

Research Reflection

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Short- and long-term effects of rearing dairy calves with contact to their mother on their reactions towards humans

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Abstract

In this Research Communication we address the hypotheses that reduced contact with humans during the first week of life would impair the relationship of dairy calves reared in dam-calf-contact systems to humans in comparison with artificially reared animals, but that this difference would vanish over time. Artificially reared calves (*Artificial*) that had been separated from their mother within 12 h after birth were bottle-fed with colostrum for 5 d and thereafter sucked milk from an automatic milk feeder. Animals reared with dam-calf contact (*Dam-contact*) were kept in the calving pen with their dam for 5 d, and then had permanent access to the cow barn and thus to their dam. Calves were weaned at an age of 12 weeks and kept in young stock groups mixed of both treatments until integration into the cow herd. We tested the animals' relationship with humans by assessing the animals' responses towards an unfamiliar person in an avoidance distance (AD) test in the home environment at 4 weeks of age, at 15 months and at 33 months. In calves, we additionally measured AD in a novel arena after a stationary person test. *Artificial* animals had lower AD, i.e. showed lower level of fear, than *Dam-contact* calves. However, the AD in *Dam-contact* calves decreased with increasing number of days they experienced assistance for suckling. Further, there was no significant difference in later ages. In conclusion, gentle human contact in combination with feeding during the first 5 d of life improved calves' relationship to humans leading to differences between the two treatments as well as within the *Dam-contact* calves. Potential effects under different conditions regarding quantity and quality of human-animal interactions need further research.

In common practice, dairy calves are separated from their dam within hours after birth and reared artificially, but rearing with cow-calf contact is receiving increased attention as a more natural, welfare-friendly and, potentially, work saving system, as the labour-intensive bucket feeding can be omitted (for review see Johnsen et al. 2016). However, the first weeks of life are a sensitive period for developing relationships with humans, which largely influence animal welfare (for review see Waiblinger, 2019). During this period, human interactions with calves reared with dam-calf contact may be reduced to negative ones (e. g. ear tagging, disbudding) and association of humans with feeding may fall away. This may negatively affect the animals' relationship with humans (animal-human relationship, AHR) in the short- and long-term (Boivin et al., 1992; Lürzel et al., 2015), although AHR is dynamic and consistent gentle contact may be as important (Boissy and Bouissou, 1988). A study in artificially reared dairy calves provides evidence that later experiences override experiences early in life, but in that study all calves were fed by humans during the postnatal sensitive period (Lürzel et al., 2016). Therefore, the aim of our study was to compare AHR of animals that had been reared either artificially (separated from their mother within the first day p.p.) or with full whole-day contact to their dam during the first 12 weeks of life. We followed the AHR of the animals from early after birth until their first lactation. We hypothesized that reduced contact with humans during the first week of life would impair the AHR of calves in dam-calf contact rearing, but that this difference would vanish later in life.

Methods

The experiments were conducted in accordance with Good Scientific Practice guidelines and national legislation.

Animals, housing and management

Animals included in this study were born between October 2009 and January 2010. Tests were performed with 39 calves (21 female and 18 male) from November 2009 to February 2010; the females were further tested as heifers in February 2011 and as cows ($n = 19$ due to loss of two animals) after their first calving in August 2012. Animals belonged to two breeds; Black-and-White German Holstein (GH; calves: $n = 16$, heifer: $n = 11$, cows: $n = 10$) and German Red Pied (GRP; calves: $n = 23$, heifers: $n = 10$, cows: $n = 9$). The cows were kept in two separate herds according to breed in cubicle loose housing (for more details on the cow barn see Wagner *et al.* 2012) with one adjacent pen for the calves each. Cows gave birth in individual calving pens, adjacent to the cow barn and the calf pens. All calves were bottle-fed 1 L of colostrum 2 ± 2.5 h after birth and ear-tagged within the first 3 d after birth. Cows stayed in the calving pens together with their calf for 1 or 5 d after calving, depending on treatment (see below). Afterwards, calves were moved into one of the two calf pens, with deep-bedded resting area and a running area, where they were kept until weaning (for more details on the calf pen see Wagner *et al.* 2013). According to treatment, calves had transponder-controlled access either to the cow barn and thus their dam *via* selection gates or to the automatic milk feeder (FA Förster-Technik GmbH, Engen, Germany). All calves had access to a transponder-controlled concentrate feeder (FA Förster-Technik GmbH, Engen, Germany) providing up to 1.5 kg per day for each calf and to silage, hay and water *ad libitum*. The calves were weaned on day 90 (min-max 86–95) by moving them into a group of weaned calves in another building, where calves from both treatments and breeds were kept together. Heifers were kept in groups according to age (4–6 months, 7–16 months; 16 months until successful insemination; pregnant heifers) until they were integrated into the cow herd about 2 months before their calving. All groups of young cattle were housed in a barn with deep-bedded loose housing during winter and on pasture during summer. Male calves were sold directly after weaning. Animals had human contact for standard animal care and management procedures (concentrate feeding on pasture, veterinary treatment, regrouping or moving to pasture, faeces sampling for parasite monitoring, oestrus monitoring, and artificial insemination, etc). Animals were not disbudded. Daily care for experimental animals during the treatment phase (the first 12 weeks of life) was provided by five experimenters to standardize quantity and quality of contact to the calves as far as possible. Daily care involved health checks, bottle-feeding of colostrum, assistance to suckle at the dam if necessary, teaching calves to drink from the automated milk feeder or to use selection gates. Experimenters were instructed to perform all necessary interactions in a calm and gentle way, including stroking if useful, but to avoid interactions at other occasions.

Treatments

Animals were randomly allocated to two treatments balanced for gender. Calves were kept in two dynamic groups, that is to say young animals entered while weaned animals left the group. Both groups consisted of calves from the two breeds and two treatments.

Dam-calf contact rearing (Dam-contact)

A total of 19 animals (12 female, 7 male) were allocated to this treatment. The calf and dam stayed together in the calving pen

for the first 5 d after calving and the calf suckled its mother. If a calf had difficulties to suckle from the udder it was assisted by a human several times a day until it was able on its own. The number of days they needed assistance by a human was recorded as 'human contact days' (range 0–4). The cow was milked in the milking parlour two times per day from the first day on. On the sixth day, the calf was moved into the calf pen and taught to use the selection-gate (two times daily for one to a maximum of 3 d). Through this gate, calves had free access to the cow barn and thus to their mother and cow herd, except during the provision of fresh straw for bedding (about 30 min) in the cow barn two times a week. During milking times, calves only had access to the lying area in the cow barn and not to their mother or the herd. Thus, calves were reared in a full, whole day, calf driven dam-calf contact system.

Artificial rearing (Artificial)

These calves (9 female, 11 male) were separated from their mother within the first 12 h after birth and the calf was moved into the calf pen. Calves were bottle-fed for 5 d four times daily (milk amount increased from 4 to 6 kg/d/animal). After the first 5 d, they had access to the automatic milk feeder where they got an increasing maximal milk portion of 8 kg/d/animal in the first week up to 16 kg/d/animal from day 27 until weaning (4–8 meals per day, with max. 4 kg/meal). These calves had no access to the cow barn.

Test procedures

We assessed the animals' relationship towards humans by measuring their responses towards an unfamiliar person in avoidance distance (AD) tests in the home environment at three ages: as calves, (4 weeks of age: all calves), as heifers (15 months old: females only) and as primiparous cows (33 ± 1.0 months old, 6 ± 1.6 months after their first calving). Calves, but not older animals, were tested additionally in a stationary person test (SPT) in a novel arena and a subsequent AD test in this arena. The SPT was performed on the same day following the AD test in the home environment.

All tests were performed by unfamiliar test persons, not involved in management and care of the animals for at least two years, and blind to the treatments. Two persons tested the calves (both female, 1.65 m height, dark blond and blond hair, respectively, both wearing a green overall), one of these tested heifers (wearing blue clothes) and a third person (female, 1.60 m height, brown hairs, wearing grey clothes) tested cows. This third person had not tested calves and heifers as she cared for calves during the first 12 weeks of life. However, she had to test the cows as the other two test persons were no longer available on the farm. As she did not have had any contact to the animals for nearly two years, she can be seen as unfamiliar for the animals and blind to treatment.

Avoidance distance tests

All avoidance distance tests in the home pen were conducted according to Waiblinger *et al.* (2002), for validity and reliability of the test see also Windschnurer *et al.* (2008, 2009). Calves avoidance distance was tested additionally in a novel arena after a stationary person test using the same procedure. When testing in the home environment (in the cow herd or group), the starting

distance was 2–3 m but in the test arena the test person went as far as possible away from the calf before starting to test.

Stationary person test

We performed a stationary person test with the calves in a novel arena with opaque partitions (size: 4.5 × 3 m). The calf was gently moved to the test arena and a 3 min habituation period started after closing the door. Then, an unfamiliar person entered the arena and sat down in a corner for 5 min. Then the person raised and performed the AD test in the arena. Behaviour of the calves was recorded with a camcorder (Sony Handycam DCR-HC47). The software Observer® (5.0, Noldus, NL) was used for behavioural observations from video. Behaviour was observed continuously, and duration (for contact person also latency) of the following behaviours recorded: contact person (licking, sniffing), head oriented towards person, exploration (other than person), vigilance (head raised, ears erect).

Data analysis

To test for effects of treatment on avoidance distance of females at different ages, we calculated an analysis of variance with ADs as target variables, and treatment and breed as fixed factors for all ages. Changes of AD from calf to cow were investigated by subtracting AD at the younger age from AD at older age and testing if this value differed significantly from 0 by a one-sample t-test. Further, AD and behaviour in the arena was analysed for male and female calves by ANOVA with the fixed effects treatment, breed and sex. Model requirements for all ANOVAs were assessed graphically and by the Levene's test for homogeneity of variance. To assess potential effect of frequency of human contact in the first 5 d of life, Pearson correlation coefficients were calculated with the number of human contact days both for only females for all ages as well as for male and female calves together.

Results

Avoidance distance of females across ages

Dam-contact calves had higher AD in the home pen (estimated mean ± SD: 101 ± 11.9 cm) than *Artificial* calves (41 ± 14.0 cm; $F_{1,18} = 10.322$, $P < 0.01$, Fig. 1), but AD did not differ significantly in the arena test (*Dam-contact*: 121 ± 16.8 cm, *Artificial*: 76 ± 19.2, $F_{1,18} = 3.191$, $P = 0.09$). About one year later no statistical significant difference was detected between AD of *Dam-contact* heifers (129 ± 14.1 cm) and *Artificial* heifers (87 ± 16.6 cm, $F_{1,18} = 3.525$, $P = 0.08$). After their first calving *Dam-contact* cows (174 ± 15.4 cm) no longer differed from *Artificial* (164 ± 19.0, $F_{1,16} = 0.158$, $P = 0.70$). This was due to an increase of avoidance distances with age (Fig. 1) that was higher for artificially reared animals (increase in AD from calf to cow: 123 ± 69.1; $T_6 = 4.736$, $P < 0.01$), which had started from a lower level, than for *Dam-contact* animals (73 ± 75.9 cm; $T_{11} = 3.349$, $P < 0.01$). Breed did not show any effect on AD.

The amount of human contact in the first 5 d of life was associated with avoidance distances of dam-contact reared calves (Fig. 2): the more days they needed assistance by a human, the lower was their AD both in the group ($r = -0.58$, $P < 0.05$) and in the arena ($r = -0.68$, $P < 0.01$). No effects were seen on AD of heifers ($r = -0.17$, $P > 0.05$) or cows ($r = 0.13$, $P > 0.05$, all $N = 12$).

Avoidance distance of male and female calves

These data are shown in online Supplementary Figure S1A–D. When including male calves in the analysis, sex had no effect on AD. Consequently, *Dam-contact* calves had higher AD than *Artificial* calves when assessed in the home pen in this analysis ($F_{1,35} = 15.566$, $P < 0.001$). With male calves included, and thus larger sample size than just analysing female calves, AD of *Dam-contact* calves was higher also in the arena ($F_{1,35} = 4.118$, $P = 0.05$). Breed had no effect. The correlation of AD with human contact days also remained comparable to only females both in the group ($r = -0.48$, $P < 0.05$) and in the arena ($r = -0.69$, $P = 0.001$, both $N = 19$).

Stationary person test for male and female calves

In the stationary person test latency until and total duration of contact with the person did not differ between treatments (Table 1). *Dam-contact* calves gazed at the human more often (head oriented to test person), were longer vigilant and explored less than *Artificial* calves (Table 1), but they were vigilant for a longer duration and explored less already in the 3 min habituation phase. Breed and gender had no effect on any of the behaviours.

Discussion

The shorter AD of artificially reared calves indicates a lower level of fear of humans as compared to *Dam-contact* calves. Within the latter, a higher amount of assisting calves to suckle and thus a higher number of human contact days decreased AD comparable to that of artificially reared animals. These results are in line with our hypothesis and confirm earlier studies in that feeding by a human and/or gentle human contact improves dairy calves' relationship to humans (Jago *et al.*, 1999; Lürzel *et al.*, 2015), and the first 5 d of life are especially sensitive (Krohn *et al.*, 2001). Although all *Dam-contact* calves received one colostrum meal *via* bottle feeding, further assisting these calves for suckling seems to be as effective as repeated bottle-feeding of artificially reared calves. In previous studies physical contact of calves to their dam hindered the establishment of a good animal–human relationship (Krohn *et al.*, 2003), however, those calves were prevented from suckling their dam by physical separation. In our study, the lack of separation from the dam and the combination of gentle human contact with suckling may have contributed to improvement of the relationship also in *Dam-contact* calves. Suckling triggers the release of several hormones involved in filial bonding, in particular oxytocin and cholecystokinin (Lupoli *et al.*, 2001; Nowak and Boivin, 2015). While the increase is lower, both hormones are released also during bucket feeding (Lupoli *et al.*, 2001). In both our treatments (artificial and dam-contact rearing) human contact was associated with feeding (bottle-feeding or assistance in suckling) and the hormonal changes associated thus may support a positive relationship with humans. Based on our results we recommend close contact to humans during suckling in the first few days or week of life in cow-calf contact systems to improve calves' relationship with humans. The question of whether gentle human contact in another context or another age period is effective merits further research. For example, the time after separation from the dam after weaning may be another option, because it was shown to be a sensitive period for improving the animal's relationship to humans in beef suckler heifers (Boivin *et al.*, 1992).

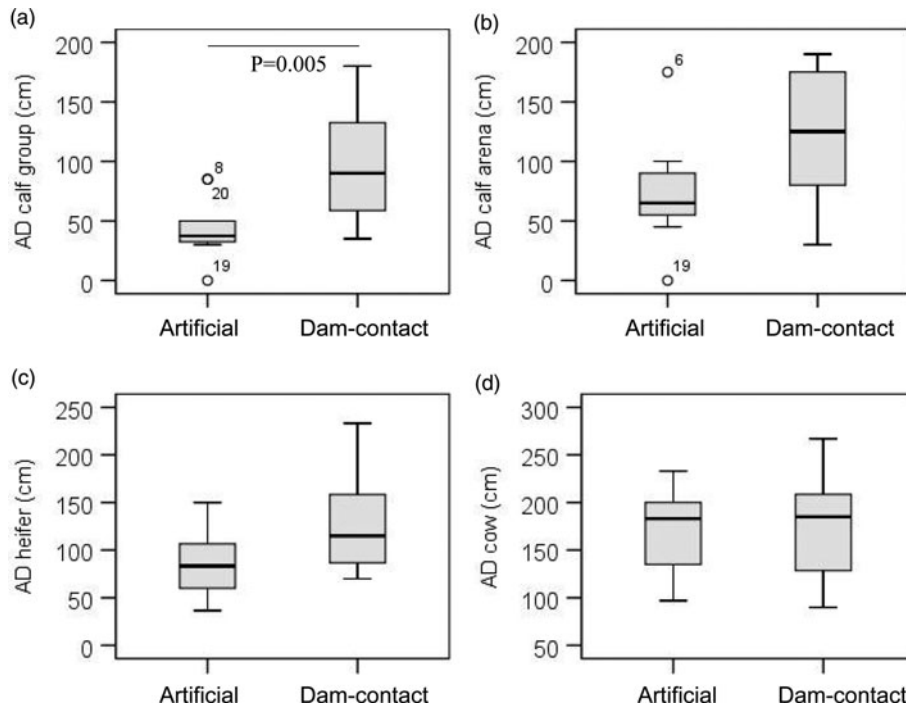


Fig. 1. Avoidance distance (AD) of animals that had been reared the first 12 weeks of life with contact to their mother (Dam-contact, $n = 12$) or separated within the first day of life (Artificial, $N = 9$ for calves and heifers, $N = 7$ for cows). Animals were tested as calves at the age of 4 weeks in their home pen (AD calf group, a) as well as in an arena (AD calf arena, b), as heifers of 15 months of age (c) and as cows (d) in the second half of their first lactation at an age of about 33 months (Artificial: $n = 7$). Boxplots based on original data; note the different scales.

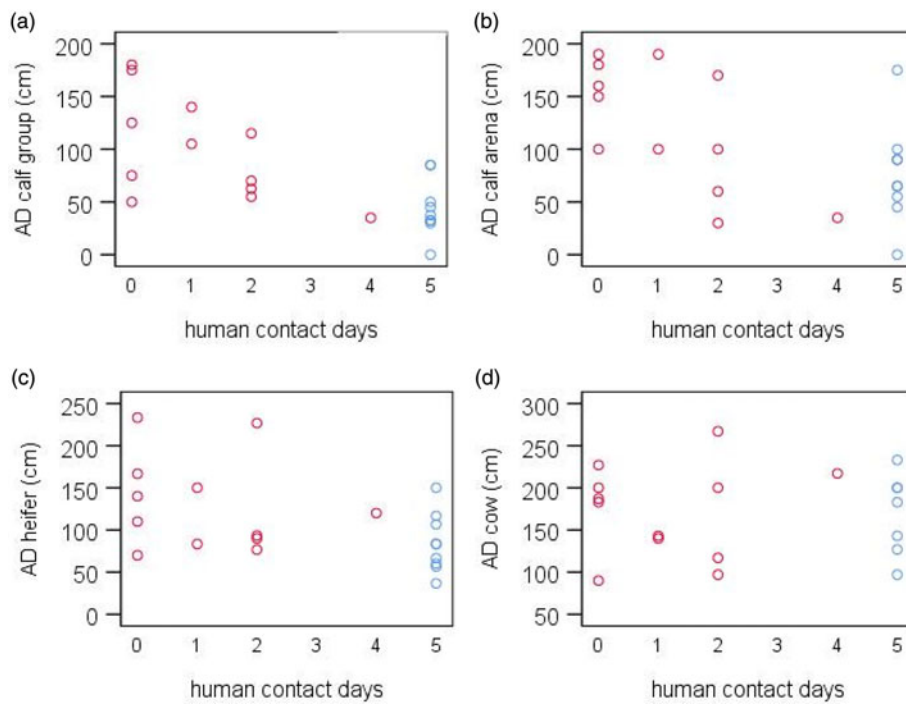


Fig. 2. Avoidance distance of animals that had been reared the first 12 weeks of life with contact to their mother (Dam-contact – red circles, $N = 12$) or separated within the first day of life and provided with milk from an automatic milk feeder (Artificial – blue circles, $N = 9$ for calves and heifers, $N = 7$ for cows) in relation to the number of days of close contact with humans in the first 5 d of life (human contact days, always 5 d for Artificial, 0–4 d for Dam-contact). Animals were tested as calves at the age of 4 weeks in their home pen (AD calf group) as well as in an arena (AD calf arena), as heifers of 15 months of age and as cows in the second half of their first lactation at an age of about 33 months. Note the different scales.

In contrast to ADT, the stationary person test did not indicate a difference between treatments in their reaction to the test person, either in latency or in duration of contact. This supports the notion of lower specificity of this test for assessing AHR, as compared to ADT, caused by stronger confounding effects of personality traits such as general fearfulness, sociability or curiosity (Waiblinger *et al.*, 2006). In our study the different levels of exploration and vigilance in artificial or dam-contact reared calves not only during the SP phase but already in the habituation phase

suggest differences in personality traits masking differences in fear of humans. The differences in vigilance and exploration independent of human presence also confirm earlier studies showing effects of the early social environment on challenge response of cattle (Wagner *et al.*, 2013, 2015).

It is striking that effects of human contact during only the first 5 d of life seem to last up to 15 months at least in some animals. Previous studies found long-term effects of early gentle interactions of 7–9 months after the last handling (Boivin *et al.*, 1992;

Table 1. Behaviour of calves reared in contact to the dam (*Dam-contact*) or artificially (*Artificial*) during the 5 min of the stationary person test or during the 3 min habituation test

Behaviour	Artificial	Dam-contact	F	P
	Estimated means \pm SE (s)			
Latency contact ¹	141.67 \pm 23.93	157.19 \pm 25.02	0.20	n.s.
Duration contact ¹	5.64 \pm 1.71	8.34 \pm 1.79	1.18	n.s.
Head oriented to TP ¹	88.17 \pm 10.55	138.91 \pm 11.03	11.13	<0.01
Vigilance ¹	10.72 \pm 3.18	24.175 \pm 3.33	8.60	<0.01
Exploration ¹	67.94 \pm 3.88	44.92 \pm 4.06	16.98	<0.001
Vigilance alone ²	26.16 \pm 7.99	52.10 \pm 8.35	5.08	<0.05
Exploration alone ²	125.01 \pm 8.95	96.93 \pm 9.36	4.74	<0.05

n.s., not significant. Data from ¹Stationary Person test or ²Habituation Test

Results of ANOVA (estimated means \pm SE, F, P) are shown. For contact with the test person (TP) duration and latency are shown, for other behaviour duration is given in seconds.

Probst *et al.*, 2012). Nevertheless, in the long-term the differences vanished supporting previous studies in dairy cattle (Lürzel *et al.*, 2016). Negative experiences and lack of positive ones later in life are probably responsible for the observed increase in avoidance distance from calves to cows in line with the concept of AHR as dynamic (Waiblinger *et al.*, 2006). Our results contradict an earlier study on one single farm where avoidance of animals decreased from around one year of age up to the midst of first lactation (Haskell *et al.*, 2012); however they agree with a study on 35 farms where no general age effect on AHR could be found (Waiblinger *et al.*, 2003), pointing again to the importance of consistent gentle human contact throughout life in addition to the use of sensitive periods. It also underlines the limitations of our study with regard to external validity, since it is based on just one farm with its specific human-animal relationship and our specific experimental design. While the general procedures and management are comparable to a commercial farm and thus the results are, in principle, applicable and valid for practice, this probably accounts mainly for farms with similar quality and quantity of human contact and thus similar human-animal relationship. Therefore, studies on commercial farms with cow-calf contact systems that show a large variety of possible human-animal relationships would be necessary to fully understand this topic.

In conclusion, under conditions similar to our experimental farm there is no long-term disadvantage of dam-calf-contact rearing on the AHR. Gentle human contact including feeding during the first 5 d of life can reduce fear of humans in both artificially reared and dam-contact reared calves. Thus, human contact with calves during suckling in the colostrum period seems to be a feasible way to start the establishment of a good animal-human relationship in cow-calf contact systems but should be maintained by regular positive contact.

Supplementary material. The supplementary material for this article can be found at <https://doi.org/10.1017/S0022029920000576>.

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