

The influence of maternal contact on activity, emotionality, and social competence in young dairy calves

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SUPPLEMENTARY FILE

Heart rate measurement

Heart rate measurements were performed before, during, and after the novel object test, in total for 45 minutes. No further analysis was performed on the recorded data due to the poor contact between the sensor and the calves' bodies.

Table S1:

Description of the behaviours observed during the open field (OF), the novel object (NO), and the confrontation test (CO) (adapted from: Wagner *et al.* 2015, Buchli *et al.* 2017). Overall mean (\pm SE) duration (D, in seconds / 15 minutes) and number of events (E, in # / 15 minutes) were assessed.

Behaviour	Description	OF	NO	CO
Elimination (E)	Urination and defecation by the calf	#/15 min	#/15 min	#/15 min
Exploration (D)	The calf touches the walls surrounding the arena or the floor with its tongue or muzzle	sec/15 min	sec/15 min	sec/15 min
Immobility (D)	The calf stands with its weight on all four legs and no extremities are moving; its head, tail, mouth, ears or eyes might be moving	sec/15 min	sec/15 min	sec/15 min
Vocalisation (E)	Any vocalization by the calf	#/15 min	#/15 min	#/15 min
Ambulation (E)	The number of squares the calf enters with its right front leg	#/15 min	#/15 min	#/15 min
Grooming (D)	The calf touches its own fur with its tongue or teeth	sec/15 min	sec/15 min	sec/15 min
Solitary play (D)	The calf's two forelegs are lifted from the ground and stretched forwards, the forepart of the body is elevated and results in an upward and forward movement; the calf's hind legs might be lifted from the ground during the last phase of the movement	-	-	sec/15 min

Latency to first contact with the novel object	The time from the start of the test until the calf's first contact with the novel object with its nose, tongue or head	-	in sec	-
Duration of contact with the novel object (D)	The calf is sniffing, touching or rubbing the novel object with its nose, tongue or head	-	sec/15 min	-
Ambulation near the novel object (E)	The number of squares the calf enters with its right front leg within a range of two squares surrounding the novel object	-	#/15 min	-
Sniffing cow (D)	The calf's muzzle is in contact with any body part of the cow (observed calf is the active participant in the behaviour)	-	-	sec/15 min
Physical contact with cow (D)	Any body part of the calf is touching any body part of the cow excluding any contact with a muzzle and agonistic behaviour (butts and kicks by the cow) (observed calf is either the active or the passive participant in the behaviour)	-	-	sec/15 min
Submission (D)	The calf is lowering its head below the horizontal to the withers with its chin outstretched	-	-	sec/15 min
Vigilance (D)	The calf's head is above the horizontal to the withers with its ears upright	-	-	sec/15 min
Received agonistic behaviour (D)	The cow threatens (presents forehead with an inclined head) or butts (with forehead or nose) the calf	-	-	sec/15 min

Table S2:

Social interactions with the dam and other individuals (means and standard deviations) together with the description of the behaviours observed during the calves' first days of age.

Behaviour	Description	Mean \pm SD	
		Maternal Contact	Motherless
Dam licks	The tongue of the mother is in contact with any body part of its calf (observed calf is the passive participant in the behaviour); in minutes	22.8 \pm 8.1	17.2 \pm 10.6
Dam sniffs	The muzzle of the mother is in contact with any body part of its calf (observed calf is the passive participant in the behaviour); number of occurrences	3.6 \pm 5.7	0.7 \pm 1.8
Dam contact	Any body part of the mother is touching any body part of its calf except of the mother's muzzle and tongue (observed calf is either the active or passive participant in the behaviour); in minutes	3.4 \pm 7.4	0.2 \pm 0.6
Cow contact	The calf is touching, licking, sniffing another cow that is not its mother (observed calf is the active participant in the behaviour) or is licked, sniffed, touched without force by another cow that is not its mother (observed calf is the passive participant in the behaviour); in minutes	0.3 \pm 0.7	2.0 \pm 5.2
Cow agonistic	A cow other than the mother is pushing forcefully the calf with her head resulting in the calf to move away from the cow; number of occurrences	0.2 \pm 0.6	0.2 \pm 0.4
Calf contact	The calf is touching, licking, sniffing another calf (observed calf is the active participant in the behaviour) or is being touched, licked, sniffed by another calf (observed calf is the passive participant in the behaviour); in minutes	0.6 \pm 1.8	1.8 \pm 1.7

Table S3:

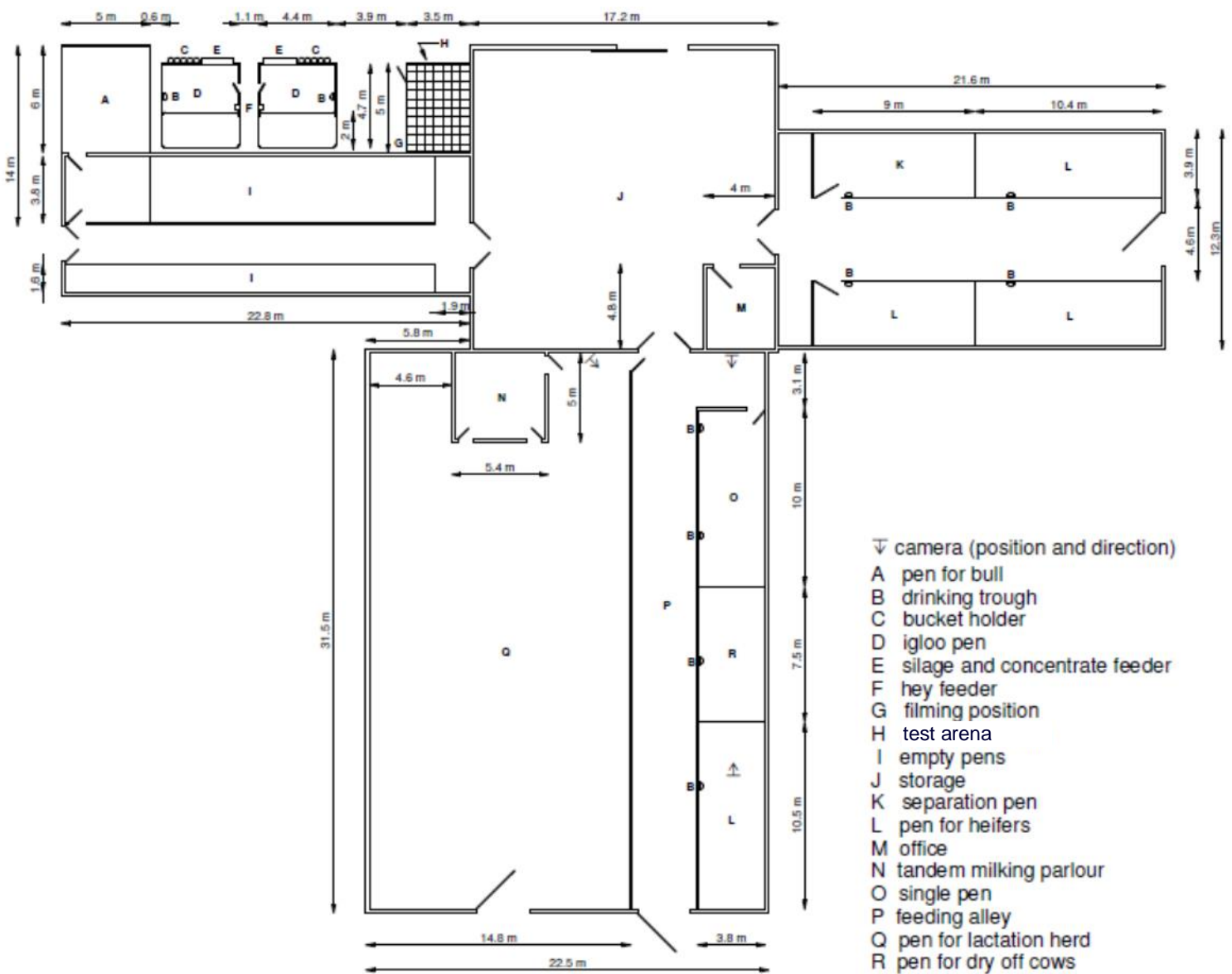
Mean (\pm SD) duration (D, in hours/ day) and number of events (E, in #/ day or steps/ day) of the analysed types of activity during the 3rd and 27th day of age (24-day-period), during the 3rd to 13th day of age (period A, i.e. before separation of Maternal Contact calves from the dams) and during the 14th to 27th day of age (period B) for Motherless (n = 8) and Maternal Contact calves (n = 8). Periods A and B were compared within each treatment and each treatment was compared within each period. * indicates levels of significance with * = P < 0.05, ** = P < 0.01, *** = P < 0.001.

Activity	Period	Mean \pm SD	U	P
Treatment effect				
Locomotion	24-day-period		14577.0	< 0.0001***
		Motherless 1481.5 \pm 485.1 steps/day		
		Maternal Contact 1260.3 \pm 473.5 steps/day		
	Period A		3189.0	0.022*
		Motherless 1362.9 \pm 502.2 steps/day		
		Maternal Contact 1192.2 \pm 379.5 steps/day		
Lying	24-day-period		19205.5	0.246
	Period A		3854.5	0.480
	Period B		5852.0	0.194
		Motherless 1574.7 \pm 451.9 steps/day		
		Maternal Contact 1313.9 \pm 531.6 steps/day		
			4060.0	< 0.0001***
Swapping	24-day-period		18458.5	0.091
	Period A		3757.5	0.368
	Period B		5402.0	0.036*
		Motherless 30.8 \pm 8.3 #/day		

	Maternal Contact	28.1 ± 8.9 #/day		
Period's effect				
Locomotion	Motherless		3734.5	0.002**
	Period A	1362.9 ± 502.2 steps/day		
	Period B	1574.7 ± 451.9 steps/day		
	Maternal Contact	1253.1 ± 455.6 steps/day	4298.0	0.061
Lying	Motherless		3410.5	< 0.0001***
	Period A	18.7 ± 1.2 hours/day		
	Period B	17.9 ± 1.3 hours/day		
	Maternal Contact		3805.0	0.003**
	Period A	18.6 ± 1.2 hours/day		
	Period B	18.1 ± 1.9 hours/day		
Swapping	Motherless	31.9 ± 9.6 #/day	4374.5	0.087
	Maternal Contact		3719.5	0.001**
	Period A	32.3 ± 9.8 #/day		
	Period B	28.1 ± 8.9 #/day		

Figure S1:

Scheme of the barn of the Oberer Hardthof in 35398 Giessen, Germany.



Prior to calving cows were housed in a pen with deep-bedded loose housing where they were kept until calving (R). After birth, calves of both treatments and the dams of Maternal Contact were housed within the same group in a single pen adjacent to the calving pen ($5 \text{ m}^2/\text{animal}$, O). Motherless calves were separated from their mothers no later than 12 hours after birth and the dams spent the first 24 hours after separation in another part of the barn where audible but no tactile or visual contact with the calves was possible (K). After this initial, 24-hour separation, the mothers of Motherless calves were brought to the production herd (Q) which was positioned in the same barn as the calves, adjacent to them but separated by a feeding alley. Maternal Contact calves had almost uninterrupted contact with their mothers for the first five days of age and were separated from the mothers only during milking in the morning and in the afternoon for approximately 15 minutes (N). At 14 days of age, all calves were moved outside the barn and kept in groups of three to five animals in commercial pens with igloos (D). The pens had concrete floors and the igloos were straw bedded.