitative behaviour assessment in handling situations	e.g. Ellingsen et al. (2014) and Sant'Anna and da Costa (2013)
HW	Categorisation of facial hair whorl position and form	e.g. Grandin et al. (1995), Lanier et al. (2001) and Olmos and Turner (2008)

ADfeed = avoidance distance at the feeding place, ADbarn = avoidance distance in the barn, QBA = qualitative behaviour assessment, HW = hair whorl.
[a] Mainly used to assess temperament in beef cattle.

studies (reviewed by Hemsworth, 2003; Rushen and de Passillé, 2010; Waiblinger et al., 2006). Cows that are easily irritated or fearful towards humans are more difficult to handle during the milking routine (e.g. Breuer et al., 2000). Further, the quality of the HAR can influence milk ejection and milk yield (e.g. Waiblinger et al., 2002) as well as aspects of udder health (Ivemeyer et al., 2011).

Behavioural measures to assess the quality of the HAR, or more precisely the reaction of dairy cows towards humans, have predominantly been used in the context of animal welfare science, and are regarded to reflect the animals level of fear or confidence in humans (Waiblinger et al., 2006). In dairy cows, mainly distance measures are used. The avoidance distance (AD), for instance, measures the distance an animal allows a moving person to approach. AD can be analysed on individual or on farm level, and has been applied in various studies at the feeding place or in the barn (e.g. Ivemeyer et al., 2011; Waiblinger et al., 2003; Windschnurer et al., 2009). According to Waiblinger et al. (2006), AD reflects the HAR well and is suitable as a basis for on-farm assessments. Furthermore, the Welfare Quality® protocol for cattle includes the AD to assess the HAR on farm level (Welfare Quality®, 2009). However, other measures might be more easily integrated in the assessment of breeding values, might be less time-consuming to apply or easier to be trained.

Besides AD and further quantitative HAR measures (reviewed in Waiblinger et al., 2006) also qualitative approaches have been developed in recent years. Based on the qualitative behaviour assessment (QBA) developed by Wemelsfelder et al. (2000, 2001), the animals' body language has been assessed in different handling situations. These studies related to calves' responses in a handling situation (Ellingsen et al., 2014), Nellore cattle temperament after exiting the crush (Sant'Anna and da Costa, 2013), pre-slaughter behaviour in Angus steers (Stockman et al., 2012), and stress during transport (Stockman et al., 2011). To our knowledge, the QBA has not been applied explicitly in a situation of human-animal interaction in dairy cows yet.

The reactivity of cows towards humans is not only of interest in the context of animal welfare research but also for dairy cattle breeding. Estimated heritability of traits relating to the HAR in cattle, e.g. milking temperament or responses in a chute test, ranged from $h^2 = 0.07$ to 0.53 (reviewed by Adamczyk et al., 2013; Haskell et al., 2014; Schutz and Pajor, 2001). Breeding related research focuses on the animals temperament that also contributes to the HAR. Breeding associations often routinely use the trait 'milking temperament' in single quotes", i.e. a subjective evaluation by the animal owner of the cow's behaviour during milking (Adamczyk et al., 2013). Since milking temperament is genetically correlated with milking speed, measured as average milk flow per minute ($r_g = 0.247 \pm 0.075$; Sewalem et al., 2011), in some countries both traits are used in combination to select for enhanced milkability and manageability (e.g. Interbull, 2009; VIT, 2015). The evaluation of breeding values is done, as a rule, once in a cow's lifetime during the first lactation and includes production traits, exterior and functional traits (linear assessment). The linear assessment is conducted by a trained assessor, who records these traits on the individual primiparous cow on-farm. Milking temperament and milk flow are assigned to the group of functional traits. However, information on the reliability of these breeding traits and their validity regarding the HAR is insufficient (Haskell et al., 2014). Milk flow is likely stronger affected by milking management and physiological factors (Bruckmaier and Blum, 1996; Sandrucci et al., 2007) than by HAR. The farmers' evaluation of milking temperament may not be reliable enough, particularly in large herds, with changing employees or on farms using automatic milking systems.

Behavioural measures, which capture aspects of the HAR for breeding purposes, were mainly evaluated in beef cattle so far. Hoppe et al. (2010), for instance, suggested that the categorical assessment of beef calves' behaviour on a 5-point scale in the 'chute test' and the 'flight-speed test' after release from restraint are suitable to improve temperament traits. However, these or similar temperament measures have barely been tested in dairy cattle so far.

In addition, position and form of facial hair whorls were found to be related to responses of extensively managed beef cattle to the chute and flight speed test (Grandin et al., 1995). Cattle with a round hair whorl located above the eyes were significantly more agitated while restrained and handled in a chute and while exiting after release from restraint. This relationship may possibly be explained by simultaneous development of hair patterns and brain in the fetus (Smith and Gong, 1974). The findings by Grandin et al. (1995) and confirming results by Randle (1998) and Lanier et al. (2001) suggest that facial hair whorl position and form might be a potential trait in selection to improve cattle behaviour towards human handling.

Thus, the aim of the present pilot study was to identify or develop measures that are appropriate for the application as dairy cattle breeding traits, i.e. that (1) allow valid conclusions, and (2) can reliably be recorded on individual animal level by different observers (3) without requiring major training, time and other resources.

2. Animals, material and methods

2.1. Selection and adaptation of measures to be tested

Based on a literature search, measures of the cows' reactivity towards humans were selected which were applicable on-farm (e.g. no necessity of an experimental arena or complex technical equipment) on individual animal level (Table 1).

The QBA according to Wemelsfelder et al. (2009) has not been used to specifically assess the HAR in dairy cows before. The chute and flight speed tests have been applied while or after restraint of the animals in a squeeze chute, which is not feasible for on-farm assessment in dairy cattle. Therefore the chute und flight speed test

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