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Investigating cow–calf contact in cow-driven systems: behaviour of the dairy cow and calf

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Abstract

Research is needed on how technology can facilitate cow–calf contact (CCC). This research communication describes the behaviour of dairy cow–calf pairs in two cow-driven CCC-systems differing in cows' access to the calves through computer-controlled access gates (smart gates, SG). Specifically, cow traffic through SG when visiting their calves, allogrooming, suckling and cross-suckling, cows' eating and resting behaviour and finally vocal response to separation were assessed. After 3 d in an individual calving pen, pairs ($n = 8$) were moved to the CCC compartment with a cow area, a calf creep and a meeting area. During the next 31 d calves could suckle the cows whenever they visited the meeting area (suckling phase). Cows had free (group 1, $n = 4$ pairs) or restricted access to the calves based on previous activity in the automatic milking system (group 2, $n = 4$ pairs). SG's controlled cow traffic between the meeting area and the cow area, in which the cows could access resources such as feed, cubicles, and the automatic milking system. Following the suckling phase cow access into the meeting area was gradually decreased over 9 d (separation phase). During the suckling phase, cows paid frequent and short visits to their calves. Pairs spent in total approximately one h/d suckling and allogrooming. However, the duration and frequencies of these events varied among pairs and groups, as did the vocal response to separation. Restricted access – cows performed more (unrewarded) attempts to visit the calves who cross-suckled more. Collectively, free access to the calves may have been more intuitive and welfare friendly. Although a low sample size limits interpretation beyond description and enabling hypothesis formulation for future research, the results indicate that the cow is motivated to visit her calf, albeit through a SG, thus facilitating particular behaviours for which cow-calf pairs are highly motivated.

In recent years dairy farmers, the dairy industry and the public have shown increasing interest in management systems that allow cow–calf contact (CCC, Sirovnik *et al.*, 2020). New rearing systems allowing CCC have the potential to improve animal health and welfare, although further investigation is needed on long-term effects on health, fertility and production (e.g. Beaver *et al.*, 2019). Technology can be used to facilitate CCC. We performed a study investigating a novel cow-driven CCC system using computer controlled access gates (smart gates) to allow the cow to visit her calf. It is not known how cows will use a smart gate to access their calves, but previous studies have shown that the cow will push up to 90 kg to access her calf (Wenker *et al.*, 2020). Compromises may be necessary in a production system and, therefore, both free and restricted cow access to the calves may be relevant. Nevertheless, new CCC systems should accommodate particular behaviours that cattle are motivated to perform, such as allogrooming and suckling. Cow–calf pairs housed in a free-suckling system spend between 10 and 60 min per 24 h on each of the behaviours suckling and allogrooming the calf (Lidfors, 1996; Paranhos da Costa *et al.*, 2006) and it is evident that maternal contact influences the emotional development of the calf (Santo *et al.*, 2020) and, in the short term only, their response to human contact (Waiblinger *et al.*, 2020). Further, cows and calves respond vocally to separation, and high-pitched vocalizations can be used as an indicator of stress at separation (Johnsen *et al.*, 2015). Behavioural responses to separation should be mitigated in new CCC-systems.

The overall aim of the current study was to describe behaviour of dairy cows and their calves in two cow-driven CCC-systems differing in cows' access to the calves. Specifically, cow movement through smart gates leading to the calves, the allogrooming, cross-suckling and suckling behaviour within the pairs, the cow's resting behaviour and finally, vocal response

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to separation were studied. Cow and calf performance is described in a companion paper (Johnsen *et al*., 2021).

Material and methods

Animals

In a parallel-group designed study four cow−calf pairs (cow parity 1–7) in each of two groups were included immediately after calving (details are provided in the online Supplementary File). All cows in the herd calving on relevant dates were eligible for inclusion. Exclusion criteria were calving difficulties, calving outside of calving pen, failure of colostrum intake or the establishment of suckling, aggression towards her calf or personnel, ignorance of own calf or signs of health problems. The cow−calf pairs were followed from birth until separation (online Supplementary Fig. S1).

The bonding phase

At signs of imminent calving, cows were moved to an individual straw-bedded calving pen (2.9 × 3.2 m). As soon as possible after parturition, the calf was offered colostrum to satiety with a teat bottle. If needed, the calf was assisted to suckle the dam until it was observed to suckle independently. The pairs were moved to the separate and specially designed CCC-compartment in the loose housing barn after a minimum of 3 d.

The suckling phase

The next 31 ± 4.1 d comprised the suckling phase. The four calves in a group (age difference 0–10 d) were housed in a calf creep (15 m^2) including a lying area. Calves also had access to a meeting area (28 m^2) which was the only area in which cows and calves could be together. In the calf creep, calves had access to *ad libitum* supplemental whole milk and concentrate from automatic feeders (CF500S, DeLaval International AB, Tumba, Sweden), hay and water.

Cows were allowed access to the meeting area (online Supplementary Fig. S2) and calves could suckle the cows once they were present in the meeting area. The cows` access to and from the meeting area was controlled by two smart gates, one for in and one for outgoing cows. The gates were 'entry gate milking parlour art. nr 184002784 (DeLaval)', modified as a smart gate which read the RFID tag of the cow. The cows' access to the meeting area differed between groups: while cows had free access during 24 h/d in group 1, in the second group, cows' access to the calves depended on their activity in the AMS. After a successful milking, cows had free access to the calves until the next milking permission was given (5.5 h), then access to the calves was denied. To access the cow-area with feed and saw-dust bedded cubicles with rubber mats, cows needed to exit the meeting area. Here, they had *ad libitum* access to grass silage from the feeding alley, access to concentrate and an automatic milking system (**AMS**, DeLaval VMS). If cows laid down in the meeting area, they were led out through the exit gate by a caretaker. Cows were prevented from accessing the calf creep due to a wall, but through two openings, cows could both see and nose-touch their calves in the creep.

The separation phase

The separation phase started at the same day for all calves in a group, thus calf age at separation varied. Cows' access to the calves was gradually decreased after 31 ± 4.1 d by limiting their access through the smart gates over 6 d to certain time periods (06 : 00–21 : 00 (2 d), 06 : 00–10 : 00 and 17 : 00–21 : 00 (2 d), 06 : 00–10 : 00 (2 d)) and finally 0-access (3 d). Physical contact between cow and calf was possible along the fence separating cows from calves.

Collection of data

Smart gate passages

For each cow and day, the following smart gate data were obtained (Delpro, DeLaval): number of successful passages and attempts to pass, time of entry and duration of every visit in the meeting area.

Suckling and allogrooming

The meeting area and the calf creep were video monitored (2MP Network Mini PTZ Dome Camera, HIK Vision, No.555, Qianmo Road, Binjang District, Hangzhou District, China) 24 h/d throughout the suckling and separation phases (online Supplementary Fig. S3). To describe suckling and allogrooming behaviours of each cow-calf pair, video material was extracted for each focal pair when the calf was 14 and 15 d old. During each of these days, the pairs' behaviour was encoded during 06.00–21.00 h using the software Behavioral Observation Research Interactive Software (BORIS©, Life Sciences and Systems Biology, *Via* dell'Accademia Albertina, 13 I-10123 Torino, Italy).

Cow eating and resting behaviour

Cows were equipped with Nedap accelerometer and neck collar activity sensors (Nedap Livestock Management, Groenlo, the Netherlands) which registered rumination time (%), eating and lying time (h).

Vocal response to separation

An observer performed live and direct observations of cow and calf vocal behaviour (online Supplementary Table S1) during the last 2 d of the suckling phase (i.e. baseline behaviour) and the first 2 d when the cows were prevented any access from 06.00 to 10.00 h.

Statistical methods

Data handling was performed in Excel (version 2016, Microsoft). Descriptive statistics were calculated for smart gate passages and behaviours using the 'summarize' syntax in Stata (Stata SE/14, Stata Corp., College Station, TX, USA). Data are presented per phase and across groups, but some parameters will be shown separately for each group. To show the daily timing of the passages during the suckling phase, we calculated the percentage of passages during the time frames 06.00–09.59 h, 10.00–13.59 h, 14.00–17.59 h, 18.00–21.59 h, 22.00–01.59 h and 02.00–05.59 h. Behavioural data (i.e. durations and frequencies) is presented as means and standard deviations per d. Vocal behaviours were not normally distributed and therefore presented as median and interquartile ranges per hour.

Results and discussion

One cow−calf pair was excluded from the study due to failure of established suckling, however a new cow−calf pair was included immediately so the final sample size was 8 cow−calf pairs. The

Table 1. Cow traffic and cow eating and resting behaviour

Groups	Group 1		Group 2	
Phases	Suckling	Separation	Suckling	Separation
Passages (frequency/d)	7.7 (1.24)	5.6 (1.77)	4.6 (1.33)	3.0 (0.98)
Attempts to pass (frequency/d)	–	20.6 (4.8)	33.3 (5.5)	19.1 (1.7)
Duration (mm:ss/d) of visit in the meeting area	20 : 06 (04 : 41)	–	28 : 12 (15 : 29)	–
Rumination (%/d)	36.2 (3.73)	31.6 (4.3)	35.1 (4.71)	32.3 (5.19)
Eating time (h/d)	5.9 (1.54)	4.6 (1.84)	6.7 (1.48)	5.8 (1.17)
Lying time (h/d)	9.8 (1.81)	10.7 (2.01)	11.4 (1.37)	11.9 (2.01)

Cow traffic is shown as successful passages (i.e. the cow had access into the meeting area and entered the meeting area), attempts to pass (i.e. the cow was not allowed entry into the meeting area during e.g. separation or due to a milking permission in the second group) from the cow area to the meeting area and the calves and duration of the visits in a study of cow–calf contact in a cow-driven cow–calf contact system, where cows ($n = 8$) could visit their calves through a smart gate. Feeding and resting behaviour were registered using Nedap activity sensors. Data are presented as means and, in parentheses, standard deviations.

bonding phase lasted for (mean ± SD) 3 ± 0.1 d and the suckling phase lasted for 31 ± 4.1 d.

Smart gate passages

Across the two groups, cows accessed their calves mainly during daytime (20, 20, 16 and 23% of the passages occurred during 06.00–09.59 h, 10.00–13.59 h, 14.00–17.59 h, 18.00–21.59 h respectively) and less after 22.00 h (12 and 9% of the visits occurred during 22.00–01.59 h and 02.00–05.59 h respectively). Reinhardt and Reinhardt (1981) showed that cattle often perform suckling during sunrise and sunset, which may explain the timing of the visits, especially in group 1 where cows could choose when to access the calves. During the suckling phase, cows visited the calves 8.1 ± 3.91 times per d, each visit lasting for 23.1 ± 14.00 min (Table 1). With the second group, visit frequency was lower but mean visit duration longer. A high number of attempts to pass during the suckling phase of the second group may signal that the system may not have been fully intuitive to the cows. This situation may have been stressful for the cows. Knowledge on other ways to make a cow-driven CCC-system with post-milking calf access more intuitive (eg spatial closeness to AMS, use of conditioning to signal when smart gates are open) is needed. During the first days of separation, all cows attempted to pass, which may indicate unfulfilled motivation to visit the calf. The results indicate that cows are motivated to access their calves through a smart gate. As also shown by Wenker *et al.* (2020), the motivation of a cow to visit her calf is high, and indicate that this motivation exists independently of resources such as feed and lying spaces.

Cow eating and resting behaviour

In the suckling phase, cows ruminated 35.7 ± 4.28% of their time, spent 6.3 ± 1.55 h eating and 10.6 ± 1.78 h lying. These behaviours changed only subtly with group and phase (cows ruminated 32.1 ± 4.75% of their time, ate for 5.2 ± 1.66 h and spent 11.3 ± 2.07 h lying during the separation phase) and lying time was within the range of what is observed in other studies (10.2–12.1 h/d, Charlton *et al.*, 2014).

Suckling and allogrooming

During d 14 and 15 cow-calf pairs spent 30.0 ± 17.1 min per d suckling and 29.8 ± 18.8 min per d allogrooming. There was an increased variation in time spent suckling among the pairs in group 2 (online Supplementary Fig. S4). The time spent suckling and allogrooming is within the range of what is shown by others (Lidfors, 1996; Paranhos da Costa *et al.*, 2006; Jensen, 2011). Since we did not record suckling events during the night (i.e. from 21.01 to 05.59 h), the total time spent suckling and allogrooming may have been higher. Separate events of suckling and allogrooming were registered at a frequency of 13 ± 15.3 and 26 ± 12.4 events per d for suckling and allogrooming, respectively. A new suckling event was recorded if the behaviour was interrupted for more than 3 sec, which may have artificially inflated its frequency. Other studies have shown 5–10 suckling bouts per day, but both time spent suckling and number of suckling bouts varies depending on the age of the calf, milk availability and the conditions under which the cow–calf pairs are kept and studied (Lidfors, 1996). Cross-suckling events mostly occurred in the second group (0.6 ± 1.19 and 4.1 ± 5.14 events/d in group 1 and group 2, respectively). In the second group, cows had been milked during the most recent 5.5 h before visiting their calf, which likely resulted in a lower udder fill. We consider that the higher variation in suckling duration in the second group indicates that calves may have been hungrier and thus more motivated to cross-suck.

Vocal response to separation

Both cows and calves vocalized at low rates before separation (ie baseline). Hourly rates of low-pitched vocalizations were almost absent: (median, IQR) 0 (0–2) and 0 (0–0) for cows and calves respectively. Similarly, hourly rates of high-pitched vocalizations were absent: 0 (0–0) and 0 (0–0). Vocal responses during the first days of gradual separation were not documented, but after separation (ie during the first two days without contact), cows and calves vocalized more, both using low pitched (4 (0–15) and 4 (0–9) vocalizations/h for cows and calves, respectively) and high-pitched vocalization (0 (0–4) and 11 (0–26) vocalizations/h for cows and calves, respectively). Similar behaviours have been shown in other studies (Johnsen *et al.*, 2015), but at higher rates. Measures to mitigate behavioural stress at separation that have been described are daytime/night-time CCC (rather than whole-day contact), and gradual separation allowing physical contact (Johnsen *et al.*, 2016). The design of the CCC-system in this study facilitated these measures, since CCC was limited to when cows visited their calf, and separation was gradual and allowed physical contact along the fence-line which may explain the low vocalization rates (Johnsen *et al.*, 2016). Even though supplemental milk may decrease behavioural responses to separation, only 3 calves drank from the milk feeder after separation (see Johnsen *et al*., 2021). To decide when the cow-calf pair can be separated with the least negative consequences, we need more information to balance the physiological and behavioural needs of the cow–calf pair with economic viability for the farmers.

In conclusion, the results of this study indicate that the cow is motivated to visit her calf, even though she has to pass through a smart gate. Cow–calf pairs perform particular behaviours for which they are highly motivated. Interpretation of the results should be viewed in light of the low sample size but may encourage more research into CCC-systems with a separate and safe 'calf home area' in combination with an AMS.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S0022029921000194.

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References

Beaver A, Meagher RK, von Keyserlingk MAG and Weary DM (2019) Invited review: a systematic review of the effects of early separation on dairy cow and calf health. *Journal of Dairy Science* **102**, 5784–5810.

Charlton GL, Haley DB, Rushen J and de Passillé AM (2014) Stocking density, milking duration, and lying times of lactating cows on Canadian freestall dairy farms. *Journal of Dairy Science* **97**, 2694–2700.

Jensen MB (2011) The early behaviour of cow and calf in an individual calving pen. *Applied Animal Behaviour Science* **134**, 92–99.

Johnsen JF, Ellingsen K, Grøndahl AM, Bøe KE, Lidfors L and Mejdell CM (2015) The effect of physical contact between dairy cows and calves during separation on their post-separation behavioural response. *Applied Animal Behaviour Science* **166**, 11–19.

Johnsen JF, Zipp KA, Kalber TA, de Passille AM, Knierim U, Barth K and Mejdell CM (2016) Is rearing calves with the dam a feasible option for dairy farms? Current and future research. *Applied Animal Behaviour Science* **181**, 1–11.

Johnsen JF, Kischel SG, Rognskog MS, Vagle I, Johanssen JRE, Ruud LE and Ferneborg S (2021) Investigating cow-calf contact in a cow-driven system: performance of cow and calf. *Journal of Dairy Research* **88**, 56–59.

Lidfors LM (1996) Behavioural effects of separating the dairy calf immediately or 4 d post-partum. *Applied Animal Behaviour Science* **49**, 269–283.

Paranhos da Costa MJR, Albuquerque LG, Eler JP and Augusto Ii de Vasconcelos Silva J (2006) Suckling behaviour of Nelore, Gir and Caracu calves and their crosses. *Applied Animal Behaviour Science* **101**, 276–287.

Reinhardt V and Reinhardt A (1981) Natural sucking performance and age of weaning in zebu cattle (*Bos indicus*). *Journal of Agricultural Science Cambridge* **96**, 309–312.

Santo NK, von Borstel UK and Sirovnik J (2020) The influence of maternal contact on activity, emotionality and social competence in young dairy calves. *Journal of Dairy Research* **87**, 38–143.

Sirovnik J, Barth K, de Oliveira D, Ferneborg S, Haskell MJ, Hillmann E, Jensen MB, Mejdell CM, Napolitano F, Vaarst M, Verwer CM, Waiblinger S, Zipp KA and Johnsen JF (2020) Methodological terminology and definitions for research and discussion of cow-calf contact systems. *Journal of Dairy Research* **87**, 108–114.

Waiblinger S, Wagner K, Hillmann E and Barth K (2020) Short- and long-term effects of rearing dairy calves with contact to their mother on their reactions towards humans. *Journal of Dairy Research* **87**, 148–153.

Wenker ML, Bokkers EAM, Lecorps B, Van Reenen G, Verwer CM and Weary DM (2020) Effect of cow-calf contact on cow motivation to reunite with their calf. *Scientific Reports* **10**, 14233.