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Stroking Different Body Regions of Dairy Cows: Effects on Avoidance and Approach Behavior Toward Humans

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ABSTRACT

Understanding perception of dairy cows to common human contact such as stroking is important for improving the human-animal relationship, animal welfare, and production. We hypothesized that repeated stroking of body regions licked most during social grooming, especially the ventral neck, would reduce cows' avoidance of and increase their approach to humans. Sixty tethered dairy cows were randomly allocated to 4 treatment groups that received 5 min of daily human contact 5 d/wk during 3 consecutive weeks: 3 groups were stroked on different body regions. The first group was stroked on the ventral part of the neck (neck); the second group on the withers (both licked often in social grooming); the third group on the lateral side of the chest (chest, licked rarely); and the last group (control) was exposed to simple human presence. The reactions to the person who had provided the treatment were measured using 2 tests in the home tie-stall assessing avoidance from an approaching person who tried to touch the head (approaching person test) and avoidance/approach reactions to a stationary person (stationary person test). Approach behavior was recorded in a novel environment using a standard arena test. In the home tie-stall, cows stroked on the neck showed less avoidance (median avoidance score: 3.33) in the approaching person test compared with cows stroked on the chest and the controls (both: 4.00). That is, at least 75% of the animals stroked on the neck tolerated the touching of their heads (75th percentile ≤ 3.75), whereas at least 50% of the cows in the other treatment groups did not accept it. The stationary person test did not reveal any differences between the treatment groups. In the arena test, the 3 stroked groups showed more approach behavior (median latencies to contact: from 145 to 240 s) compared with simple human presence (300 s), but stroking treatments did not differ from each other. Stroking, particularly the neck, reduced avoidance of and increased approach reactions to humans in both the home tie-stall and the arena. Increasing acceptance of being touched after being stroked on the neck suggests that this procedure should be adopted to improve routine handling of dairy cattle.
Key words: cattle, human-animal relationship, tactile stimulation, animal welfare

INTRODUCTION

Improving the human-animal relationship is important because it has beneficial effects on animal welfare and production as well as human working conditions and safety (Rushen et al., 1999; Hemsworth, 2003; Waiblinger et al., 2006). Genetic selection and improvement of handling facilities may help to attain this goal, but it is crucial to improve the human-animal interactions throughout life of an animal by avoiding aversive and enhancing positive or pleasant interactions with humans (Boivin et al., 2003; Waiblinger et al., 2006). The handling of animals might be improved by imitating the species-specific behaviors for establishing social bonds, which suggest that the best places for touching animals are those where they groom each other (Rushen et al., 1999). In cattle, social licking contributes to building and maintaining social affiliative relationships, characterized by spatial proximity between individual cows, increased tolerance, socio-positive interactions and social support in conflicts or challenging situations (Sambraus, 1969; Sato, 1984). Moreover, social licking likely reduces social tension within the herd (Waiblinger et al., 2002). During routine practices in dairy cattle husbandry, some stock people regularly use gentle tactile interactions such as stroking, resembling the tactile stimulation of social licking by another cow (Hemsworth et al., 2000). In previous studies, tactile stimulation of cattle by a human was mostly used to-

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gether with other forms of contact such as talking or offering food (de Passillé et al., 1996; Munksgaard et al., 1997). Results on effects of gentle tactile stimulation per se without other forms of contact on their reactions to humans are still controversial in cattle (Boivin et al., 1998; Jago et al., 1999).

The manner of stroking (e.g., the body region onto which the tactile stimulation is directed) has received little attention, but may be influential. An uneven distribution of social licking at different body regions in cows (Sambraus, 1969), together with differing reactions of the licked animals (Schmied et al., 2005), suggests that tactile stimulation was perceived differently depending on the region. Because social licking was linked to affiliative social relationships in cattle, this could implicate that stroking the body regions licked most, like the dorsal (19%, median of total social licking) and ventral part (16%) of the neck, could be more effective for improving the relationship of cows to humans than body regions licked rarely such as the lateral part of the chest (0%). In a recent study in cattle, differences in immediate behavioral and physiological (heart rate) reactions to human stroking of body regions often or rarely licked in social licking were detected (Schmied et al., 2008). When the ventral part of the neck was stroked, cows more likely showed behavioral reactions similar to those observed during social licking (e.g., neck stretching) and had similar physiological responses (i.e., a decrease in heart rate). This variation in the dairy cattle perception of stroking different body regions leads to the question of whether this stroking has an effect on the cattle-human relationship. Different procedures were developed for testing the animal-human relationship with different human cues (Waiblinger et al., 2006). For example, the avoidance of an approaching human and voluntary approach behavior toward a stationary human are 2 measures widely used to assess the animal relationships to humans. Several tests seem necessary for assessing the animal-human relationship because they are all influenced by different emotions and motivations (e.g., fear due to isolation and novelty in an unfamiliar environment or exploratory motivation) apart from the animal-human relationship itself (de Passillé and Rushen, 2005; Waiblinger et al., 2006).

Therefore, the 2 aims were 1) to investigate whether dairy cows show less marked avoidance and more approach behavior when stroked regularly toward an experimenter as compared with cows exposed to simple human presence, and 2) to investigate if the body region stroked affects approach and avoidance behavior. We predict that cows will approach the human more and avoid less when stroked at the ventral side of the neck, an area commonly licked in allogrooming.

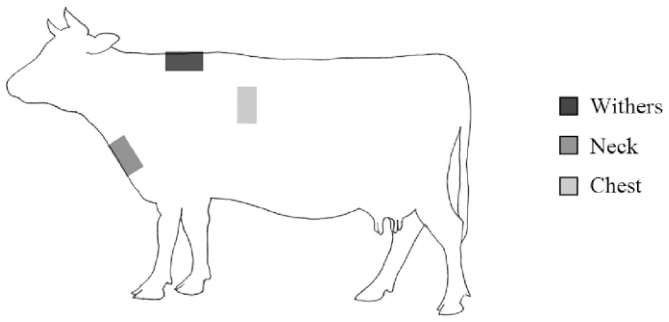

Figure 1. Location of the 3 body regions stroked in 60 dairy cows to test the effects on avoidance and approach behavior toward humans.

MATERIALS AND METHODS

Animals and Housing

The experiment was carried out in February and March 2003 with 30 Brown Swiss and 30 Austrian Simmental lactating cows of the Teaching and Research Estate of the University of Veterinary Medicine Vienna in Lower Austria. The cows were 4.7 ± 1.8 yr (mean ± SD), milk yield was 5,700 ± 1,800 kg/yr, and they averaged 2.6 ± 1.6 lactations. The 60 cows were randomly selected from a herd of 80 cows, excluding dry cows (4 to 6 wk before parturition). All cows were reared under the same housing (loose housing during rearing, tied since first calving) and management conditions. During the experiment the cows were milked twice daily by their regular milk persons. The cows were used to different stock people and to frequent human contact, but they were not used to regular stroking at the 3 body regions used in this experiment. Human contact was limited to necessary management routines during the experiment.

Treatment

The cows were divided into 4 treatment groups balanced for breed, age, state of pregnancy, number of lactations, and tethering position. There were 3 stroking groups and 1 control: in the first stroking group the experimenter (female, 175 cm, and 68 kg, unknown to the animals prior to the experiment) stroked the ventral part of the neck (neck, in Figure 1). The second stroking group was stroked at the withers. These were body regions licked mostly in social licking of cows (Schmied et al., 2005). The third stroking group was stroked at a body region rarely licked during social licking, the lateral side of the chest (chest, Figure 1). The experimenter approached the animals from the back by addressing them gently in a standardized manner ("cow's name" and "good cow"), and then positioned herself by

Main course	Day (d)/week (wk)/month (mo)	Detailed description
Tests before	d −27	APT, SPT
	d −26	Arena (cow 1 to 40)
	d −25	Arena (cow 41 to 60)
Experiment immediate reactions	d −24	Each cow stroked once for 6 min (2 min on neck, withers, chest), 1st session (Schmied et al., 2007)
	d −23	
	d −22	
Treatment	wk −3 (d −21 to −15)	3 stroking event groups: neck, withers, chest 1 control: human presence
	wk −2 (d −14 to −8)	
	wk −1 (d −7 to 0)	
Tests immediately after	d 1	APT, SPT
	d 2	Arena (cow 1 to 40)
	d 3	Arena (cow 41 to 60)
Experiment immediate reactions	d 4	Each cow stroked once for 6 min (2 min on neck, withers, chest), 2nd session (Schmied et al., 2008)
	d 5	
	d 6	
No contact	d 7	No contact with experimenter
	wk 2 (d 8 to 14)	
	wk 3 (d 15 to 21)	
	wk 4 (d 22 to 28)	
Tests after 4 wk	d 29	APT
	d 30	Arena (cow 1 to 40)
	d 31	Arena (cow 41 to 60)
No contact	wk 5 (d 32 to 35)	No contact with experimenter
	wk 6 (d 36 to 42)	
	wk 7 (d 43 to 49)	
	wk 8 (d 50 to 56)	
Test after 8 wk	d 57	APT
No contact	mo 3 (wk 9 to 12)	No contact with experimenter
	mo 4 (wk 13 to 16)	
Test after 4 mo	d 113	APT

Figure 2. Time schedule of the experiment indicating the treatment (3 wk of stroking beginning at d −21 or human presence) and the 5 times when behavioral tests were performed; APT = approaching person test; SPT = stationary person test; arena = arena test.

the left shoulder of the cow, remaining quiet for the entire procedure. The stroking treatment (d −21 to 0 in Figure 2) was carried out for 5 min/d on 5 d/wk for 3 consecutive weeks (total 15 d for 75 min of tactile stimulation per cow). Leather protective gloves with a suede palmar side were used for the stroking, and stroking speed was between 40 to 60 strokes/min, thereby imitating the speed of social licking (Schmied et al., 2005). The control group consisted of cows exposed to simple human presence. In the presence-only treatment, the experimenter stood still by the left chest with arms by the side, using the same approach routine, time schedule, and position as in the stroking groups.

The cows used were the same animals as used by Schmied et al. (2008) investigating immediate reactions to stroking (Figure 2). In each session of Schmied et al. (2008), all cows were stroked for 2 min on each of the 3 body regions (on 1 of the 3 experimental days); thus each cow had experienced 6 min of stroking before the treatment within the present study. When cows were

tested for the first time (d –27 to –25), they had no experience with the stroking treatments.

Behavioral Tests

To detect changes in the reactions of cows to the experimenter, 3 behavioral tests measuring the reactions to a (stationary or moving) person in the home stall or a novel environment were carried out before and after the treatment with all animals of the 4 treatment groups (Figure 2). The person who carried out the treatment was also the experimenter of these tests, and she wore the same clothing during both the treatment and the testing.

Two tests were carried out in the home environment:
1. Approaching person test (**APT**): reactions to an approaching person in the home tie-stall;
2. Stationary person test (**SPT**): reactions to a stationary person in the home tie-stall.

In these 2 trials the cows were tested in the same place where they were tethered throughout the entire experiment.

One test was carried out in a novel environment:
3. Arena test: reactions to a stationary person in an arena used only for experimental purposes.

APT. The avoidance reactions were measured with a procedure used by Waiblinger et al. (2003), who conducted this test with loose-housed dairy cows restrained in the feed barrier. We modified the test for tethered cows.

The test procedure started with the experimenter positioned in the feeding aisle 1.5 m in front of a cow standing in her home tie-stall. The experimenter held her arm overhand (the backside of the hand was directed to the muzzle) in an angle of 45° in front of the body, looking at the muzzle, and waited for attention of the focus cow. Then, the experimenter approached the cow slowly with constant speed (1 step/s, practiced before the experiment) from the front until the animal withdrew or until the cow was touched. The distance between the back of the experimenter's hand and the muzzle at the moment of withdrawal was determined (10 cm resolution) or the time (s) a cow tolerated touching was recorded. Withdrawal was defined as stepping back or turning the head away (>90°). If the cow accepted being touched at the muzzle, the experimenter ran the hand to the cheek and tried to stroke the cheek for up to 6 s. Table 1 lists and defines the reactions and the scores assigned to each animal. High interobserver reliability ($r \geq 0.97$, $P < 0.001$) on these criteria was observed in another study (I. H. Windschnurer, C. Schmied, S. Waiblinger, Inst. Anim. Husb. and Anim. Welf.; X. Boivin; unpublished data).

Table 1. Score of avoidance reactions in the approaching person test

Score	Behavioral reaction
1	Stroking the cheek for >5 s possible
2	Stroking the cheek for 3 to 5 s possible
3	Stroking the cheek for 1 to 2 s possible
4	Avoidance immediately after touching the muzzle
5	Avoidance <10 cm
6	Avoidance between 10 to 20 cm
7	Avoidance >20 cm

Each animal was tested 3 times at an interval of at least 15 min; an average score was used for statistical analysis. The APT was carried out 5 times, once before (d –27), and 4 times after the treatment (d 1, 4 wk, 8 wk, and 4 mo), to examine how long the stroking effect would endure (Figure 2).

SPT. This second test was carried out according to Munksgaard et al. (1997). In the home tie-stall, the experimenter (hands in pockets) walked slowly (1 step/s) toward a position in front of the standing cow. The test started when the experimenter had reached the test position 0.75 m in front of the bar to which the cow was tethered. During the actual test situation, the experimenter (hands in pockets) stood still for 60 s. The position of the cows was videotaped and scored every 5 s, beginning 5 s after the test had started, according to the criteria listed in Table 2. One overall score per animal, averaged over the 12 scans, was calculated. The SPT was carried out once before the treatment (d –27) and for the second time immediately after the treatment (d 1; Figure 2). Because no difference was observed between the treatment groups in these 2 test sessions, this test was not repeated.

Arena Test. The arena for testing the voluntary approach of the cows in a new environment was built of paddock panels (Patura, Laudenbach, Germany) outdoors beneath the barn and measured 7.2×7.2 m. There was no possibility of visual contact with herd mates. From the start of the test, the experimenter was standing in the middle of the side opposite the entrance. The experimenter in the test position was surrounded by 2 semicircles marked with sawdust at radii of 1 and 3 m, respectively. The experimenter remained motionless

Table 2. Score of reactions in the stationary person test

Score	Position of the cow
1	In contact with the experimenter
2	Muzzle in front of the tie bar
3	Muzzle at level with the tie bar
4	Muzzle behind the tie bar
5	Muzzle behind the tie bar and the chain fully extended
6	Muzzle behind the tie bar and the head turned away from the experimenter

with the hands in her pockets throughout the 5-min test. In a gentle procedure, each single cow was moved to the arena; 2 people (a regular stock person of the research farm and a technician of the Institute of Animal Husbandry and Animal Welfare, both male) led the cow carefully with a halter, a procedure the cows were used to through routine husbandry on the farm. The test started after the entrance was closed by the assistants. The halter remained on the cow. During the test, apart from the experimenter, no other human was visible to the cow.

Latencies were measured for approaching within a distance of 3 m, 1 m, and to establish contact with the experimenter (cow sniffed at or licked the experimenter). The experimenter recorded the latencies directly by using a stop watch with interval memory in her pocket and recorded these values directly after the end of the test before the next cow was tested. The tests were video-recorded, but due to technical problems no additional observation was possible. The arena test was carried out 3 times, once before (d –26 to –25) and twice after the treatment (d 2 to 3 and wk 4; Figure 2). Unfortunately, it was not possible to test the animals later on.

Statistics

Statistical analyses of behavioral test data were carried out with the software package SPSS, version 14.0. Due to nonnormal distributions, heterogeneity of the variances, and some measures on an ordinal scale, behavioral traits were analyzed using nonparametric statistics. Testing for differences between the 4 groups within 1 test session was done by means of the Kruskal-Wallis test followed by the Mann-Whitney test. The differences between the individual test sessions (development of reactions over time) within each treatment were tested by means of the Friedman test and the Wilcoxon test. Results with a $P \leq 0.05$ were considered significant, whereas those with $P > 0.05$ but ≤ 0.1 were described as tendencies.

RESULTS

APT

Before the treatment, there were no differences in avoidance reactions among the 4 treatment groups ($P = 0.422$, Table 3). Immediately after the treatment (d 1), after 4 wk, as well as 8 wk later, the groups differed (Table 3) with the group that had been stroked on the ventral neck, showing lower scores (median: 3.33) as compared with the animals of the chest-group and the control (4.00; $P < 0.05$); animals stroked on the withers were intermediate. In the neck-group the 75th percentile level was ≤ 3.75, which indicates that at least 75% of the animals accepted being touched on their heads after the ventral part of the neck had been stroked during the treatment. By contrast, at least 50% of the cows in the other treatment groups did not accept being touched on their heads (median: 4.00). The effect disappeared after 4 mo ($P = 0.645$). The 3 other treatment groups did not differ significantly from each other in the APT (Table 3).

A change over time was found for cows stroked on both the neck and the withers (Table 3): the scores of the cows having been stroked at the neck ($P < 0.001$) or the withers ($P < 0.01$) decreased over time to 4 wk, that is cows showed less avoidance and increasingly tolerated being touched at their heads immediately after these treatments. The avoidance scores of the animals of the chest-group tended to be lower ($P = 0.062$), whereas in the control no difference was found immediately after the treatment through 8 wk ($P = 0.972$). Avoidance in the control group increased ($P < 0.05$) in mo 4 compared with before or d 1 to 3 after the treatment. The effects of stroking the ventral part of the neck and the withers persisted over 4 (neck: $P < 0.001$; and withers: $P < 0.01$) to 8 wk ($P < 0.01$; and $P < 0.05$), but were no longer found after 4 mo ($P = 0.115$; and $P = 0.260$). No effect was found in the chest-group after 4 wk ($P = 0.526$), 8 wk ($P = 0.478$), or after 4 mo ($P = 0.461$).

SPT

The 4 treatment groups did not differ in the scores of the SPT on d –27 ($P = 0.395$) and d 1 ($P = 0.671$, Table 3). In general, the scores of this test were rather low (no avoidance) in our 60 cows (median, 25th to 75th percentile: first test: 2.17, 1.75 to 2.92; second test: 2.00, 1.33 to 2.58).

Accordingly, there was no significant change between the time before and after the treatment (Table 3). Because this test did not show any difference between the 4 treatment groups and no significant change over time, it was only performed twice.

Arena Test

In the first arena test before the treatment period (d –26 to –25), the latencies to come within a distance of 3 m, 1 m, or to establish contact with the experimenter did not differ among the 4 treatment groups ($P > 0.471$, Table 4).

The 4 groups showed no differences in latency to the approach within a distance of 3 m immediately after treatment (d 2 to 3). There was a tendency after 4 wk ($P = 0.078$) for cows having been stroked on the withers to approach quicker within 3 m than those stroked on

Table 3. Avoidance reaction scores (median; 25th to 75th percentile) of the 4 treatment groups (ventral part of the neck = neck, withers, lateral side of the chest = chest, control) in the 2 tests in the home tie-stall (APT = approaching person test; SPT = stationary person test) at the different test times

Test[1]	Neck	n	Withers	n	Chest	n	Control	n	P (KW[2])
APT									
Before	4.00 (4.00 to 4.33)^{x}	15	4.33 (4.00 to 5.67)^{w}	15	4.33 (3.67 to 4.67)^{xy}	15	4.00 (3.67 to 4.33)^{x}	15	NS
After	3.33 (2.25 to 3.75)^{a,y}	14	4.00 (2.67 to 4.33)^{ab,xyz}	15	4.00 (3.33 to 4.33)^{b,x}	15	4.00 (3.33 to 4.67)^{b,x}	15	*
4 wk	3.00 (1.59 to 3.75)^{a,z}	14	4.00 (3.00 to 4.00)^{ab,y}	15	4.00 (3.75 to 4.59)^{b,x}	12	4.00 (3.59 to 4.75)^{b,xy}	14	**
8 wk	3.50 (1.58 to 3.92)^{a,y}	12	4.17 (3.33 to 4.67)^{b,z}	14	4.00 (3.67 to 4.33)^{b,x}	11	4.33 (3.50 to 5.00)^{b,xy}	13	*
4 mo	4.17 (3.58 to 4.33)^{x}	10	4.33 (3.67 to 5.08)^{wx}	14	4.33 (4.00 to 4.67)^{y}	9	4.33 (4.00 to 4.84)^{y}	14	NS
P (Friedman)	***		***		***		*		
SPT									
Before	2.42 (1.71 to 3.00)	15	2.38 (1.67 to 2.98)	15	1.83 (1.75 to 2.30)	15	2.42 (1.92 to 2.92)	15	NS
After	2.04 (1.17 to 2.33)	14	2.00 (1.62 to 2.81)	15	1.83 (1.33 to 2.14)	15	1.92 (1.33 to 2.92)	15	NS
P (Wilcoxon)	NS		NS		NS		NS		

[a,b]Medians within a row with different superscripts differ (Mann-Whitney: $P < 0.05$).

[w–z]Medians within a column with different superscripts differ (Wilcoxon: $P < 0.05$).

[1]Before = before the treatment (d –27); After = immediately after the treatment (d 1); 4 wk = after 4 wk; 8 wk = after 8 wk; and 4 mo = after 4 mo.

[2]KW = Kruskal-Wallis.

***$P < 0.001$; **$P < 0.01$; *$P < 0.05$; and NS = not significant.

the chest (median: 12 vs. 25 s). For approaching within 1 m, the 4 treatment groups tended to differ immediately after the treatment (d 2 to 3; $P = 0.097$); after 4 wk, the animals of the 3 stroking groups approached within 1 m sooner (neck: 39 s; withers: 57 s; chest: 48 s) than the control animals (92 s; for all 3 groups: $P \leq 0.05$).

In the second arena test immediately after the treatment (d 2 to 3), cows of all 3 stroking groups approached to sniff at or lick the experimenter quicker than the 300 s for control cows (240 s, neck: $P = 0.07$; 186 s, withers: $P < 0.01$; 145 s, chest: $P < 0.01$, Table 4). Yet, the 3 stroking groups did not differ from each other ($P > 0.354$). After 4 wk, cows stroked at the neck were faster (184 s) to approach the human compared with the controls (300 s; $P < 0.05$). After 4 wk, despite higher median the 75th percentile level was below 300 s in the neck-group in contrast to the other stroking groups, which indicated that at least 75% of the animals having been stroked at the ventral part of the neck during the treatment approached to sniff at or lick the experimenter in the arena.

The 4 groups differed in how the response in the arena test changed over time (Table 4). Immediately after the treatment (d 2 to 3) cows of all 3 stroking

Table 4. Approach behavior (latency in s; median; 25th to 75th percentile) of the 4 treatment groups (ventral part of the neck = neck, withers, lateral side of the chest = chest, control) in the arena test during the different test times

Test[1]	Neck	n	Withers	n	Chest	n	Control	n	P (KW[2])
Approach <3 m									
Before	47 (36 to 56)^{x}	15	35 (24 to 91)^{x}	15	53 (40 to 78)^{x}	15	52 (38 to 58)	15	NS
After	10 (5 to 31)^{y}	14	12 (3 to 26)^{y}	15	25 (13 to 48)^{y}	15	24 (8 to 80)	15	NS
4 wk	1 (1 to 15)^{y}	14	2 (1 to 28)^{y}	15	5 (1 to 28)^{y}	11	23 (6 to 62)	14	NS
P (Friedman)	***		**		**		NS		
Approach <1 m									
Before	202 (110 to 300)^{x}	15	195 (148 to 293)^{x}	15	202 (102 to 300)^{x}	15	300 (134 to 300)^{x}	15	NS
After	67 (25 to 158)^{y}	14	95 (40 to 132)^{y}	15	83 (23 to 190)^{y}	15	170 (35 to 300)^{x}	15	NS
4 wk	39 (21 to 62)^{a,z}	14	57 (15 to 118)^{a,y}	15	48 (29 to 64)^{a,y}	11	92 (64 to 265)^{b,y}	14	*
P (Friedman)	***		***		***		*		
Contact with person									
Before	300 (285 to 300)^{x}	15	300 (257 to 300)^{x}	15	300 (235 to 300)^{x}	15	300 (277 to 300)	15	NS
After	240 (111 to 300)^{ab,y}	14	186 (112 to 300)^{a,y}	15	145 (105 to 300)^{a,y}	15	300 (290 to 300)^{b}	15	**
4 wk	184 (74 to 261)^{a,y}	14	148 (80 to 300)^{ab,y}	15	115 (69 to 300)^{ab,y}	11	300 (239 to 300)^{b}	14	*
P (Friedman)	**		**		*		NS		

[a,b]Medians within a row with different superscripts differ (Mann-Whitney: $P < 0.05$).

[x–z]Medians within a column with different superscripts differ (Wilcoxon: $P < 0.05$).

[1]Before = before the treatment (d –26 to –25); After = immediately after the treatment (d 2 to 3); and 4 wk = after 4 wk.

[2]KW = Kruskal-Wallis.

***$P < 0.001$; **$P < 0.01$; *$P < 0.05$; NS = not significant.

groups approached within a distance of 3 m, 1 m, and established contact with the experimenter quicker than before (10, 67, and 240 s, neck: $P < 0.01$; 12, 95, and 186 s, withers: $P < 0.01$; 25, 83, and 145 s, chest: $P < 0.05$, respectively). These effects persisted over 4 wk. In contrast, there was no change in the control group, except for a reduction in the latency to come within 1 m 4 wk after the treatment compared with before treatment (92 vs. 300 s; $P < 0.05$).

DISCUSSION

Tests in the Home Tie-Stall

APT. The results of the APT support our hypothesis that the effect of human contact depends on the body region that is stroked. Stroking body regions licked most in intraspecific social grooming (ventral neck and withers) decreased avoidance of an approaching human and increased acceptance of being touched on the head, and this effect lasted several weeks. In contrast, stroking the lateral side of the chest resulted in only a small and short-lasting decrease in avoidance. Effects were most pronounced in cows stroked at the ventral part of the neck, the only group differing significantly from the control up to 8 wk after the stroking treatment.

In the APT, the experimenter approached the cows from the front in their normal tethered position and, if possible, touched their muzzles. When the cow accepted contact, the experimenter ran the hand to the cheek and tried to stroke the cheek. The head area of cattle is particularly sensitive; it is involved in most social interactions and tactile contact of longer duration was seen during affiliative social interactions (Schmied et al., 2005). The specific result observed for stroking the neck, as compared with the other regions, suggests that stroking this region is effective to habituate cows to such touching. This result could be explained by habituation to being touched in the head region because the hand was closer to the head when stroking the neck compared with the other treatments. On the other hand, behavioral and physiological data suggest a relaxation state in the cows being stroked at the ventral part of the neck (Schmied et al., 2008).

The response to the experimenter during the APT may reflect an improvement of the animal-human relationship based on the rewarding effect stroking the ventral part of the neck. Stroking the body regions licked most (neck and withers) elicited more behavioral reactions that were similar to those observed during social licking (neck stretching, ear hanging) as compared with stroking the chest (Schmied et al., 2008). Additionally, stroking the ventral neck was the only treatment effective in eliciting a physiological response because it resulted in a significant decrease in heart rate (3 beats/min). Finally, the different responses of cows to a human approaching them from the front cannot be explained by the position of the experimenter during the treatment because the person stood by the left shoulder of the cows in all 4 treatment groups.

By contrast to the neck, no differences were found for stroking the lateral side of the chest in the APT compared with the control. This result indicated that this body region may be too far from the head for a generalization of the response to being stroked there or that stroking this body region probably does not have the same rewarding value as observed for the neck. The latter interpretation could explain why this body region is almost never licked during intraspecific social grooming.

SPT. In the second test conducted by a stationary person in the home environment, no difference was found between the 3 stroking groups and the control as well as between the different stroking groups.

This lack of difference between the treatment groups may be explained by the cows being used to different people present in the feeding aisle at a distance similar to the distance between the experimenter and the barn in the SPT. Munksgaard et al. (1997) found differences when comparing the effects of positive (stroking, speaking friendly, offering food) and aversive (sudden movements, hitting with hand) handling treatments. In the beginning of their study, cows scored 3.4, after aversive treatment 3.1, and after gentle treatment 2.2 (all scores for the home stall). Still, the median avoidance score of our 60 cows was 2.17 before the treatment, similar to the value attained after gentle treatment in the study of Munksgaard et al. (1997). This suggests that this test may show differing results only for more fearful animals. Thus, if cows were not very fearful, this test may not be sufficiently sensitive for measuring effects of positive handling (Waiblinger et al., 2006).

Test in the Novel Environment: Arena Test

In the arena test, cows exposed only to the presence of the experimenter took longer to approach than any of the stroked treatments. Yet, cows did not differ significantly in time to approach based on the region stroked. Thus, our hypothesis on stroking body regions mostly licked in intraspecific social grooming being more effective for the purpose of improving the animal-human relationship, indicated by an increased approach of the cows to humans, was not supported in this test situation.

Stroking any region could have simply led to a habituation to the close presence of the human, as suggested by Boivin et al. (1998). The distance cows keep to humans was greater for cows that had experienced nega-

tive handling and less when they had experience with gentle contact including stroking (Munksgaard et al., 1997; Waiblinger et al., 2003). Thus, stroking in general may help reduce the approach distance such that cows are quicker to approach the human.

The arena test, also called a standard human approach test when it included a motionless human stimulus, was developed to test fear of humans in a standardized environment (Hemsworth and Coleman, 1998). The test conditions could possibly inhibit the expression of behavioral differences according to the stroked body regions because the test was designed to detect changes in another dimension of the animal-human relationship (i.e., fear of humans) and less the positive dimension of the relationship toward humans. Through testing in the arena, we may have potentially confounding factors of tests in an unfamiliar environment (e.g., pretest moving to the arena, novelty, social isolation) possibly overriding the effect depending on the body region stroked. The standard human approach test was generally performed with a first period of few minutes of familiarization to the test arena before the human entered the test pen (Hemsworth et al., 1996). But, in our experiment, the familiarization period was excluded due to time constraints and to standardize the starting distance of cows to the experimenter. This may have increased the impact of the confounding factors. Another possible explanation could be that the effects of stroking various body regions found in the home environment might not be generalized to a novel situation because cows may react according to the handling (stroking) only in the location of this handling (de Passillé et al., 1996; Jago et al., 1999). Nevertheless, our animals did generalize their perception of the human to another location when they were stroked as compared with experiencing mere presence of the human in the home pen.

Comparison of the Behavioral Tests

All tests had the same underlying principle. Animals that are the most fearful of humans will keep the greatest distance from them. Alternatively, animals which are the most confident might approach themselves, or allow a human to approach (de Passillé and Rushen, 2005). However, the discrepancies between the tests point to a difference in the perception of the different test situations. Such differences in the perception of cows are most likely related to differences in test conditions, namely variation in behavior of the experimenter (stationary or approaching) and the familiarity of the environment and the test location (Waiblinger et al., 2006). In general, tests assessing approach behavior and tests assessing avoidance reactions do not appear as alternative ways of measuring the same thing, but rather measure different dimensions of the relationship with humans (de Passillé and Rushen, 2005; Waiblinger et al., 2006). For example, Hemsworth et al. (2000) found negative associations of avoidance distances to an approaching human with positive behavior of milkers (positive dimension), whereas approach behavior in a standard arena test correlated negatively only with negative behavior of milkers (fear). This could be an explanation for the detection of differences between the stroked body regions only in the APT.

General Discussion about the Effect of Stroking on Cow Behavior

In cattle, few studies have tried to demonstrate the effect of gentle tactile stimulation per se, and Jago et al. (1999) with dairy calves as well as Boivin et al. (1998) with beef calves failed to observe such an effect despite 2 wk of daily stroking (without other forms of contact) in early life. In this last study, very few animals approached the familiar stationary person at all. Our study is the first to demonstrate the beneficial effects of stroking without other forms of contact for cattle.

Possible reasons to explain the difference between our results and those of previous studies are numerous and include the duration of the stroking period or the social environment of the treatment. But, one difference in the present experiment is that dairy cows were the subjects. Through the milking process and the tie-stall housing, dairy cows were used to close human presence and contact, suggesting they may have had a different perception of stroking as compared with the calves in previous studies. Indeed, calves stroked or brushed from an age of few days on were not habituated to close human presence before this treatment (Boivin et al., 1998; Jago et al., 1999). This interaction between the level of human-animal relationship and the perception of the cows should be considered in further studies, in particular in cattle with less human contact. Another possible important difference arises from the body regions stroked. In Jago et al. (1999), the body regions stroked were mainly the dorsal and lateral side of the neck and the shoulders (J. G. Jago, Dexcel Ltd., Hamilton, New Zealand; personal communication), and in Boivin et al. (1998) the backs of the calves were brushed. Results of our study show clearly that the best effect for improving the animal-human relationship, via decreasing avoidance reactions, was observed for stroking the ventral part of the neck.

Practical Implications and Future Research Questions

The ratio between positive and negative interactions is a decisive factor in the cattle-human relationship

[i.e., necessary negative interactions due to farm management should be outweighed by rewarding elements of human-animal interactions (Hemsworth, 2003)]. Stroking the ventral part of the neck displayed most immediate beneficial effects for the cows (Schmied et al., 2007). Accordingly, the results of our present study show that stroking cows, particularly on their ventral neck, decreased avoidance of the human and facilitated touching the animals. This could make them easier to handle in daily routine with lower risk of accidents and improve their welfare. In commercial dairy farms for example, fewer avoidance reactions of the cows in test situations were related to decreased stepping during milking (Rousing et al., 2004), and Waiblinger et al. (2004) showed that gentle treatment including stroking (mainly the ventral neck) decreased kicking of cows during rectal palpation. Furthermore, the persistence of the effect of stroking the ventral neck over at least 8 wk without further stroking denotes that repeated tactile stimulations for a few minutes a day for 3 wk could have a long lasting effect on the reactions of dairy cows toward humans. Finally, because social licking, which is often directed to the ventral part of the neck accompanied with neck stretching and lowest heart rate of the licked animal (Schmied et al., 2005), is positively related to milk production in cows and weight gain in calves (Wood, 1977; Sato, 1984), stroking of this body region could have positive effects on health, well-being, and production of dairy cows.

In studies of loose-housed dairy herds, a higher percentage of cows accepting touching on their head was related to more positive behaviors of the stock people (talking quietly, petting, touching) toward their animals (Waiblinger et al., 2003); those farmers providing much gentle tactile interaction often targeted the ventral neck and start with such interactions early in the lives of calves (S. Waiblinger, personal observation). Nevertheless, general conditions might vary across farms and across categories of cattle. Adult dairy animals are handled twice or three times daily, whereas calves, heifers, or beef cattle often are handled less regularly, and occasions for handling are limited if interacting with the animals does not have priority for the stock person.

In future studies, stroking the ventral neck could be applied to loose-housed dairy or beef cattle with a higher level of fear of humans to investigate whether stroking this body region is effective in animals which are more naïve to human contact. Additionally, testing with unfamiliar experimenters would add information about whether stroked cows generalize their reactions across people. Recent studies found similar responses of cattle to familiar and unfamiliar persons after aversive as well as gentle handling (Krohn et al., 2001; Breuer et al., 2003), although cattle clearly are able to discriminate between people (Rybarczyk et al., 2001) and react differently according to former handling experiences (de Passillé et al., 1996; Munksgaard et al., 1997). Additionally, it could be interesting to test other possibly sensitive body regions that are far from the head (e.g., the basis of the tail, which is often used by farmers trying to calm down cows) using the same experimental design. As human contact was effective in young animals (Boivin et al., 2003), stroking different body regions could be tested in dairy and beef calves during these sensitive periods using regions of the body which are licked by the mother during suckling.

CONCLUSIONS

Cattle that are stroked regularly in the home pen were more likely to approach a human in an arena. The effects of stroking varied with the region of the body that was touched during the treatment period. Cows stroked on the ventral side of the neck showed less avoidance when a human approached them and tried to touch their head in the home pen. Cattle clearly remembered this stroking, and the reduced avoidance in the home pen lasted weeks beyond the initial treatment. These results indicate that regularly stroking allowed cattle to habituate to humans and made them more willing to approach. This work is the first to focus on body regions licked in allogrooming and to test these effects without other commonly used "gentling" such as talking softly and offering food.

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