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Short communication: Genetic variation in choice consistency for cows accessing automatic milking units

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ABSTRACT

Dairy cows milked in automatic milking systems (AMS) with more than 1 milking box may, as individuals, have a preference for specific milking boxes if allowed free choice. Estimates of quantitative genetic variation in behavioral traits of farmed animals have previously been reported, with estimates of heritability ranging widely. However, for the consistency of choice in dairy cows, almost no published estimates of heritability exist. The hypothesis for this study was that choice consistency is partly under additive genetic control and partly controlled by permanent environmental (animal) effects. The aims of this study were to obtain estimates of genetic and phenotypic parameters for choice consistency in dairy cows milked in AMS herds. Data were obtained from 5 commercial Danish herds (I–V) with 2 AMS milking boxes (A, B). Milking data were only from milkings where both the present and the previous milkings were coded as completed. This filter was used to fulfill a criterion of free-choice situation (713,772 milkings, 1,231 cows). The lactation was divided into 20 segments covering 15 d each, from 5 to 305 d in milk. Choice consistency scores were obtained as the fraction of milkings without change of box [i.e., 1.0 – μ(box change)] for each segment. Data were analyzed for one part of lactation at a time using a linear mixed model for first-parity cows alone and for all parities jointly. Choice consistency was found to be only weakly heritable (heritability = 0.02 to 0.14) in first as well as in later parities, and having intermediate repeatability (repeatability coefficients = 0.27 to 0.56). Heritability was especially low at early and late lactation states. These results indicate that consistency, which is itself an indication of repeated similar choices, is also repeatable as a trait observed over longer time periods. However, the genetic background seems to play a smaller role compared with that of the permanent animal effects, indicating that consistency could also be a learned behavior. We concluded that consistency in choices are quantifiable, but only under weak genetic control.

Key words: choice consistency, automatic milking system milking, heritability

Short Communication

Dairy cows milked in automatic milking systems (**AMS**) with more than 1 milking box may, as individuals, have a preference for specific milking boxes if allowed free choice. Previously, it has been reported that cows have consistent preferences for right or left sides of milking parlors (Paranhos da Costa and Broom, 2001; Grasso et al., 2007), and that parlor side preferences persist over several months (Hopster et al., 1998). Hopster et al. (1998) also found that cows with strong side preferences show various stress responses, such as reduced yield, when milked in the nonpreferred side of the parlor. Similarly, in herds using AMS, for individual cows with strong milking box preferences the milking process could be affected if milked in the nonpreferred milking box. However, reports on milking box preferences and consistency in time are scarce, and because AMS use is becoming increasingly common this deserves further study.

The choice between 2 available milking boxes represents a choice situation where, ideally, the 2 alternatives are equally attractive to the cow. Several external factors may affect the choice in the given situation, such as previous experience and training as well as construction detail differences that are not obvious to humans. Individual animals may vary between the 2 extremes of complete consistency and changing boxes at every milking, thereby adopting a favorite box or flexible box choice patterns. Similar choice categories and intermediates were described by Hopster et al. (1998) with a continuous range of values assigned as consistency scores. By assuming that consistency is an attribute of

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Table 1. Overview of data for first parity and multiparous cows, overall and within 4 stages of lactation (DIM section; means ± SD)

Item	Cows, no.	Records, no.	Choice consistency, score	Milk yield, kg/d	Box time, min/d	Milking frequency, no./24 h
Primiparous						
5–50 DIM	493	1,384	0.67 ± 0.15	29.3 ± 5.1	20.3 ± 5.6	2.76 ± 0.57
51–110 DIM	470	1,694	0.64 ± 0.15	32.2 ± 4.6	21.4 ± 5.2	2.76 ± 0.57
111–215 DIM	530	2,970	0.62 ± 0.16	30.3 ± 4.6	18.2 ± 4.6	2.70 ± 0.55
216–305 DIM	470	2,307	0.60 ± 0.15	28.0 ± 4.6	16.2 ± 3.7	2.53 ± 0.48
All	730	8,355	0.63 ± 0.16	29.9 ± 4.9	18.6 ± 5.1	2.73 ± 0.57
Multiparous						
5–50 DIM	873	2,449	0.66 ± 0.16	34.1 ± 8.0	21.0 ± 5.8	2.93 ± 0.65
51–110 DIM	883	3,225	0.63 ± 0.16	36.5 ± 7.0	21.6 ± 5.5	3.02 ± 0.64
111–215 DIM	990	5,756	0.61 ± 0.16	33.3 ± 6.1	18.9 ± 4.9	2.75 ± 0.57
216–305 DIM	854	4,247	0.61 ± 0.16	29.4 ± 5.6	16.8 ± 4.1	2.53 ± 0.50
All	1,231	15,677	0.62 ± 0.16	33.0 ± 7.0	19.2 ± 5.3	2.76 ± 0.61

the animal, and that individuals differ in this aspect, consistency may be partly under genetic control and partly controlled by permanent environmental (animal) effects, including learned behavior (e.g., Rioja-Lang et al., 2012). Estimates of quantitative genetic variation in behavioral traits of farmed animals have previously been reported with estimates of heritability ranging widely (e.g., aggression and maternal behavior in sows, Løvendahl et al., 2005; time budgets in dairy cows, Løvendahl and Munksgaard, 2016). However, for choice consistency, we found no published estimates of heritability for dairy cows.

Individual and genetic variation has been shown for several traits related to the milking process, such as yield per milking and per day, milking frequency, flow rates, and time used in the milking box (e.g., Løvendahl and Chagunda, 2011; Løvendahl et al., 2012). These traits are correlated at the genetic and phenotypic level, but their relationship with choice consistency has so far only been briefly reported (Hopster et al., 1998; Paranhos da Costa and Broom, 2001), and not for AMS choice situations. Our hypothesis was that choice consistency is partly under additive genetic control and partly controlled by permanent environmental (animal) effects, and that consistency at all levels is correlated with a range of other milking traits. The aims of our study were to estimate genetic and phenotypic parameters for choice consistency in dairy cows milked in AMS herds and for correlated milking traits of the same cows. To do so, a cohort study was undertaken using detailed milking data obtained from 5 Danish herds, each keeping cows in a single group with free access to 2 milking boxes.

Data were obtained from 5 commercial Danish herds (I–V) with 2 AMS milking boxes (A, B; DeLaval VMS, DeLaval, Tumba, Sweden) and keeping Holstein cows of mixed parities in single groups. There was no general training scheme for cows before their first calving. The cows were trained to AMS when newly calved in first parity during 2 daily sessions over a few days where they were fetched and guided into any available box, thus usually being introduced to both boxes. There were 730 cows in first parity, and 1,231 cows when considering parities 1 to 4 (Table 1). The data were retrieved over a period of 1 yr in herd I and 2 yr in herds II to V. Data were downloaded from the herd-management software (Delpro, DeLaval) and only records coded as milkings were used. The data contained information about box identification, animal identification, date and time for each milking, and total milk yield. The number of milkings per day per milking box varied between herds from a mean of 86 to 132 with a standard deviation of 11 to 21. Within herd the 2 boxes were visited equally and the number of daily milkings varied little with season. Parity number and stage of lactation, as DIM, was obtained as supplementary information by linking to the national cattle database, which was also used for tracing ancestries for genetic analysis, giving a total of 16,089 animals in the pedigree (Nordic Cattle Genetic Evaluation, SEGES, Skejby, Denmark).

Variables were derived from each milking after filtering on a completion code from the management software splitting milkings into complete and incomplete groups. Following an incomplete milking, the cow will have immediate access to be milked again; thus, overriding system settings for minimum required milking intervals. Consequently, the subsequent milking of the same cow after an incomplete milking was assigned to a category of disturbed milkings, using the approach of Løvendahl and Chagunda (2011). Only data from undisturbed milkings were then used for the statistical analysis to fulfill a criterion of free-choice situation.

At each milking the milking interval in hours was calculated and also expressed as milking frequency per 24 h (MF). Milk yield was measured per milking (MY). Milk yield per day (MY24) was then calculated using a curve-linear extrapolation formula (Løvendahl and Chagunda, 2011):