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The relationships between attitudes, personal characteristics and behaviour of stockpeople on dairy goat farms

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Abstract

*The aim of this study was to investigate the human-animal relationship on dairy goat farms, in particular associations between stockpeople's attitudes towards goats (*Capra hircus*) and actual behaviour when handling goats and making decisions. Data were collected on 45 Austrian and German dairy goat farms. Attitude questionnaires of 119 stockpeople (58 female, 61 male) were analysed and 14 attitude components were extracted by five Principal Component Analyses (PCA) regarding general attitudes about goats and human-animal relationship, behavioural attitudes about specific human-goat interactions and interactions during milking, and affective attitudes. To investigate associations between stockpeople's attitudes and their subsequent behaviour, we calculated linear and logistic regression analysis on their behaviour during milking (n = 53 milkers) and on management decisions (n = 45 farms). Several attitude components were predictors of behaviour during milking. The attitude 'Needs of goats' was included in all models: the higher stockpeople scored on 'Needs of goats', the more positive interactions they showed and the less likely they were to use negative interactions. Gender influenced five attitude components: females showing greater agreement than males on positive general and affective attitudes, eg 'Needs of goats.' Regarding management, the more strongly decision-makers disagreed on using negative interactions during milking, the better was their farm's housing and management. To conclude, these results highlight the importance of the stockpeople's attitudes, not only for the interactions with their animals, but also for their decisions related to management and housing. Our results indicate opportunities for improvement of animal welfare by training specifically targeting stockpeople's attitudes.*

Keywords: *animal welfare, goats, human-animal relationship, milker behaviour, small ruminants, stockmanship*

Introduction

Farmers' influence over their animals' living conditions and well-being should not be underestimated (Coleman & Hemsworth 2014) since they determine — or at least strongly influence — most of the animals' environment via their decisions on housing and management. Farmers' management practices concern, for example, quality, quantity and frequency of feeding, hygiene management, composition and stability of the social environment (eg regrouping) and care for diseased animals. Further, farmers' interactions with their animals directly affect animal welfare by eliciting negative or positive emotions as well as associated physiological responses (in terms of stress or anti-stress effects), leading to long-term effects on health and well-being (Waiblinger *et al* 2006b; Hemsworth *et al* 2009; Waiblinger 2019). Thus, farmer behaviour — including direct interaction and management — is an important component to animal welfare.

Attitudes can explain differences in behaviour between people (Ajzen & Fishbein 1980; Eagly & Chaiken 1993; Hemsworth & Coleman 2011). Attitudes are subjective evaluations of an attitude object (eg object, living being, behaviour) and they reflect the extent to which a person likes or dislikes something (Maio & Haddock 2009; Hemsworth & Coleman 2011). Attitudes are extremely influential, as they not only guide behaviour but also influence attention, interpretation of information and memory (Maio & Haddock 2009). Cognitive aspects of an attitude include what a person knows or believes about an attitude object, while affective attitudes reflect how a person feels about it (Allport 1935; Eagly & Chaiken 1993; Albarraccin *et al* 2005). Generally, these aspects are consistent with each other; for example, a farmer who has positive beliefs about stroking cows, eg rating importance of stroking cows high, will also have positive affective responses, ie will enjoy stroking them (Waiblinger *et al* 2002; Maio & Haddock 2009).

Demographic variables (eg age, gender, education) or farm characteristics (eg herd size) may influence human attitudes and behaviour (Herzog 2007; Muri *et al* 2012; Wikman *et al* 2016). Knowledge about these influences is important to gain a better understanding of differences in stockperson attitudes and behaviour and thus of the human-animal relationship (HAR) on farms and helps in developing improvement strategies for behavioural changes of stockpeople, eg by targeting

education of future generations of stockpeople or providing information relevant to audience (De la Fuente *et al* 2015).

The sequential relationships of attitudes with actual farmer or stockperson behaviour and consequently with animal behaviour, welfare and production were confirmed in different farm animal species (Hemsworth *et al* 1994; Breuer *et al* 2000; Hemsworth *et al* 2000; Lensink *et al* 2000; Waiblinger *et al* 2002), but not yet for dairy goats (*Capra hircus*), where research on the HAR is still quite limited. To our knowledge, there have been no studies investigating farmers' or stockpersons' attitudes in relation to their behaviour towards their goats during routine handling. In a questionnaire survey with Norwegian dairy farmers, Muri *et al* (2012) and Muri and Valle (2012) investigated associations between farmers' attitudes towards goats, goat-oriented empathy, demographic variables and provision of veterinary treatment. In an on-farm study by Muri *et al (*2013), farmers' positive attitudes towards petting goats were negatively related to the goats' reaction towards an unfamiliar human in the milking parlour. Also, the behaviour of the farmer when trying to mark animals in a test situation and the animal's immediate reaction to this handling were associated — however potential associations of attitudes and human behaviour were not reported (Muri *et al* 2013). In a recent study on Italian goat farms, farmers' attitudes and the goats' vocal, approach or avoidance reactions towards an unfamiliar human in specific tests differed according to whether the HAR had been assessed as 'good' or 'poor' beforehand by a technical advisor (Battini *et al* 2016). In all these studies, the actual behaviour of stockpeople towards their goats during routine handling was not observed. The only study including both attitudes and behaviour of the farmer used a test situation to observe farmer behaviour and did not correlate it with attitudes (Muri *et al* 2013). Further, the cognitive and affective components of attitude were not distinguished.

Mersmann *et al* (2016) investigated the associations between caretaker behaviour during milking and goats' behaviour towards an unfamiliar human in four standardised test situations. The proportion of negative milker interactions was associated with more avoidance and less approach behaviour towards the person in all four tests. Within the same on-farm study, data on farmers' and caretakers' attitudes were collected that will be evaluated in the present article. The aim was to survey stockpeople's attitudes towards dairy goats and towards handling them, including beliefs, behavioural intentions, and affective attitudes, and to: (i) investigate factors such as demographic variables and farm characteristics that potentially influence attitudes; (ii) explore associations of attitudes with stockpeople's actual behaviour when handling goats taking into account further potential predictors; and (iii) investigate the association of attitudes with decisions about management and housing. Thus, together with the results of Mersmann *et al* (2016), we investigate the whole sequential relationships of caretakers' attitudes with their behaviour and the consequential animal behaviour on dairy goat farms, while also considering further influencing factors. This will enhance our understanding of human-goat relationships.

Materials and methods

Stockpeople and farms

One hundred and thirty-four stockpeople on 45 dairy goat farms in Austria and Germany took part in this study. The collection of data on attitudes and other aspects of the human-animal relationship was part of a larger project examining social stress and injuries on middle- to large-sized dairy goat farms in relation to horn status (Waiblinger *et al* 2010). So, farms keeping goats with fully intact horns and farms practicing disbudding, ie keeping goats without horns, were selected from a list of farms provided from breeding/farmer associations by telephoning farms in random order and taking regional distribution into account in final selection. Farms were required to fulfil the following selection criteria: minimum herd size of 80 dairy goats and minimum time of keeping goats of two years. Comparable variation of herd size between horned and dehorned herds and comparable regional distribution was also controlled for during selection. For final characteristics see *Results*.

Data collection

Each farm was visited on two consecutive days between March 2008 and November 2009. Data collection followed a fixed schedule and data relevant for the present study were recorded as follows: On day 1, milker behaviour was observed and thereafter stockpeople were asked to fill in the attitude questionnaire. On day 2, farmers were questioned in a structured interview about farm characteristics, including management decisions. Additionally, measures regarding housing conditions were directly assessed on both days. Prior to data collection, data collection methods were performed on two additional farms for the purposes of training. The study was performed in line with institutional guidelines and national legislation. No ethical approval was necessary.

Attitude questionnaire

All people working with the goats and aged a minimum of ten years old filled in a questionnaire, with the exception of six milkers unable to do so due to difficulties understanding German, resulting in 127 filled-in questionnaires. The questionnaire was based on previous versions for dairy cattle (Waiblinger *et al* 2002; Ivemeyer *et al* 2011) and modified for dairy goats to fit differing species characteristics, animal needs and handling procedures using input of goat farmers and preliminary observations of goat husbandry and handling. The finalised questionnaire comprised 130 attitude items in three main divisions with its subdivisions (see Table S1 for examples of items): division 1, general attitudes comprising beliefs about goats' characteristics and needs (subdivision 1, 51 items) and beliefs about the animal-human relationship (subdivision 2, 7 items); division 2, attitudes towards behaviour, also called behavioural attitudes further on, including beliefs about the importance of certain human-goat interactions (subdivision 1, 18 items) and behavioural intentions and beliefs regarding interactions during milking (subdivision 2, 37 items); division 3, affective attitudes, ie how comfortable

stockpeople feel about the contact with goats in certain situations (17 items). In addition, the questionnaire contained a section on subjective workload, including statements on the level of workload during different seasons (four items, see Table S1). The 130 items were measured on a seven-point Likert scale, with 1 indicating complete disagreement or discomfort or lowest importance, and 7 indicating strongest agreement, enjoyment or importance.

Stockpeople demographics

The questionnaire also included a section on stockpeople demographics. This part enquired about age, gender, whether the stockperson grew up on a farm and, if yes, on what kind of farm, years of experience in keeping goats and about educational background in agriculture. In the structured interview, farmers (who may also be stockpeople) were asked who the main caretaker and the decision-maker was.

Stockpeople's behaviour during milking and milking-related variables

The behaviour of the stockpeople was observed in the milking parlour by the same observer (DM) during evening milking of the first day of the farm visit (for repeatability of milking observations, see Waiblinger *et al* 2002). All interactions with goats were recorded thus including not only milking *per se* but also the moving of the goats in and out of the milking parlour, as long as the stockperson was not leaving it. If two or more people milked the goats, all were observed, with the observer focusing on one milker at a time. The proportion of time a milker was observed corresponded approximately to the proportion of goats milked by said milker. Tactile, acoustic and deliberate visual interactions by the milker towards the goats were recorded (see below for single behaviours, and Mersmann *et al* 2016, for detailed definitions) and categorised as positive, neutral and negative based on previous work (Waiblinger *et al* 2002).

For further analysis, tactile interactions were combined in three categories: positive tactile interactions (*Pos_t*; sum of touching, stroking, udder gentle), neutral tactile interactions (*Neu_t*; sum of patting, hand gentle, stick gentle, leg gentle, push/pull gentle, holding leg) and negative tactile interactions (*Neg_t*; sum of hand strong, push/pull strong, leg strong). Furthermore, tactile and acoustic interactions were summarised resulting in the total of positive interactions (*POS*; sum of *Pos_t* and talking calmly), neutral interactions (*NEU*; sum of *Neu_t* and talking dominantly) and negative interactions (*NEG*; sum of *Neg_t* and talking harshly). Visual interactions with the goats (*Vis*, sum of lifting arm with/without object in hand and waving hand with/without object in hand) were treated as a separate category. All variables represent interactions per milked goat, ie the number of interactions was divided by the observed number of goats milked by each milker. As different milking steps could be performed by different milkers, the number of goats milked by a milker was calculated by dividing the sum of instances where the milker was observed putting on or detaching teat cups by two. Additionally, the proportions of negative and positive interactions in relation to the total number of interactions (*propNEG*, *propPOS*) were calculated. To this purpose, the number of total interactions per milked goat (*TIA*) was calculated by adding up all interactions mentioned above plus acoustic other (eg whistling) and udder firmly, which were not categorised as positive, neutral or negative (see Mersmann *et al* 2016). Udder tactile (*Udder_t*) represents the number of all tactile interactions directed towards the udder (udder gentle, udder firmly, touching and stroking if directed towards the udder).

Milking and moving was not equally distributed amongst milkers on all farms due to division of work. As some interactions are more likely to occur during moving than during milking, the number of goats a milker moved in or out of the milking parlour during an observation (*MovedGoats*) was assessed by recording the number of times this milker moved a group of goats in or out of the milking parlour and multiplying it by the respective group size.

Milking management practices (ie wet and/or dry cleaning, forestripping, attaching and detaching teat cups, milking out the udder, antimicrobial spraying/dipping) varied between farms (and milkers). This might result in a varying number of steps of milking and, consequently, in a varying *TIA* between farms and milkers. Thus, the number of working steps (*MilkingSteps*) was also recorded.

In order to prevent changes in milker behaviour due to observation, milkers were told that the goats' reactions towards being handled were observed. At the end of data acquisition on the farm the milkers were debriefed as to the true aim (observation of the milkers' behaviour) and asked for permission to use the data. All milkers gave their permission.

Housing and management

Housing and management of the goats was evaluated extensively during farm visits by assessment performed by the researchers (including sensoric evaluation of feed, measuring dimensions of the barn and equipment and evaluating maintenance status, ie whether the equipment was functioning or [partly] broken) and, for management that could not be assessed directly in the barn, by a structured interview. The structured interview took place in the morning of the second day with the main decision-maker(s) of the farm and comprised pre-formulated open questions on farm data and management, eg number of caretakers and distribution of tasks, feeding management, management of social behaviour, kidding management, management of kids, young goats and bucks, animal health management. Farmers responded freely, the experimenter noted responses either by ticking fitting pre-formulated responses or writing down the response. Single characteristics were summarised into seven indices reflecting main functional areas of housing and management that potentially affect goat social behaviour and welfare: quality of roughage (four characteristics: hygiene and nutritional value of hay and of silage), feeding management and feeding area (five characteristics: feed rack type palisade, head partitions exist, feeding *ad libitum* according to interview and experimenter assessment, feeding fresh food more than once a day), general management of the

goats (three characteristics: special management for horned animals necessary, habituation of fresh milkers to milking parlour, control kidding), pen structure (five characteristics: eg outside run available, no dead-ends, no bottlenecks), management of social behaviour (ten charactereristics, eg no regrouping, no integration of older animals, rounding horn tips, kids with dams for ≥ 20 days), low competition at feeding and drinking (three characteristics, at least one drinker per 25 animals and two drinkers per pen, hay rack) and other aspects promoting well-being (four characteristics, eg brushes available, claw trimming ≥ two per year). The characteristics of the latter six indices were recorded as a binomial variable, taking the needs of goats into account (value 1) or not (value 0); the characteristics of the first index, quality of roughage, were recorded on a four-level scale (1 = good to 4 = bad). The average of included characteristics was calculated to obtain one final value for each index. The final values of the latter six indices ranged between 0 and 1 and correspond to the proportion of single characteristics being in accordance with goats' needs. The final value for quality of roughage ranged from 1 to 2.5. Finally, an overall index variable *Good husbandry* was calculated by averaging the seven indices; quality of roughage was included by adding (2 – value) in the formula to ensure the indices were all measured on the same scale and thus could be properly averaged.

Statistical analysis

Prior to initiating data analysis, we determined criteria to be fulfilled by stockpeople and milkers to be included in analysis. People with only limited experience with milking or caring for the goats were excluded. Further, milking observations of insufficient reliability (too short observations) were not considered. Thus, only questionnaires from stockpeople that worked regularly with the goats, had experience greater than three months and were older than 16 years were included in analysis, resulting in 119 questionnaires from 45 farms (N_{women} = 58; N_{men} = 61). The average number of questionnaires per farm was 2.6 (± 0.93) (1–5). Regarding milker behaviour data from non-regular milkers, milkers with observations of less than ten milked goats and observations with technical problems (leading to too few milked goats) were excluded resulting in a data set of 53 milkers on 36 farms for whom data on both attitudes and behaviour during milking were obtained with 1.5 (± 0.56) (1–3) questionnaires per farm.

To extract attitude components, Principal Component Analysis (PCA) with Varimax rotation, using correlation matrix, was applied separately to each of the four subdivisions (of division 1 and 2) and to the division 3 of the attitude questionnaire, ie in total five PCA were run. All items of a respective (sub-) division were included in the PCA (for numbers of items see Table S1). Separate PCA per (sub-) division were performed to allow for studying different aspects of attitudes and their interrelationships and for comparison with previous studies in cows (eg Waiblinger *et al* 2002) as well as to guarantee sufficient numbers of cases per PCA. The number of components was selected by scree plot, with all selected components having an eigenvalue > 1 (Tabachnick & Fidell 1996). For further analysis and in accordance with previous studies (eg Hemsworth *et al* 2000; Waiblinger *et al* 2002), two steps were applied for the calculation of the components: First, we selected the items to be included in a specific component: to exclude clearly ambiguous items which loaded on more than one component with similar strength, an item was included in a component if its loading exceeded 0.6 and had a loading smaller than 0.4 on any other component, or if it had a loading exceeding 0.4 and did not load on any other component exceeding 0.3. Second, component values were calculated by averaging the original values of the included items; thus, the resulting component could vary on the original scale from 1 to 7 (ie lowest to highest average agreement/importance/pleasantness). As two respondents did not complete the entire questionnaire, sample size was reduced to 118 for five attitude components, ie for one female one attitude component could not be calculated and for one male four other attitude components could not be calculated due to missing values in the respective items.

To investigate the associations within attitudes, Spearman rank correlation coefficients were calculated between attitude components.

To investigate factors (such as demographic variables and farm characteristics) that potentially influence attitudes, linear regression models were calculated for the 14 attitude components extracted by the 5 PCA (see Table S1). In these 14 models, each with one of the attitude components being the dependent variable, seven potential influencing factors (ie '*Gender*', '*Age*', '*Experience*', '*Working time*', '*Grown up on farm*', '*Agricultural education*', number of milked goats per farm [*MilkedGoats*]) were used as potential explanatory variables in a step-wise forward procedure.

To investigate factors that potentially influence stockpeople behaviour during milking, we calculated Spearman rank correlation coefficients in a first step and, in a second, a total of four regression models with the main variables of stockperson behaviour as dependent variable. That is, linear regression models were calculated for the three dependent variables *POS*, *propPOS* and *NEU*. The occurrence of negative interactions was recoded into a dichotomous variable (*NEGoccuring*; yes: negative behaviour was observed at least once, no: negative behaviour never observed), because a high number of stockpeople (n = 30) did not show any negative interactions. Thus, *NEGoccuring* as dependent variable was analysed by logistic regression. For model selection, a conditional, step-wise forward procedure was used. For all four regression analyses with stockpeople behaviour during milking as dependent variable, all 14 attitude components extracted by the five PCA, six demographic variables (ie '*Age*', '*Gender*', '*Experience*', '*Agricultural education*', '*Grown up on farm*', '*Working time*') as well as the number of milked goats (*MilkedGoats*) were included in the initial models independently of their bivariate association with the dependent variable. If one of the further confounding

variables *MovedGoats* or *MilkingSteps* had an association with $P < 0.2$ in the bivariate analyses (ie Spearman rank correlation), it was also included in the initial model for this dependent variable (*MovedGoats* for *NEU* and *NEGoccuring*, *MilkingSteps* for *POS* and *NEU*). We did not include farm as a random effect as: (i) personal data (including attitudes questionnaires and behaviour) were collected independently and are person-specific; (ii) 20 farms had only one milker observation; and (iii) to be able to test for specific farm characteristics which otherwise might be obscured by a general farm effect. However, we additionally tested for a potential farm effect on milker behaviour by calculating mixed effects models including all predictor variables of the four final models as fixed effect and the farm as random effect (ie calculating one mixed model per response variable *POS*, *propPOS*, *NEU* and *NEGoccuring*). The results were essentially unchanged, supporting our approach. In all four models, only three out of 37 predictor variables changed the level of significance from significant to only a tendency (ie *MovedGoats* and *Experience* changed to tendency in the model for *NEGoccuring*; *Negative characteristics* changed to a just tendency for *propPOS*).

To explore associations between attitudes and farmers' decisions about housing and management practices we: (i) analysed potential differences in attitudes between farmers practicing or not practicing disbudding by Mann-Whitney *U* tests; and (ii) calculated a linear regression model with a forward step-wise procedure with '*Good husbandry*' as dependent variable and all 14 attitude components and '*Subjective workload*' as potential explanatory variables.

For linear regression models, assumptions (homogeneity of variance, normal distribution of residuals) were checked graphically, and multicollinearity was checked by the VIF value (variance inflation factor). If model assumptions were not fulfilled, the outcome variable was transformed by square-root or arcsine square-root transformation (Chatterjee *et al* 2000). Outliers of a model (residual > 3 × SD) were excluded for *Needs of goats* (one case), *POS* (one case) and *Milking ambiguous* (two cases). For inclusion of variables during step-wise procedures, $P_{entry} = 0.2$ and $P_{removal} = 0.25$ for all regression analyses. Predictor variables included in the regression models with $P > 0.05$ are presented in the *Results* but not considered in the *Discussion*. Only regression models with adjusted $R^2 > 0.1$ are presented.

The stockperson was the statistical unit in all analyses of the associations within attitudes (n = 119), between potential influencing variables and attitudes (n = 119) and between stockpeople's attitudes and their behaviour during milking (n = 53). The farm was the statistical unit in the investigation of the relationship between farmers' attitudes and husbandry practices (n = 45). Fifteen farms had one decision-maker, 28 farms had two and two farms had three; if there was more than one decision-maker on a farm, their scores were averaged to obtain one value per farm.

According to Martin and Bateson (1993), we refer to correlation coefficients below 0.4 as low correlation, 0.4–0.7 as moderate, 0.7–0.9 as high, and from 0.9 as very high in the *Results* and the *Discussion*. The level of significance was $P \leq 0.05$; the results with $0.05 < P \leq 0.1$ are referred to as tendencies. All analyses were performed using IBM® SPSS Statistics, version 20 (IBM® Corp, Armonk, NY, USA).

Results

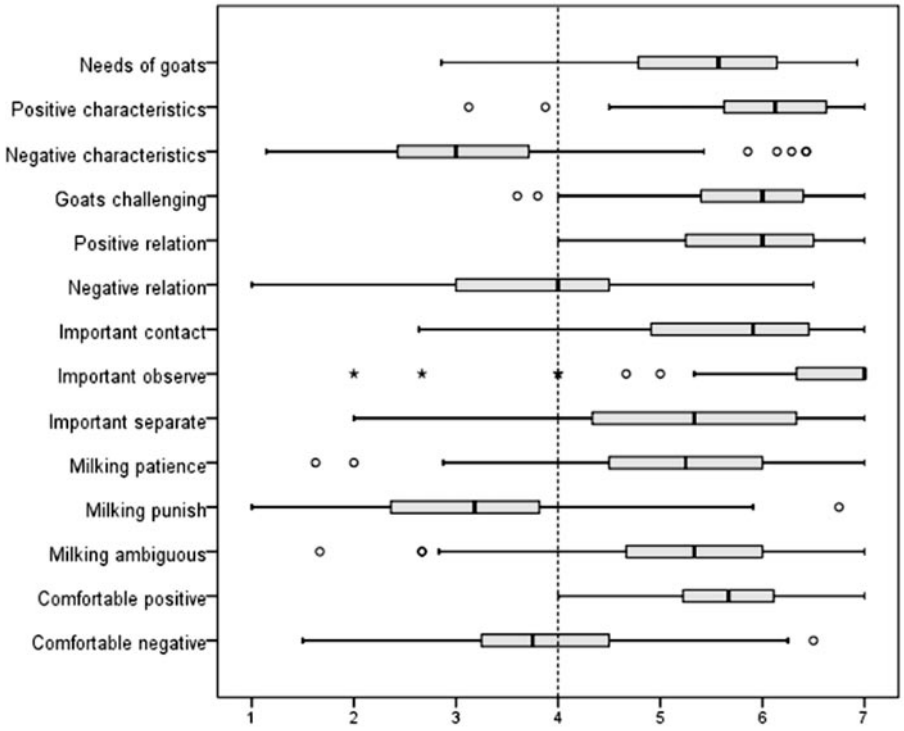
Farm characteristics

Fifteen farms exclusively kept goats without horns (hornless: herd partly polled, partly disbudded). Thirty farms had at least one goat with fully intact horns (horned; percentage of horned animals: mean [± SD] was 45 ± [26.5]%, [range: 1–78%]). Twenty-seven farms disbudded the kids (Disbudding = 1). Eighteen did not disbud the kids at the time of the visit (Disbudding = 0), but eight of them had done so previously. Eight farms were conventional and 37 were organic farms, they did not differ regarding performance of disbudding (yes/no: conventional 5/3, organic 21/15). Thirty-seven farms were run as full-time farms, on the rest of the farms, less than half of the income stemmed from agriculture, ie sideline farms. The farms obtained 78 (± 24.2)% (25–100%) of their farm income from the goats. Other farm income was mainly due to other agricultural business, eg other animals (on 20 farms) such as dairy cows (on eleven farms). The farms had kept goats for 12 (± 7.7) years (2–30 years) and had 3 (± 1.3) (1–7) stockpeople (ie all people regularly working with the goats including farmers, family members and weekend replacements) of which 2 (± 1.0) (1–4) were milking the goats. The average number of goats per stockperson was 50 (± 33.1) (15–150) and 76 (± 58.4) (16–244) for goats per milker. The mean number of milked goats per farm on the days of the visits (*MilkedGoats*) was 151 (± 97) (54–518).

Attitudes and demographics

Attitude questionnaires from 58 female and 61 male stockpeople, aged between 17 and 68 (median 40), were analysed, 53 of whom were also observed during milking (29 female, 24 male). The stockpeople varied considerably in their daily working time (median, min–max: 12, 4–16; n = 117), their experience with goat-keeping (12, 0–30 years; n = 119), their early experience regarding the keeping of animals (67 grew up on farms with dairy cows or goats, 24 on farms with other animals than dairy, 26 on farms without animals or not on a farm, two did not respond) and their agricultural education (47 had no approved formal agricultural education, 42 had a formal agricultural education on the level of a skilled worker and 27 had formal education to master craftsmen or university level). Demographic variation within milkers was very similar (see Table S2).

Figure 1



Distribution of scores of 119 stockpersons on the 14 attitude components derived from the five PCA on the 5 (sub-) divisions of the attitude questionnaire (for details on the components, see Table S1). Component scores are averages of the included items and could range from complete disagreement, discomfort or lowest importance on the left-hand side (1), to strongest agreement, enjoyment or importance on the right-hand side (7). The dashed line indicates the neutral value (4; 'partly/partly'). The central bar in the boxes represents the median, the grey boxes range from the first to the third quartile; the whiskers represent the minimum and maximum of the sample excluding outliers (dots) or extreme values (asterisks).

Variation in stockpeople's attitudes

In total, 14 components were extracted by the five PCA, comprising 97 of the original 130 items (see Table S1 for numbers and names of attitude components in each [sub-] division and for numbers of items included in each component, as well as three examples of items per component and the original number of items in the [sub-] divisions). The stockpeople's attitudes varied to a great extent: scores of eight components ranged over at least six scores and only two components (positive relation and comfortable positive) showed lower variation with a range of only four (Figure 1). To summarise, the majority of stockpeople showed positive beliefs about goats' characteristics ('*Positive characteristics*') and acknowledged their needs ('*Needs of goats*') and the importance of a good animal-human relationship ('*Positive relation*'; Figure 1). Accordingly, the majority held positive behavioural beliefs and intentions with regard to interacting with the goats, ie agreed on patient handling ('*Milking patience*') and frequent contact ('*Important contact*', '*Important observe*'), and as well having positive affective attitudes, ie they enjoyed positive contact with the goats ('*Comfortable positive*'). Furthermore, stockpeople generally tended to disapprove of negative attitudes ('*Negative characteristics*', '*Milking punish*', '*Comfortable negative*').

Correlation between attitude components

Stockpeople holding more positive beliefs about goats (higher score on '*Positive characteristics*'), placed a higher value on a positive relationship of goats with humans ('*Positive relation*', $r_s = 0.53$; $P < 0.01$), on positive interactions with goats in general ('*Important contact*', $r_s = 0.46$; $P < 0.01$) and during milking ('*Milking patience*', $r_s = 0.26$; $P < 0.01$) and enjoyed positive contact with goats more ('*Comfortable positive*', $r_s = 0.50$; $P < 0.01$). Similarly, holding negative beliefs about goats (higher agreement on '*Negative characteristics*') was associated with negative beliefs about the animal-human relationship ('*Negative relation*', $r_s = 0.33$; $P < 0.01$) and also with an increased behavioural intention to use negative interactions ('*Milking punish*', $r_s = 0.31$; $P < 0.01$). This component in turn was related to reduced discomfort when using such negative interactions ('*Comfortable*' negative, $r_s = 0.23$; $P < 0.05$) and with supporting the need of fear and respect in goats ('*Negative relation*'). The general attitude components '*Needs of goats*' and '*Goats challenging*' correlated with similar attitude components as '*Positive characteristics*', in the same direction but with lower coefficients (for detailed correlations see Table S3).

Table 4 Final linear regression models for attitude factors (dependent variables). The reported predicting demographic variables resulted from a step-wise forward procedure starting for all models with six demographic variables (ie *Gender*, *Age*, *Experience*, *Working time*, *Grown up on farm*, *Agricultural education*) and the number of goats milked on the farm (*MilkedGoats*) (n = 119 stockpeople).

Dependent variable	Predicting variable	B	SE	Beta	*P*-value	Adj R^2	*F* (model)	*P* (model)	n
Needs of goats	Gender[1]	–0.45	0.16	–0.24	0.007	0.17	8.50	< 0.001	116
	Grown up farm[2]	–0.31	0.10	–0.28	0.002				
	MilkedGoats	–0.00	0.00	–0.19	0.030				
Positive relation	Gender[1]	–0.39	0.14	–0.26	0.005	0.11	4.63	0.002	114
	Experience	–0.02	0.01	–0.16	0.086				
	Agricultural education[3]	–0.13	0.09	–0.13	0.148				
	Working time	0.04	0.03	0.12	0.173				
Milking ambiguous	Gender[1]	–0.86	0.17	–0.44	0.000	0.18	25.79	< 0.001	117
Comfortable positive	Working time	0.08	0.03	0.28	0.002	0.11	8.26	< 0.001	117
	Gender[1]	–0.27	0.12	–0.21	0.021				
Comfortable negative	Gender[1]	0.63	0.17	0.34	0.000	0.12	8.52	< 0.001	116
	Agricultural education[3]	–0.20	0.10	–0.17	0.055				

Only regression models with adjusted $R^2 > 0.1$ are presented;
[1] Gender: 1: Women, 2: Men;
[2] Grown up farm: 0: no farm or farm without animals, 1: with other than dairy, 2: with dairy (cows or goats);
[3] Agricultural education: 0: no approved formal agricultural education, 1: formal agricultural education (level: skilled worker), 2: formal agricultural education (level: master craftsmen or university).

Relationships between stockpeople demographics and attitudes

For five attitude components, demographic variables explained between 10 and 18% of the variation between stockpeople (Table 4). '*Gender*' was a predictor in all five final models: Female stockpeople showed more consideration of the needs of goats ('*Needs of goats*') than men, found a positive animal-human relationship more important ('*Positive relation*') and felt more comfortable when working with the goats in positive contact ('*Comfortable positive*') and less comfortable when working with the goats in slightly negative situations ('*Comfortable negative*'). Other demographic variables were confirmed as predictors for one or two attitude components each.

Behaviour during milking

Variation between stockpeople

There was a great variation in number and quality of interactions towards the goats between the 53 milkers on 36 farms (Table 5). Positive milker interactions were most frequently observed, while neutral and negative interactions occurred much less. For multivariable analysis, negative interactions were recoded into a 1/0 variable ('*NEGoccuring*'): 23 of 53 milkers used negative interactions including pushing or pulling the goat forcefully. Individual stockpeople were observed milking 10–308 goats (median = 60), moving 0–672 goats (*MovedGoats*: median = 160) and applying 1–7 different work steps (*MilkingSteps*: median = 3).

Relationships between attitudes, demographic variables and behaviour during milking

The linear regression models on positive interactions, proportion of positive interactions, and neutral interactions are shown in Table 6 and the logistic regression model of the occurrence of negative interactions in Table 7. Regarding the linear regression models (Table 6), between 41 and 50% of the variation in milker behaviour can be explained by 7–12 predicting variables.

Forty-one percent of the variation in the milkers' use of positive interactions per milked goat was explained by four attitude components and three variables concerning demographics or, as confounding variables, milking practices. The higher the milkers rated the attitude components '*Important contact*', '*Needs of goats*' and '*Milking patience*', the higher the number of positive interactions per milked goat. In contrast, the higher the score for '*Goats challenging*', the

Table 5 Median and range of behaviour of 53 milkers on 36 farms. All except the proportional variables are calculated as interactions per milked goat (for further details, see *Stockpeople's behaviour during milking* in *Materials and methods*).

Variable	Description	Median	Min–max	N
Pos_t	Number of positive tactile interactions	4.02	0.67–14.78	52*
Neu_t	Number of neutral tactile interactions	0.09	0.00–3.10	53
Neg_t	Number of negative tactile interactions	0.00	0.00–0.23	53
Vis	Number of visual interactions	0.01	0.00–0.58	53
Udder_t	Number of tactile interactions with the udder	4.55	0.53–90.60	53
TIA	Total interactions (tactile, acoustic or visual) with goats per milked goat	5.13	1.16–19.49	52*
POS	Number of positive (tactile or acoustic) interactions	4.39	0.85–15.57	52*
NEU	Number of neutral (tactile or acoustic) interactions	0.29	0.00–3.81	53
NEG	Number of negative (tactile or acoustic) interactions	0.00	0.00–0.30	53
PropPOS	Proportion of positive interactions (tactile or acoustic) to total interactions with goats	0.86	0.29–1.00	53
PropNEG	Proportion of negative interactions (tactile or acoustic) to total interactions with goats	0.00	0.00–0.10	53

* One milker had an extremely high number of positive tactile interactions (*Pos_t* = 90.30) and was excluded from further multivariate analysis with the number of positive interactions. Thus, data of this milker are not included in the data shown for *Pos_t* and *POS*, and *TIA*. (Median and maximum with this milker included were 4.55; 90.3 for *Pos_t*, 4.61; 90.30 for *POS*, and 5.24, 91.30 for *TIA*).

lower the number of positive interactions. The more milking steps applied by a milker — as the most influential predicting variable — the higher the number of positive interactions.

The regression model on the proportion of positive interactions included eight attitudinal and two demographic factors and explained 43% of the variation between milkers. Predicting variables predominantly had a positive relationship: A higher agreement on '*Positive characteristics*' and '*Negative characteristics*' was related to a higher proportion of positive interactions. In contrast, the more the milkers agreed on '*Milking punish*', the lower it was. '*Agricultural education*' and '*Working time*' were positively correlated with the proportion of positive interactions.

For the number of neutral interactions per milked goat, eight attitudinal and four demographic or other variables together explained approximately 50% of the variation found between milkers. A higher score on '*Important separate*', '*Comfortable positive*' and '*Negative characteristics*' was associated with a lower number of neutral interactions. In contrast, a higher agreement with '*Negative relation*', '*Important contact*', '*Needs of goats*' and also '*Positive relation*' was associated with more neutral interactions. The older a milker was, the more goats a milker moved into or out of the milking parlour and the lower a milker's score for '*Grown up on farm*' was, the higher was the number of neutral interactions. Male milkers used more neutral interactions than female milkers.

The final model for occurrence of negative interactions during milking (Table 7) included four attitudinal and three demographic variables as well as a confounder variable ('*MovedGoats*', number of goats moved by the stockperson). It predicted 82.4% of the values correctly, with 75.9% for the absence of negative interactions and 90.9% for the occurrence of negative interactions; it was significantly better than the constant-only model ($\chi^2 = 29.652$, df = 8; $P < 0.001$) and had a good model fit (Hosmer & Lemeshow: $\chi^2 = 5.498$, df = 8; $P = 0.703$). Nagelkerke's R^2 of 0.59, a measure of effect size, shows the model's usefulness in predicting the occurrence of negative interactions (Bewick *et al* 2005).

The Exp (B) value indicates that when '*Needs of goats*' was scored higher by one unit, milkers were about four times less likely to use negative interactions during milking. While higher '*Age*' of the milker and larger numbers of goats moved by the milker increased the probability of negative interactions, longer '*Experience*' was associated with a reduced probability (Table 7).

Relationships between attitudes and management decisions

Farms not practicing disbudding differed from farms currently practicing disbudding in their decision-makers' scores for four attitude components. Decision-makers practicing disbudding stated a lower agreement for '*Needs of Goats*' ($P = 0.001$) and '*Positive characteristics*' ($P = 0.047$) but also disagreed stronger for '*Milking punish*' ($P = 0.025$) and '*Comfortable negative*' ($P = 0.001$); for detailed results see Table S8.

Table 6 Final linear regression models for stockpeople's behaviour during milking (dependent variables). The reported predicting attitudinal and demographic variables resulted from a step-wise forward procedure starting for all models with the 14 attitude components, six demographic variables (ie *Gender*, *Age*, *Experience*, *Working time*, *Grown up on farm*, *Agricultural education*) and the number of goats milked on the farm (*MilkedGoats*); in addition the number of goats moved by the stockperson (*MovedGoats*) was included in the procedure for *NEU* and the number of working steps during milking (*MilkingSteps*) for *POS* and *NEU* (n = 52).

Dependent variable	Predicting variable	B	SE	Beta	*P*-value	Adj R^2 (model)	*F* (model)	*P* (model)
Positive interactions/milked goat[1] (POS)	MilkingSteps	0.34	0.09	0.49	0.001	0.41	6.05	0.000
	Important contact	0.21	0.09	0.34	0.017			
	MilkedGoats	0.00	0.00	0.22	0.073			
	Needs of goats	0.21	0.08	0.31	0.016			
	Milking patience	0.15	0.08	0.26	0.050			
	Goats challenging	–0.22	0.10	–0.27	0.041			
	Gender[3]	0.26	0.17	0.19	0.131			
Proportion of positive interactions[2] (propPOS)	Needs of goats	0.05	0.03	0.21	0.148	0.43	4.82	0.000
	Agricultural education[4]	0.15	0.04	0.45	0.001			
	Positive characteristics	0.10	0.05	0.27	0.048			
	Milking punish	–0.08	0.03	–0.34	0.008			
	Negative characteristics	0.06	0.03	0.29	0.020			
	Working time	0.03	0.02	0.22	0.050			
	Comfortable positive	0.12	0.06	0.27	0.057			
	Milking ambiguous	0.04	0.03	0.17	0.162			
	Positive relation	–0.06	0.04	–0.21	0.151			
	Important separate	0.03	0.02	0.17	0.189			
Neutral interactions/milked goat (NEU)	Important separate	–0.32	0.06	–0.68	< 0.001	0.50	5.23	0.000
	Negative relation	0.20	0.05	0.54	< 0.001			
	Age	0.02	0.01	0.24	0.037			
	MovedGoats	0.00	0.00	0.35	0.003			
	Grown up on farm[5]	–0.24	0.09	–0.32	0.009			
	Comfortable positive	–0.51	0.15	–0.45	0.002			
	Important contact	0.24	0.09	0.41	0.008			
	Negative characteristics	–0.22	0.07	–0.40	0.002			
	Needs of goats	0.21	0.09	0.35	0.022			
	Gender[3]	0.42	0.16	0.35	0.014			
	Positive relation	0.24	0.12	0.32	0.047			
	Positive characteristics	–0.21	0.12	–0.22	0.102			

[1] Square root of (POS + 3/8); [2] Arcsine of square root of *POS_P*; [3] Gender: 1: Women, 2: Men; [4] Agricultural education: 0: no approved formal agricultural education, 1: formal agricultural education (level: skilled worker), 2: formal agricultural education (level: master craftsmen or university); [5] Grown up farm: 0: no farm or farm without animals, 1: with other than dairy, 2: with dairy (cows or goats).

Table 7 Final logistic regression model for the occurrence of negative interactions with the goats during milking as dependent variable. The reported predicting attitudinal and demographic variables resulted from a step-wise forward procedure starting with the 14 attitude components, six demographic variables (ie *Gender*, *Age*, *Experience*, *Working time*, *Grown up on farm*, *Agricultural education*), the number of goats milked on the farm (*MilkedGoats*) and the number of goats moved by the stockperson (*MovedGoats*). A higher score in the attitudinal variables represents higher agreement (n = 51).

Predicting variable	B	SE	Wald's Chi^2	df	*P*-value	Exp (B)
Constant	–0.60	4.73	0.02	1	0.899	0.55
Important separate	1.00	0.53	3.61	1	0.057	2.73
Needs of goats	–1.35	0.63	4.57	1	0.033	0.26
Age	0.20	0.09	5.30	1	0.021	1.22
Experience	–0.23	0.11	4.62	1	0.032	0.80
MovedGoats	0.02	0.01	4.22	1	0.040	1.02
Working time	–0.55	0.29	3.46	1	0.063	0.58
Milking patience	1.24	0.67	3.42	1	0.064	3.45
Positive contact	–1.10	0.82	1.82	1	0.178	0.33

Table 9 Final linear regression model for the overall housing and management index *Good husbandry* (dependent variable). The reported predicting variables resulted from a step-wise forward procedure starting with the 14 attitude components and Subjective workload. A higher score in *Good husbandry* represents better management/housing on the farm. A higher score in the predicting variables represents a higher agreement or a higher workload. All scores of predicting variables represent average farm values of decision-makers (n = 45 farms).

Predicting variable	B	SE	Beta	*P*-value	Adj R^2 (model)	*F* (model)	*P* (model)
Milking punish	–0.05	0.02	–0.40	0.007	0.305	4.87	0.001
Subjective workload	0.05	0.02	0.42	0.004			
Goats challenging	0.03	0.02	0.20	0.144			
Negative relation	–0.02	0.01	–0.20	0.167			
Important observe	0.04	0.03	0.18	0.172			

15 farms had one decision-maker, 28 farms had two and two farms had three decision-makers.

The average score for the overall housing and management index '*Good husbandry*' on the 45 farms ranged between 0.12 and 0.65 with a median of 0.45. Linear regression analysis revealed that 31% of the variation can be explained by four attitudinal variables and '*Subjective workload*' (Table 9). Farmers who disagreed more strongly with applying negative interactions during milking ('*Milking punish*') and who had a higher subjective workload, catered better to the needs of goats with respect to housing and management. Their farms had a higher score for '*Good husbandry*', ie they fulfilled more of the requirements summed in this variable.

Discussion

For the first time, this study has shown a link between stockpeople's attitudes and their behaviour both when interacting with animals and regarding decision-making on dairy goat farms. Together with an earlier paper on the link between stockpeople behaviour and animal behaviour (Mersmann *et al* 2016) the results indicate the existence of sequential relationships similar to those found on pig and dairy farms (Hemsworth *et al* 1989, 2002; Breuer *et al* 2000; Waiblinger *et al* 2002). This study also found associations of attitudes or behaviour with gender, age and early experiences.

Variation in stockpeople's attitudes

In general, our results are in agreement with studies in European dairy sheep and cow farmers, indicating at least moderate agreement with positive attitudes and at least moderate disagreement with negative ones in most farmers (Waiblinger *et al* 2002; Napolitano *et al* 2011). Furthermore, our dairy goat stockpeople's attitudes are very

similar to dairy cow stockpeople's (Waiblinger *et al* 2002) regarding six attitude components (ie '*Positive characteristics*', '*Negative characteristics*', '*Important contact*', '*Milking patience*', '*Milking punish*' and '*Comfortable positive*') which are comparable with respect to included items. Despite the positive attitudes in many farmers, the huge variation indicates potential for improvement in quite a large proportion of goat stockpeople.

Relationships between attitude components

Our results are in line with attitude theories and previous studies (eg for a review, see Waiblinger *et al* 2002; Maio & Haddock 2009) in that positive beliefs about an attitude object (here: goats) were associated with positive affective responses about that object (here: '*Comfortable positive*') and these positive attitudes also correlated with positive attitudes towards behaviour when interacting with the goats. Similar associations were found for negative beliefs and affective responses with behavioural intentions towards negative interactions. This pattern was expected because attitudes are not independent from each other: attitudes form a system, within which they are more or less consistently related to each other (Hemsworth & Coleman 2011) and, according to cognitive dissonance theory, inconsistency elicits unpleasant dissonance (Ferstinger 1957, cited in Ajzen & Fishbein 1980).

The general attitude component '*Needs of goats*' correlated positively with positive attitude components of all subdivisions, although the strength of correlation was generally low. Recognition of the animal's needs is a precondition for taking these needs into account during husbandry decisions and thus for maintaining good animal welfare. Positive attitudes towards animals and interacting with them may facilitate accepting the animals' needs and/or enhance the acquisition of knowledge about the animals, eg because of higher work motivation (Hemsworth *et al* 2009). Furthermore, positive attitudes may best reflect an underlying perception of the animals as individual sentient beings with needs that have to be respected (Waiblinger *et al* 2006a).

Relationships between influencing factors and attitudes

Gender

Female stockpeople showed more positive cognitive and affective attitudes than men. These differences fit well with earlier studies in goats and cattle (Lensink *et al* 2000; Waiblinger *et al* 2003; Muri *et al* 2012; Wikman *et al* 2016). In a review on gender differences including human-animal relationships in a broad range of contexts but mainly investigating people not working in agricultural animal husbandry, Herzog (2007) concluded that women have higher levels of positive behaviours and attitudes toward animals than men.

Unexpectedly, female stockpeople in our study scored higher than men in their behavioural intention to move goats in and out of the milking parlour by ambiguous interactions (*Milking ambiguous*), ie use of 'the hand' or 'a loud call.' The interpretation of these behaviours may differ largely between stockpeople: for example, moving goats by calling loudly may reach from a loud but soft, low-pitched voice to shouting; the 'use of the hand' may reach from touching the goats gently to slaps or even hits, pulling or pushing. Thus, in future questionnaires such ambiguous terms should be avoided.

It is important to mention that male and female stockpeople neither differed in their behavioural intentions to use positive or negative interactions during milking and moving ('*Milking patient*', '*Milking punish*') nor in their actual use of clearly negative or positive interactions during milking, although male milkers used more neutral, ie moderately negative, interactions. Previous studies have shown contradictory results: no gender differences were found in the actual handling of pigs and dairy cows (Coleman 2001, cited in Hemsworth & Coleman 2011; Waiblinger *et al* 2003), although in the study of Waiblinger *et al* (2003) females tended to rate patient behaviour during milking more important than men. In the veal industry, female farmers not only had more positive beliefs about the importance of contacts with calves but also showed more positive behaviour towards the calves (Lensink *et al* 2000). A potential explanation for gender differences found in the care for young veal calves is the baby schema effect, which is positively associated with female gender and empathy (animal infant faces; Lehmann *et al* 2013; see also review on gender differences in empathy by Christov-Moore *et al* 2014) and which is assumed to induce stronger motivation for caretaking in women than in men (human infant faces; Glocker *et al* 2009).

Further influences on attitudes

Regarding the positive relation between '*Working time*' and '*Comfortable positive*', one might argue that it can be interpreted in a way that people who enjoy positive contact with goats more, do not mind to and actually work longer for/with the goats. However, the variable '*Working time*' is not restricted to working time related to goats and thus interpretation of this association remains speculative.

The more familiar the stockpeople were with agriculture and keeping of dairy animals during their childhood, the less they agreed on '*Needs of goats*.' This is somewhat in line with results from Norway, where farmers who grew up on goat farms had less positive beliefs about goats (Muri *et al* 2012; p 543). It might be that farmers who grew up with dairy cows or goats might have been prone to feeling informed about the animals' needs already, while people with a non-farm background might have actively sought information about goats and their requirements, resulting in better knowledge of goats' needs. The topic on information-seeking according to farming background merits further research as it would be important for future strategies to improve farm animal welfare.

The larger the herd size, the lower the stockpeople's agreement on '*Needs of goats*.' A large herd size may be a sign of farmers engaging in more intensive farming (Ivemeyer *et al* 2017), with the individual animal — and thus probably the animal's needs — being less important for economic success (van der Ploeg 1993). On dairy cow farms, the intensity of contact and management procedures

to reduce social stress in the herd was lower on farms with larger herd size (Menke 1996; Waiblinger & Menke 1999). In a Finnish study, farmers of small beef bull farms took disbudding pain more seriously than farmers of large farms and they were also more sensitive to pain caused by cattle diseases (Wikman *et al* 2016).

Relationships between attitudes, demographic variables and behaviour during milking

The general attitude component '*Needs of goats*' was the most important predictor as it was the only factor associated with the frequency of milker behaviour of all three categories. The higher the stockpeople's agreement with the included items, the more positive and neutral interactions they used and the less likely they were to apply negative interactions during milking. Thus, the results indicate that better recognition of the goats' needs with respect to husbandry requirements is linked with better recognition of their needs regarding handling, ie using positive and avoiding negative interactions. This is in line with expectations of consistent attitudes, where recognition of the species-specific needs probably reflects a positive general attitude and a deep understanding of goats.

Number and proportion of positive interactions

The behavioural attitudes included as predictors in the two models were in agreement with expectations and earlier studies, where agreement on the importance of regular positive interactions or patient milker behaviour was related to a higher frequency or a higher percentage of positive interactions, while a higher intention to apply punishing interactions during milking was related negatively with the percentage of positive interactions (Waiblinger *et al* 2002; Mülleder & Waiblinger 2004; Ivemeyer 2010). The negative association with the general attitude component '*Goats challenging*' suggests that this attitude reflects at least partly a perception of goats as being animals difficult to keep and thus a somewhat negative attitude towards goats. The positive association with the number of milking steps was in agreement with our expectations, because more milking steps offer more opportunities for interactions. Thus, we recommend also considering this confounding variable in future research.

Regarding general attitudes, the positive association between the proportion of positive interactions and '*Positive characteristics*' again confirms previous results in dairy cows (Waiblinger *et al* 2002), while this was not the case for '*Negative characteristics*.' Comparable negative attitudes had no predictive value for milker behaviour at all on dairy cow farms both in Australia and Austria (Hemsworth *et al* 2000; Waiblinger *et al* 2002). '*Negative characteristics*' became significant only after inclusion of '*Milking punish*' and '*Positive characteristics*' so that variance fractions co-varying with these predictors (positively or negatively) were partialled out and only the remaining fraction of '*Negative characteristics*' was positively associated (Tabachnik & Fidell 1996).

Regarding '*Working time*', the positive association with percentage of positive interactions contradicts previous studies on dairy cow farms (Waiblinger *et al* 2003) but is consistent within our study in that: (i) it tended to be lower on farms where milkers used negative interactions; and (ii) it was positively associated with the affective attitude '*Comfortable positive*' (see previously in *Relationships between influencing factors and attitudes*).

'*Agricultural education*' of the farmer showed the greatest association with the proportion of positive interactions, with higher educated farmers using a greater proportion of positive interactions. Agricultural education may lead to more knowledge about handling of animals including the importance of positive interactions during milking.

Neutral interactions

The associations between the number of neutral interactions and attitudes were ambiguous, as positive as well as negative attitudes were associated in both directions, positively and negatively, depending on the exact attitude component. For example, the positive attitudes '*Needs of goats*', '*Positive relation*' and '*Important contact*' were positively associated with the number of neutral interactions, while '*Comfortable positive*' was associated negatively. The categorisation of milker behaviour as positive and negative is quite clear-cut — both from the animals' and humans' perspective (positive interactions: Seabrook 1984; Boivin & Braastad 1996; Waiblinger *et al* 2002, 2006b; Schmied *et al* 2008a,b; negative interactions: Rushen *et al* 1999; Breuer *et al* 2003; Waiblinger *et al* 2006b). However, categorisation of neutral interactions is less clear-cut, especially when it comes to vocal interactions, and talking dominantly was the neutral interaction applied most often. The perception as negative or neutral by the animals also depends on the animal's actual relationship with humans; and the corresponding reactions by the animals may reinforce stockpeople attitudes (Hemsworth & Coleman 2011).

The positive association with the number of moved animals indicates that neutral interactions are increasingly applied when moving animals. Indeed, on dairy cow farms, 80% of all neutral interactions during milking were shown when moving the cows out of or into the milking parlour, while both positive and clearly negative interactions were shown mostly during actual milking, ie from attachment of cups until moving out (Waiblinger *et al* 2003).

Stockpeople used more neutral interactions with increasing age. This is in agreement with findings in Austrian dairy cow milkers (Waiblinger *et al* 2003), while Lensink *et al* (2000) did not find age to be a predictor for veal farmers' behaviour. There was also an influence of childhood experience: the more familiar stockpeople had been with farm animals, especially with dairy cows, during their childhood ('*Grown up on farm*'), the less neutral interactions they used. The potentially ambiguous interpretation of 'neutral interactions' with respect to animals' perception, as discussed above, and a lack of published studies reporting on childhood experiences with farm animals make the interpretation of this finding difficult.

Negative interactions

Significant predictors for the occurrence of negative interactions during milking were the general attitude '*Needs of goats*', the two demographic variables '*Age*' and '*Experience*' and the confounder '*MovedGoats*', ie the number of moved animals. The importance of acknowledging the '*Needs of goats*' for the quality of handling is discussed previously. The more animals a milker moved, the higher the probability of negative interactions, indicating that negative interactions were more likely during moving goats, in contrast to a study on dairy cow farms (Waiblinger *et al* 2003).

While the age of the milker increased the risk of negative interactions, experience decreased it. No such associations were found in dairy cow or veal calf farmers (Lensink *et al* 2000; Waiblinger *et al* 2003) but both positive and neutral interactions were positively associated with age of the milker in the dairy cow study (Waiblinger *et al* 2003). Information on the importance of avoiding negative behaviours for welfare and production has increased much over the years since the 1980s (see, for example, Hemsworth & Coleman 2011); younger milkers may also have had more access to such information, by using better diverse sources, including the internet. Milkers with longer experience might have learnt over the years to avoid negative interactions if, for instance, they have experienced strong reactions of goats.

Relationships between attitudes and management decisions

Good husbandry

One may expect the beliefs about '*Needs of goats*' to predict '*Good husbandry*.' However, besides attitudes, other factors such as subjective norms and perceived behavioural control act on the intention to perform a behaviour; and the actual behavioural control moderates the performance of the behaviour (Ajzen 1988), as there can be factors outside the actor's control limiting the realisation (Ajzen 2002, cited in Kauppinen *et al* 2010). Perceived and actual behavioural control may hinder the implementation of good housing and management practices in particular which might cost real investment regarding working time or construction costs. In contrast, changes in handling behaviour generally do not cost time but can even save time and money by increasing ease of handling and production (Seabrook 1984; Waiblinger *et al* 2006b). This may partly explain the link between '*Needs of goats*' and handling behaviour but not decision-making.

The association of high scores on '*Good husbandry*', ie more of the requirements summed in this variable are fulfilled, with stronger disagreement of the use of negative interactions (ie low scores on '*Milking punish*') may be explained in two ways. Firstly, both may arise from a common basis, potentially higher empathy, leading to the wish to provide pleasant environmental conditions to the goats, be it during handling or in general. This interpretation also fits with the greater proportion of positive behaviours used by these milkers and results of a previous study: In dairy stockpeople the empathy factor '*Feelings towards animals*' was correlated with positive behavioural attitudes as well as good management (Mülleder & Waiblinger 2004). Secondly, good husbandry may lead to animals being more relaxed and calmer and thus easier to handle (for a review, see Waiblinger *et al* 2006b; Hemsworth & Coleman 2011), thus showing less behaviour (stopping during moving, kicking etc) that might cause negative milker behaviour.

A higher subjective workload was associated with better management and housing, potentially reflecting either a truly greater time investment to optimise environmental conditions for the goats or merely a more intense feeling of the difficulties in providing an optimised environment. When keeping horned dairy cows, some successful management practices are more time-consuming, eg separating cows in heat, sorting animals at the feed rack (Menke 1996; Menke *et al* 1999). However, the subjective workload in our study was not associated with the actual working time, be it total working time or working time close to goats.

Disbudding

As found in European cattle farmers, keeping animals with or without horns is not merely management detail but rooted in farmers' differing views (Kling-Eveillard *et al* 2015); disbudding and non-disbudding dairy goat farmers differed in four attitude components. Farmers not disbudding their goat kids assigned more '*Positive characteristics*' to their goats and acknowledged '*Needs of goats*' more than farmers who disbudded their goat kids. This fits well with statements of German organic farmers indicating that they keep horned cows because of their respect for the cows and their physical integrity (Kling-Eveillard *et al* 2015). Taking the animals' needs into account during husbandry decisions facilitated keeping horned dairy goats in terms of risk of injuries (Waiblinger *et al* 2011). Contrarily, the non-disbudding farmers also assigned higher scores to '*Negative contact*' and '*Milking punish*', indicating a dislike of negative behaviour towards the goats less strongly and also rejecting the use of negative interactions less strongly. Disbudding farmers might have assigned less agreement to the two negative attitude components ('*Milking punish*', '*Negative contact*') because of a social desirability bias (see Ajzen & Dasgupta 2015). Compared with non-disbudding farmers, disbudding farmers probably had a greater interest in presenting their farming as positive, as they may have: (i) perceived negative attitudes towards disbudding goats from sections of society; and (ii) felt more dependent on the outcome of the study (which was expected to be crucial for the future ban or permission of disbudding). It is important to note that the practice of disbudding was not related to herd size or other general farm characteristics such as being organic or not. The unequal sample size regarding practicing disbudding somewhat reduces the power of the Mann-Whitney *U* test; a more equal sample size thus may reveal more differences in attitudes.

Animal welfare implications and conclusion

This study enhances our understanding of what shapes human-animal interactions on dairy goat farms and thus builds a basis for their improvement. Dairy goat farmers' attitudes are important predictors not only for their behaviour towards the goats but also for their decisions regarding management and housing. Therefore, they are important factors influencing animal welfare. Together with the results of Mersmann *et al* (2016), we confirmed the existence of sequential relationships between human attitudes, human behaviour towards animals and the animals' subsequent perception of and behaviour towards humans on dairy goat farms. These relationships offer opportunities for improvement of animal welfare by training that targets stockpeople's attitudes. Gender, education and farmers' early experiences as well as working conditions influence their attitudes and behaviour and need to be considered in improvement strategies.

Declaration of interest

None.

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