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How to measure dairy cows' responsiveness towards humans in breeding and welfare assessment? A comparison of selected behavioural measures and existing breeding traits

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ABSTRACT

For dairy cattle breeding as well as animal welfare science reliability and validity issues regarding measures of cows' responsiveness towards humans are relevant. The objective of this study was to investigate reliability and validity aspects of four selected behavioural measures at the feeding gate (BM) and to compare them with existing breeding traits and with observations of cows' behaviour during milking. This included the analysis of criterion validity at animal and at herd level and of repeatability of the BM over time. Data on avoidance distances (AD), tolerance to tactile interaction (TTI), release behaviour (RB), and qualitative behaviour assessment (QBA) were collected on a total of 33 dairy farms. The breeding traits average milk flow (AMF), milking speed (MS), and milking temperament (MT) had been recorded per test-day or during linear description by milk testing or breeding associations. Inter- and intra-test associations were investigated by Spearman rank or Pearson correlation analysis. At animal level, significant correlations of different strengths were found within BM ranging from $r_s = 0.28$ ($p < 0.01$, $n = 1890$) between AD and TTI to $r_s = 0.74$ ($p < 0.01$, $n = 582$) between RB and QBA, and between MS and MT ($r_s = 0.62$, $p < 0.01$, $n = 269$). No significant correlations were found between BM and breeding traits. For analyses at herd level, medians and percentages of certain categories were calculated and the average number of stepping (STEP) and kicking (KICK) per cow during milking was recorded. Between all BM closer correlations were found than at animal level. STEP correlated with KICK ($r_s = 0.80$, $p < 0.01$, $n = 24$), while no further significant correlations were found between BM, STEP or KICK and breeding traits. For analysis of repeatability BM were applied repeatedly on three farms following a three-week interval. Correlations ranged from $r_s = 0.33$ ($p < 0.01$, $n = 67$) for TTI to $r_s = 0.73$ ($p < 0.01$, $n = 23$) for QBA. Apparently, behavioural measures at the feeding gate reflect partly similar and partly different aspects of cows' responsiveness towards humans. The present study underlines methodological problems that exist with MT and MS, and questions the relationship between milkability, milking behaviour and responsiveness in the barn. The analyses show that AD, TTI, and RB appear to be vulnerable to short- or mid-term influences. Overall, QBA turned out to be a promising measure for breeding and welfare assessment.

1. Introduction

The level of fearfulness of dairy cows towards humans has an impact on their welfare including health as well as on dairy production (reviewed by Hemsworth, 2003; Rushen and de Passillé, 2010; Waiblinger et al., 2006). Moreover, fearful or highly responsive cows may reduce work safety and quality for the stockperson, e.g. during milking routine (Breuer et al., 2000) or when moving the cows to claw trimming (Lindahl et al., 2016). The level of fearfulness is determined by experiences the animal has made, in interaction with their individual genetic disposition. The animals' responses towards humans are indicators of the human-animal relationship (HAR), receiving increasing attention in animal welfare science for several years. Also in dairy cattle breeding, functional traits reflecting the animals' responsiveness towards humans are gaining interest. In behavioural traits, such as milking temperament (MT), estimated heritabilities are ranging from

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h^2 = 0.07 to h^2 = 0.47 (reviewed by Haskell et al., 2014), making them amenable for breeding selection.

To assess responsiveness, fear and confidence towards humans, a broad spectrum of behavioural measures has been developed and applied in various animal welfare studies (reviewed by Forkman et al., 2007; Waiblinger et al., 2006). A widely used HAR-measure in dairy cows is the avoidance distance (AD) towards an unfamiliar person approaching the cow at the feeding place or inside the barn. Aspects of its reliability and criterion validity at individual animals and at herd level have repeatedly been investigated (e.g. Ebinghaus et al., 2016; Rousing and Waiblinger, 2004; Windschnurer et al., 2008). In addition, stepping and kicking behaviour during milking is suggested to indicate the quality of HAR at herd level (e.g. Dodzi and Muchenje, 2011; Rousing et al., 2004). In research focussing on the genetics of animalś behaviour towards humans, different handling tests are routinely used in order to assess the animals' temperament. They are applied during confinement in a chute as well as after release from restraint. While the animal is restrained in a head gate, the behavioural reaction is assessed on a scale from quiet to extremely excited (chute score/crush score). Various studies have combined this test with the assessment of exit behaviour – either on a multistage scale or by measuring the exit speed. These tests have been developed and applied to assess beef cattle (e.g. Burrow et al., 1988; Burrow and Dillon, 1997; Cafe et al., 2011; Grandin, 1993; Hoppe et al., 2010; Lanier and Grandin, 2002) predominantly, but have also been conducted to assess dairy cows more recently (e.g. Dodzi and Muchenje, 2011; Sutherland and Huddart, 2012; Sutherland et al., 2012). Aspects of reliability and criterion validity have likewise been investigated in beef cattle (e.g. Curley et al., 2006; Grignard et al., 2001) and in dairy cows (Gibbons et al., 2011).

In recent years, qualitative behaviour assessment (QBA) developed by Wemelsfelder et al. (2000, 2001) has been adopted to assess the animals' behavioural reactions and body language in various handling situations (dairy cows: Ebinghaus et al., 2016; calves: Ellingsen et al., 2014; beef cattle: Sant'Anna and da Costa, 2013; Stockman et al., 2011, 2012).

To genetically improve dairy cows' manageability, breeding associations routinely record the milking temperament (MT), which is related to the cows' behaviour during milking routine. This is subjectively assessed by the animal owner using a multistage scale from very nervous to very quiet (Adamczyk et al., 2013). Along with MT, breeding associations in Germany and other countries also record the cows' milkability by means of subjective classification of milking speed (MS). Alternatively, milking speed is measured as average milk flow per minute (AMF) (e.g. Interbull, 2009; VIT, 2016), showing a moderate genetic background (Santos et al., 2015). AMF is recorded monthly via Lactocorder, or MS classified by the animal owner within linear assessment of exterior traits once during the first lactation. Which traits are recorded on-farm, differs regionally in Germany. If recorded in combination, AMF and MS are summarised with a weighting of 50 : 50 (VIT, 2016). Milkability traits and MT are not included in the total merit index within dairy cattle breeding programmes as yet, but reported as relative breeding values (VIT, 2016).

However, information on reliability and validity aspects of these breeding traits is insufficient (reviewed by Adamczyk et al., 2013; Haskell et al., 2014). On a phenotypic level, AMF is influenced by anatomical and physiological factors and by milking management, such as pre-milking operations (e.g. Bruckmaier and Blum, 1996; Sandrucci et al., 2007). To lesser degrees it is also influenced by the cows' responsiveness towards humans. Furthermore, MT and MS scores based on animal owner interviews may not be sufficiently reliable, particularly on farms with larger herd sizes and with specialised work organisation (VIT, 2016). Thus, there is an urgent need for more reliability and validity information and for improved breeding traits referring to dairy cows' behaviour towards humans (Adamczyk et al., 2013). At the same time, also studies investigating the HAR in the context of animal welfare science have to deal with partly low levels of reliability of current measures and uncertainties regarding their validity (de Passillé and Rushen, 2005).

In a preceding pilot study, four selected or modified behavioural measures of dairy cows' responsiveness towards humans at the feeding gate (BM) have been identified as practically applicable within a linear assessment for breeding evaluation on three different farms, and as sufficiently repeatable in terms of inter- and intra-observer reliability (Ebinghaus et al., 2016). These measures were the avoidance distance (AD), the tolerance to tactile interaction (TTI), the behaviour during and after release from restraint (RB), and the general cow's responsiveness during a simulated linear assessment expressed as a QBA-score.

In order to recommend HAR-measures for breeding and welfare assessment, the objective of the present study was to extend reliability and validity testing of these four BM under varying on-farm conditions and to compare them with the existing breeding traits AMF, MS and MT as well as observations of the cows' behaviour during milking. This included the analysis of criterion validity of all measures at individual animal and at herd level, as well as of repeatability of the BM over time.

2. Farms, animals, material and methods

2.1. Farms and animals

Data were collected in Middle and Northern Germany during the winter period 2014/2015 and 2015/2016 on 33 dairy farms (25 organic and eight conventional farms) equipped with loose housing. A total of 24 farms provided summer pasture for all cows, five farms for dry cows only, and four farms were managed with zero grazing. Nine farms used automatic milking systems (AMS), the others milked in fishbone or tandem milking parlours. While 11 organic farms kept horned cows, the other 14 organic and eight conventional farms kept dehorned or genetically hornless cows. All herds consisted of > 50 % Holstein Friesian cows. Herd sizes ranged from 29 to 530 cows (mean = 102, sd ± 105, median = 81).

Since the cows had to be fixed in the feeding gate for the application of the behavioural measures TTI, and RB, all farms were at least partly equipped with self-locking feeding gates.

Behavioural assessments were conducted once on each farm at one or a maximum of two consecutive days, depending on the herd size. To test intra-test consistency, application of behavioural measures was repeated on three farms after a period of about three weeks (21, 24, and 25 days, respectively).

2.2. Behavioural measures at individual animal level

The following measures were applied at individual animal level: 1) avoidance distances towards an unfamiliar person at the feeding place (AD), 2) tolerance to tactile interaction (TTI), 3) behaviour during release from restraint in the feeding gate (RB), and 4) cows' behaviour and body language in a simulated linear assessment by means of Qualitative Behaviour Assessment (QBA).

Lactating cows of all parities (26.5% primiparous), and dry cows only when kept in the same group with lactating cows were tested by using the measures AD, TTI, and RB. Pregnant heifers were not tested. Since QBA requires a high level of concentration from the observer, this method was carried out on a sample of 12–30 cows with an equal distribution of different parities per farm.

Data collection was conducted by seven trained observers altogether (six female, one male; all wearing green overalls and gumboots, differently experienced in working with cows and in behavioural observation). Inter-observer reliabilities for all observers were tested prior to data collection and acceptable agreements (r_s = 0.71–0.94) were reached. For analysis of intra-test consistency, recordings of TTI, RB, and QBA were done by the same observer, whereas for organisational reasons AD was applied by different trained observers at first and repeated measurement.