Animal (2012), **6:12**, pp 2003–2010 © The Animal Consortium 2012
doi:10.1017/S1751731112001346

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Evaluation of on-farm veal calves' responses to unfamiliar humans and potential influencing factors

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(Received 28 March 2011; Accepted 30 March 2012; First published online 3 July 2012)

The human–animal relationship is an important component of the welfare of farm animals and for this reason animal responsiveness tests to humans are included in on-farm welfare assessment schemes that provide indicators for this. However, apart from the behaviour of stockpersons towards their animals, other factors may also influence animals' reactivity to humans as observed through behavioural tests, which can add a further layer of complexity to the interpretation of test results. Knowledge of these factors may help a better interpretation of differences from one farm to another in the outcome of human–animal relationship tests, and may provide clues for improving the relationship between animals and humans. The main objective of this study was to identify whether management or environmental factors could influence the outcome of human–animal relationship tests in veal calves. Two tests were performed when calves were aged 14.9 $\pm$ 1.6 (SD) weeks in 148 veal farms: the voluntary approach of an unfamiliar human standing at the feeding fence and the reaction towards an unfamiliar human who entered the home pen and tried to touch each calf in a standardised way (Calf Escape Test (CET) – score 0 to 4). Questionnaires were filled in and interviews with the stockpersons were performed in order to obtain information on stockpersons, management, animal and building characteristics. The latency to touch an unfamiliar human at the feeding fence was significantly correlated with the CET scores. Total number of calves on the farm, space allowance, breed, environmental enrichment, stockperson's experience and season of observation influenced the percentage of calves that scored 0 in CET (i.e. calves that could not be approached). Type of milk distribution, type of breed and number of calves per stockperson influenced the percentage of calves that scored 4 in CET (i.e. calves could be touched). For both CET0 and CET4, the level of self-reported contacts by the stockperson (analysed only on the French subset of 36 farms) did not influence the results. This paper concludes that according to the tests conducted on veal calves on commercial farms, factors such as milk distribution method, breed of the calves or the level of experience of stockpersons with veal farming can have an impact on the results of tests focusing on human–animal relationships.

Keywords: calves, human–animal relationship, avoidance, risk factor analysis

Implications

This study was performed within the Welfare Quality® project, which aims at developing an on-farm monitoring system for animals' welfare. The human–animal relationship is an important component of the welfare of veal calves as the latter are in contact every day with stockpersons. This explains why tests evaluating the human–animal relationship are included in the welfare assessment scheme. In this article, we evaluated whether management or environmental factors could influence the outcome of these tests. We established that factors such as milk distribution systems, breed of the calves or stockperson's level of experience have an impact on the level of response of the calves to these tests. These factors could therefore be taken into account when interpreting results of tests focusing on human–animal relationships between stockpersons and calves. In addition, these results suggest ways of reducing the veal calves' fear of humans under commercial conditions.

Introduction

The relationship between stockpersons and breeding stock is an important component of the welfare of farm animals

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(Hemsworth *et al.*, 1993). Several studies have shown that behaviour of the stockperson has an impact on both welfare and productivity of animals (pigs: Hemsworth and Barnett, 1991; poultry: Barnett *et al.*, 1994; dairy cattle: Rushen *et al.*, 1999; veal calves: Lensink *et al.*, 2001). Therefore, potential indicators of the relationship between stockpersons and animals are included in on-farm welfare assessment schemes (e.g. Botreau *et al.*, 2007). Observations used for integration in these schemes should be easy and quick to perform, be repeatable, valid and ideally not be influenced by external factors such as the test person or the test location (Martin and Bateson, 1993; de Passillé and Rushen, 2005).

In on-farm conditions, the human–animal relationship is often assessed through the response of animals to human presence or to physical contact by humans during feeding (e.g. veal calves: Lensink *et al.*, 2000b; dairy cows: Waiblinger *et al.*, 2003), at the feeding place (e.g. veal calves: Bokkers *et al.*, 2009; pigs: Lensink *et al.*, 2009) or in the home pen (e.g. dairy cows: Windschnurer *et al.*, 2008; veal calves: Bokkers *et al.*, 2009). The response of farm animals to the presence of an unfamiliar experimenter who remains stationary has been observed in a special test arena (e.g. dairy cows: Hemsworth *et al.*, 2000; sheep: Tallet *et al.*, 2006). A number of reports support that these farm tests can give an indication of the level of avoidance of the tested animals (for review: Waiblinger *et al.*, 2006). In production systems animals are in contact daily with the stockperson, but also with other people such as veterinarians on a regular basis. Fear of humans might lead to, for instance increased cortisol responses or reduced productivity (for review: Hemsworth and Coleman, 2010), which are indicators of low welfare.

For veal calves housed in groups, Bokkers *et al.* (2009) developed several tests focusing on the human–animal relationship. For two of these tests, the Human Approach Test (HAT) and the Calf Escape Test (CET), the inter-observer and the test–retest reliability were good. Therefore, an on-farm animal welfare assessment scheme for veal calves could consider including these tests. The calves' responses to a familiar or unfamiliar stockperson were highly correlated, suggesting a generalisation of the calves' responses to humans. Responses of veal calves in these types of tests were shown to be reflecting the stockperson's behaviour towards the animals in both experimental and on-farm conditions (Lensink *et al.*, 2000a and 2000b). In addition to the behaviour of the stockperson, other factors may influence responses of farm animals, including veal calves, in tests focusing on the human–animal relationship. Knowledge of these factors may help to explain differences between farms in the outcome of tests focusing on the relationship between animals and stockpersons, and may provide clues for improving farm parameters that directly affect this relationship. Few studies have focused on the human–animal relationship under farm conditions. In dairy cattle, the avoidance distance of cows is correlated with the quality and quantity of daily contacts with the milker and, to a lesser extent, with factors related to animals, management and housing (Waiblinger *et al.*, 2003). In a previous comprehensive study on veal calves housed individually, factors such as attitude towards calves, years of experience with calves and the number of stockpersons working on the farm were linked with calves' responses to humans, next to stockperson's behaviour towards calves (Lensink *et al.*, 2000a). According to current regulations in the European Union, it is compulsory to keep calves in group housing from the age of 8 weeks onwards. Group housing can make handling of calves more difficult, therefore the effect of group size on human–animal interactions must be examined further (Raussi, 2003). In studies on (veal and dairy) calves mainly dairy breeds have been studied so far (Lensink *et al.*, 2000a and 2000b; Rousing *et al.*, 2005; Bokkers *et al.*, 2009). In beef cattle, clear breed differences were found in terms of temperament and reactivity to humans (Murphey *et al.*, 1981; Boivin *et al.*, 1992 and 1994). Similar differences may therefore also apply between veal calves of dairy and beef breeds.

The objective of the present study was to investigate behavioural responses of veal calves to humans on livestock farms and to determine potential influencing factors other than the stockperson's behaviour. Therefore, at all farms, calves were observed during two behavioural response tests as described by Bokkers *et al.* (2009), data regarding housing conditions and management of calves were collected and stockpersons were interviewed. An overall analysis of the potential influencing factors for calves' behaviour was performed on the data.

Material and methods

Farm sample

Data were collected between summer 2007 and spring 2009 on 148 veal farms in the Netherlands ($n = 88$), France ($n = 36$) and Italy ($n = 24$). Farms were selected so as to make up a representative cross-section of the veal production in Europe. Calves were housed in small groups of 5 to 15 calves and fed milk replacer and solid feed by a bucket (45) or a trough (103). The sample within each country consisted of farms located in the main regions where veal calves are reared. All farmers took part in this study on a voluntary basis. A single batch of calves was considered for each farm, and the tested batches were distributed across all four seasons. Calves arrived at the farms at the age of ~15 days and were slaughtered at the age of 17 to 33 weeks. Farms showed a variety in type and origin of calves, size of the farm, feeding plan (amount of milk replacer and amount and type of solid feed), climate control, day light intensity and general management.

Behavioural tests

Two behavioural tests were carried out on all farms when the calves were aged 14.9 ± 1.6 (SD) weeks: the HAT and CET previously described by Bokkers *et al.* (2009).

HAT: the behavioural response of calves to a passive unfamiliar person (experimenter) was measured. An unfamiliar experimenter approached the pen to be tested and stood still in the middle at the front of the pen. The experimenter was leaning against the fence with his/her elbow on top of the fence allowing the calves to voluntarily approach and touch the person. Eye contact was avoided. The test started when the experimenter with a clear but normal voice said a sentence to catch the attention of the calves. All calves could simultaneously approach and touch the experimenter; the number of calves standing was noted and the latency to every first touch was recorded for each individual calf. A maximum time allowance of 3 min was recorded for calves that did not touch the experimenter.

CET: the behavioural response of a calf to an active approach of an unfamiliar person (experimenter) was measured. The experimenter entered the pen and waited for 1 min to let the calves get used to his/her presence. Next, the experimenter standing erect in the pen chose a calf standing with its head oriented towards the experimenter at $\sim$1.5 m distance. The test consisted of four stages: (1) the experimenter can only make eye contact with the calf; (2) the experimenter can make one step towards the calf with one arm stretched forward and stand still with two feet next to each other for 1 s; (3) the experimenter can make a second step and stands still again for 1 s; and (4) the experimenter can touch the calf's muzzle. The test was ended whenever the calf moved one of its forelegs backwards. For each successful stage, one point was given (0- to 4-point scale), with 0 points for calves unable to make eye contact with and with a maximum of three attempts per calf.

In total, five experimenters (two men, three women; one experimenter per farm) performed the observations on the farms. They were wearing similar (dark blue coloured) clothing at all farms. Although the experimenters were experienced in behavioural research, they completed a training assessment with videos and photos of calf behaviour and practised together at a farm beforehand. Ten pens per farm were observed for HAT and 20 pens per farm for CET (including the 10 pens observed for HAT). On all farms, the HAT was performed between 1000 and 1200 h, whereas the CET was performed between 1400 and 1600 h.

Farm data

At all farms, information on characteristics of the building and equipment was collected by the experimenter using a pre-defined questionnaire with questions concerning, for example, type of milk distribution system within the farm, number of calves, space allowance per calf, prevailing breed of the batch, etc. Stockpersons were asked before the behavioural observations about their management practises (such as number of years of experience with calves, daily time spent in the building, frequency of visits by a technician, etc.). These data were used to build a list of potential risk factors (Table 1).

Table 1 *List of the analysed potential factors influencing the human–animal relationship in veal calves*

Item	Average ± s.e. (range) or proportions ($n = 148$)	Classes and unit
Milk distribution system	Bucket: 30%/Trough: 70%	Bucket feeding or trough feeding
Farm size	800 ± 58 (128 to 5800)	Total number of calves: ≤300, 300< x ≤600, 600< x ≤1200, >1200
Space allowance	1.9 ± 0.2 m^2 (1.8 to 2.4)	1.8 or >1.8 m^2/calf
Season of observation	Spring: 20%/Summer: 35%/Autumn: 30%/Winter: 15%	Spring, summer, autumn, winter
Prevailing breed	Dairy breed: 70%/Dual breed: 15%/Crossbred or meat breed: 15%	More than 50% of calves are of dairy breed, dual-purpose breed, crossbred or meat breed type
Frequency of visits by technician	Weekly: 88%/every 2 weeks: 12%	Weekly, every 2 weeks
Frequency of visits by stockperson/day	2.4 ± 0.1 (1 to 3)	Number of times one of the stockpersons visits the calves' building each day: ≤2, >2
Stockperson's experience	18.6 ± 1.0 year (1 to 45)	≤5, 5< x ≤15, 15 < x ≤25, >25 years
Adoption of the present animal housing system	7.5 ± 0.4 year (1 to 26)	≤2, 2 < x ≤ 10, >10 years
Environmental enrichment	No: 85%/Yes: 15%	Presence of hanging objects in the pens: yes/no
Number of calves per stockperson	500 ± 26 (32 to 1540)	≤200, 201 < x ≤ 400, 401 < x ≤ 600, 601 < x ≤ 800, >800 calves per stockperson
Gender of stockperson	Man: 44%/Woman: 32%/Both: 24%	Man/woman/both a man and a woman working at the farm
Duration visit/calf	1.0 ± 0.1 min (6 to 25)	Average daily time spent in the building by the farmer per calf (daily time spent in the building (min)/number of calves): <1 min per calf/>1 min per calf
Self-reported positive contacts[1]	17.1 ± 0.8 (6 to 25)	Score: <14/14 to 18/18 to 21/>21
Self-reported negative contacts[1]	4.0 ± 0.4 (2 to 8)	Score: <2/2 to 4/4 to 6/>6

[1]Only for French data set ($n = 36$).

Stockperson's behaviour

For practical reasons, it was not possible to observe the stockperson's behaviour towards the calves. For the French farms ($n = 36$) included in this study, an additional questionnaire was filled in by the stockpersons with six questions aiming to obtain a description of their interactions with their calves. The questions were asked in the form of 'How often do you *x* your calves?', where *x* was either '*touch*', '*pet*', '*talk*', '*let them suck your fingers*', '*slap with your hands*' or '*kick*'. Answers were given on a 7-point scale with 1 = never, 4 = sometimes and 7 = very often. This data were then grouped into two variables. First, the farmer's answers about the four forms of positive contact ('*touch*', '*pet*', '*talk* and '*let them suck your fingers*') were summed up into a score of self-reported level of positive contacts (with possible score ranging from 4 to 28 points). Second, the farmer's answers about the two types of negative contacts ('*slap with your hands*' and '*kick*') were summed up into a score of self-reported level of negative contacts (with possible score ranging from 2 to 14 points). These scores were added to the list of potential risk factors (Table 1).

Statistical analysis

Data were analysed by using GenStat software (GenStat Committee, 2000), which takes each farm as a statistical unit. Spearman rank correlations were calculated between the behavioural tests. For the CET test, variables used for the analyses were the percentage of calves per farm with a score 0 (CET0) and 4 (CET4) as these variables represent extreme responses of calves to experimenters. For the HAT, mean latency of the first five calves (HATlat) was used for analysis. When means are indicated, standard errors are given.

Two series of risk factor analyses were performed with response variables CET0, CET4 and HATlat. The generalised linear model comprised a logit link function and a binomial variance function with an additional multiplicative dispersion parameter. Estimation was by maximum quasi-likelihood. The multiplicative dispersion parameter was estimated from Pearson's χ^2 statistics. Significance tests were based on the Wald test. Details may be found in McCullagh and Nelder (1989). For the first series of analyses, explanatory variables were the potential risk factors obtained from the questionnaire (listed in Table 1). For the second series of analyses only performed on the French data, the same explanatory variables were used, together with the farmers' self-reported contacts with the calves. All explanatory variables were expressed in the form of factors. Factor levels were defined such that each level corresponded to a sizeable number of farms in the sample. First, potential risk factors were inspected one at a time. Risk factors with a significance level below 0.10 ($P < 0.10$) were retained for further study. Second, the remaining risk factors were jointly entered into the model. Further analyses comprised variable selections by stepwise backward and forward selection. For all potential risk factors that were selected either by backward or forward selection, best subset selection was performed and significance tests for the selected risk factors were evaluated. Only main effects were considered, avoiding multicollinearity problems. Selection was based on adjusted R^2, and final significance ($P < 0.05$) of potential risk factors. For each risk factor that was finally selected, odds ratios and associated 95% confidence intervals were obtained from the final model. Results are presented in such a way that level I is compared with level II. Odds ratios >1 with a *t*-value level <0.05 indicate a significant risk factor.

Results

General results

For the HAT, the mean latency for touching the experimenter (HATlat) was 113.4 ± 2.0 s (range 52.8 to 172.0 s). For the CET, the average score (CETaverage) was 1.7 ± 0.1 (range 1.0 to 2.8), with average percentages of 5.8% ± 0.7% of calves per farm that could not be approached (CET0; range 0.0% to 38.1%), 54.4% ± 1.4% of calves per farm with score 1 (range 18.4% to 84.5%), 21.5% ± 0.6% of calves per farm with a score 2 (range 3.6% to 41.7%), 4.5% ± 0.4% of calves per farm with score 3 (range 0.0% to 22.4%) and 13.9% ± 0.8% of calves with score 4 (CET4; range 0.9% to 49.3%).

The mean HATlat was positively correlated with CET0 ($n = 148$; $r_s = 0.36$; $P < 0.01$) and negatively correlated with CET4 ($n = 148$; $r_s = -0.38$; $P < 0.01$).

Risk factor analyses

The multiple regression analysis showed that none of the variables studied were significantly linked with the mean latency of the calves to be touched in the HAT.

Total number of calves at the farm, space allowance per calf, environmental enrichment, season of observation, breed and stockperson's experience were found to influence significantly (all $P < 0.05$) the percentage of calves that were scored 0 during CET (Table 2). The variables accounted for 37.89% of the variance. For all the class comparisons (except for farm size <300 calves compared with 300 to 600 calves), a larger farm size was associated with a higher risk of finding a higher proportion of calves with CET0. A space allowance of 1.8 m^2 per calf and the absence of environmental enrichment (hanging objects) in the calves' pens were also associated with higher risks of observing a higher percentage of CET0 on the farm. Observations performed during autumn or winter led to a higher risk of observing a higher percentage of CET0 on the farm when compared with summer or spring observations. Herds with mainly milk type calves when compared with dual-breed calves and crossbred calves had higher percentages of CET0. The more experience a farmer had with veal calves, the lower was the risk of finding increased percentages of calves with CET0.

When performing statistical analyses on the French subset ($n = 36$) by including the stockperson's self-reported levels of positive and negative contacts, these factors did not influence the CET0 level when analysed individually and were omitted from further analyses. For the final model for

Table 2 *Multivariate regression model for the percentage of calves scored 0 (could not be approached;* n = *138)*

Risk factor[1,2]	Level of comparison I	Level of comparison II	OR	95% confidence interval	*t*-value of pairwise comparison
Total number of calves on the farm	<300	300 to 600	0.95	0.48 to 1.47	0.889
	<300	600 to 1200	0.59	0.32 to 1.09	0.094
	<300	>1200	0.32	0.16 to 0.64	0.002
	300 to 600	600 to 1200	0.62	0.39 to 0.98	0.044
	300 to 600	>1200	0.34	0.20 to 0.56	0.000
	600 to 1200	>1200	0.55	0.34 to 0.87	0.011
Space allowance	1.8 m^2/calf	>1.8 m^2/calf	2.12	1.30 to 3.45	0.003
Enrichment	No	Yes	2.11	1.16 to 3.82	0.015
Season of observation	Summer	Autumn	0.34	0.19 to 0.62	0.000
	Summer	Winter	0.54	0.30 to 0.99	0.048
	Summer	Spring	1.31	0.58 to 2.94	0.519
	Autumn	Winter	1.58	1.04 to 2.39	0.034
	Autumn	Spring	3.80	1.89 to 7.65	0.000
	Winter	Spring	2.41	1.21 to 4.80	0.014
Type of breed	Dairy breed	Dual breed	2.01	1.11 to 3.64	0.023
	Dairy breed	Crossbred	1.65	0.83 to 3.27	0.155
	Dual breed	Crossbred	0.82	0.34 to 1.99	0.662
Stockpersons' experience	<5 years	5 to 15 years	1.11	0.53 to 2.33	0.777
	<5 years	15 to 25 years	0.65	0.30 to 1.40	0.271
	<5 years	>25 years	0.44	0.21 to 0.92	0.030
	5 to 15 years	15 to 25 years	0.58	0.35 to 0.96	0.036
	5 to 15 years	>25 years	0.40	0.25 to 0.62	0.000
	15 to 25 years	>25 years	0.68	0.42 to 1.10	0.119

OR = odds ratio.
[1]All risk factors in the multivariate regression model were significant for $P < 0.05$; adjusted $R^2 = 37.89$.
[2]Variable or class is a risk factor when OR > 1 and *t*-value <0.05.

Table 3 *Multivariate regression model for the percentage of calves scored 0 (could not be approached) for the sample with farmer's self-reported contacts (*n = *36)*

Risk factor[1,2]	Level of comparison I	Level of comparison II	OR	95% confidence interval	*t*-value of pairwise comparison
Space allowance	1.8 m^2/calf	>1.8 m^2/calf	2.37	1.02 to 5.49	0.053
Stockpersons' experience	<5 years	5 to 15 years	4.90	1.54 to 15.58	0.012
	<5 years	15 to 25 years	2.54	0.65 to 9.94	0.190
	<5 years	>25 years	1.12	0.40 to 3.12	0.830
	5 to 15 years	15 to 25 years	0.52	0.11 to 2.57	0.428
	5 to 15 years	>25 years	0.23	0.06 to 0.86	0.037
	15 to 25 years	>25 years	0.44	0.10 to 1.91	0.282

OR = odds ratio.
[1]All risk factors in the multivariate regression model were significant for $P < 0.05$; adjusted $R^2 = 20.71$.
[2]Variable or class is a risk factor when OR >1 and *t*-value <0.05.

the French subset, the variables space allowance per calf and stockperson's experience influenced significantly ($P < 0.05$) CET0 levels and accounted for 20.71% of the variance observed (Table 3). Space allowance per calf and stockperson's experience gave the same interpretations as for the results presented in Table 2, which means a higher space allowance per calf and increased experience of stockpersons leading to lower CET0 levels.

With regard to the proportion of calves with CET4, type of milk distribution, breed and number of calves per stockperson explained significantly (all $P < 0.05$) 16.26% of the variance in the multiple regression model (Table 4). Calves raised on farms with bucket feeding had a higher risk of increased CET4 levels when compared with those with trough feeding. Farms with dual-breed or crossbred calves were more likely to have a higher proportion of calves with CET4 compared with the farms with only dairy breed calves. In general, farms with a lower number of calves per stockperson had a greater chance of higher levels of calves with CET4.

When performing statistical analyses on the French subset ($n = 36$) by integrating the stockperson's self-reported levels of positive and negative contacts, these factors did not

Table 4 *Multivariate regression model for the percentage of calves scored 4 (could be touched;* n = 147*)*

Risk factor[1,2]	Level of comparison I	Level of comparison II	OR	95% confidence interval	*t*-value of pairwise comparison
Type of milk distribution	Bucket	Trough	1.33	0.97 to 1.83	0.077
Type of breed	Dairy breed	Dual breed	0.70	0.51 to 0.96	0.030
	Dairy breed	Crossbred	0.63	0.46 to 0.87	0.006
	Dual breed	Crossbred	0.90	0.60 to 1.34	0.599
Number of calves/stockperson	<200	201 to 400	1.03	0.72 to 1.46	0.889
	<200	401 to 600	1.34	0.90 to 2.00	0.156
	<200	601 to 800	2.12	1.23 to 3.65	0.007
	<200	>800	1.47	0.89 to 2.45	0.138
	201 to 400	401 to 600	1.30	0.94 to 1.82	0.120
	201 to 400	601 to 800	2.07	1.26 to 3.39	0.004
	201 to 400	>800	1.44	0.93 to 2.23	0.108
	401 to 600	601 to 800	1.59	0.98 to 2.56	0.061
	401 to 600	>800	1.10	0.72 to 1.68	0.658
	601 to 800	>800	0.69	0.40 to 1.21	0.197

OR = odds ratio.
[1]All risk factors in the multivariate regression model were significant for $P < 0.05$; adjusted $R^2 = 16.26$.
[2]Variable or class is a risk factor when OR > 1 and *t*-value <0.05.

Table 5 *Multivariate regression model for the percentage of calves scored 4 (could be touched) for the sample with farmer's self-reported contacts (*n = 36*)*

Risk factor[1,2]	Level of comparison I	Level of comparison II	OR	95% confidence interval	*t*-value of pairwise comparison
Type of breed	Dairy breed	Dual breed	0.29	0.12 to 0.72	0.012
	Dairy breed	Crossbred	0.80	0.47 to 1.36	0.423
	Dual breed	Crossbred	2.75	1.01 to 7.44	0.056
Frequency of visit by the technician	Weekly	Every 2 weeks	5.10	1.04 to 24.90	0.053

OR = odds ratio.
[1]All risk factors in the multivariate regression model were significant for $P < 0.05$; adjusted $R^2 = 16.26$.
[2]Variable or class is a risk factor when OR > 1 and *t*-value <0.05.

influence the CET4 level when analysed individually and were omitted from further analyses. For the final model for the French subset, the variables type of breed and frequency of visits by the technician influenced significantly ($P < 0.05$) CET4 levels and accounted for 16.26% of the variance observed (Table 5). Farms with dual-breed or crossbred calves had a higher risk of having a higher proportion of calves with CET4 compared with the farms with dairy breed, and farms with dual-breed calves had a higher risk of having a higher proportion of calves with CET4 compared with farms with crossbreds. Farms that were visited weekly by the technician had a higher risk of increased CET4 levels when compared with those were the technician came every 2 weeks.

Discussion

In the present study, two tests were performed on all farms in order to determine the human–animal relationship. The HAT was based on the voluntary approach of calves when the experimenter was standing at the feeding fence, whereas during the CET the experimenter entered a pen and tried to touch calves in a standardised way. A higher latency to touch during HAT was moderately negatively correlated with the CET score 4, demonstrating that calves not approaching an unfamiliar person easily, also avoided this person when he/she approached these calves. At farms with a high HAT latency, a low proportion of calves that could be touched was found. However, stockperson's management and animal characteristics did not influence latency to touch during HAT. It is possible that a voluntary approach of a human during the day is not a challenge for the animals. Animals may be in a situation of conflict between curiosity and fear when an unknown person is present (de Passillé and Rushen, 2005). During the CET, a human is clearly provoking a reaction of the animal and it is likely that those that can be touched are not fearful of humans (Boivin *et al*., 1998). However, animals that cannot be touched may not necessarily be frightened (Waiblinger *et al*., 2003), and tests like our CET might be a mixture of measuring fear (extreme reactions), disinterest (moderate reactions) and lack of interest (Scott *et al*., 2009).

Farm animals' reactions to humans are generally an indicator of the quality and quantity of contacts they had with stockpersons (Hemsworth and Coleman, 2010). Ideally, the stockperson's behaviour towards the animals should be observed in order to have a more exact evaluation of the human–animal relationship. As for the majority of field studies published, no direct observations of the stockperson's behaviour towards their calves were performed during the present study. For practical reasons it was not possible to perform these observations on such a large scale and within the limited time available for the experimenters. Therefore, for a part of the stockpersons, questions were asked on the quality and frequency of their contacts with calves. In several studies, a clear link was demonstrated between stockperson's attitudes and their behaviour towards animals (Hemsworth *et al.*, 1994 and 2002; Coleman *et al.*, 2000; Waiblinger *et al.*, 2002). In the present study, no relationship was established between the level of contacts with the calves reported by the farmer and the behaviour of calves measured in the CET. Several reasons can be imagined for this apparent lack of relationship. It is possible that the variation in the results from the questionnaire and the number of questions were insufficient to have any effect in the analysis. Furthermore, stockpersons might have moderated their responses to questions concerning negative interactions and might have exaggerated their responses to questions regarding positive interactions (Lensink *et al.*, 2000a). In addition, some aversive contacts such as moving or vaccinating calves and other types of contacts such as visual contact during daily routine procedures were not integrated in the assessment explaining therefore the lack of relationship.

At larger farms, especially those with more than 1200 calves, animals avoided the experimenter more than at smaller farms. Furthermore, on farms with fewer calves per stockperson more calves could be touched during the CET. This supports earlier findings that stockpersons in bigger units have less time to interact individually with animals (English, 1991; Lensink *et al.*, 2000a). For this reason, these variables are reflecting a lower level of physical and visual contact per animal, which in turn might influence the animals' reactions to humans (Barnett *et al.*, 1994).

The way calves were fed influenced their response during the CET. Calves fed in a trough were more fearful than those fed in a bucket. It is possible that in the bucket system, calves have more visual and physical contact with the stockperson compared with the trough system. In fact, in the bucket system, for each meal the stockperson stands still in front of each bucket (and therefore each calf) in order to fill the bucket, whereas in the trough system the stockperson stands only directly in front of one calf or troughs are filled automatically without any human presence. This finding seems to support the suggestion that the amount of visual contact with stockpersons during feeding can influence the animal's behaviour towards humans (Jago *et al.*, 1999; Lensink *et al.*, 2000b). Furthermore, higher average space allowance per calf led to a lower proportion of calves with a score 0 (no eye contact) during the CET. Normally, farmers keep their calves at the minimum required space allowance as laid down in the regulations of the European Union (1.8 m^2/calf), but in some farms calves had some more space. Although the test was standardised, these calves might have been able to escape more easily or walk away from the experimenter or were less challenged by the test situation leading to a lower proportion of score 0.

Breed differences were found in the outcome of the CET. Crossbred calves generally tended less to avoid humans compared with dual-purpose breeds and dairy breed calves, while compared with dairy breed calves, dual-purpose breed calves demonstrated also less avoidance of humans. These findings are in accordance with previous studies demonstrating potential differences in reactivity to humans between beef cattle breeds (Murphey *et al.*, 1981; adult cattle: Boivin *et al.*, 1992; calves: Boivin *et al.*, 1994). However, it is generally believed that beef cattle are more fearful of humans than dairy breeds (Murphey *et al.* 1981), but this could be partially due to a lower level of contact with humans rather than a genetic effect. In our study, crossbred calves, which were a cross between dairy and beef breeds, and dual-purpose (milk and meat) breed calves were generally less fearful than dairy breed calves. As calves from those different breeds were raised in similar conditions, these effects might be due to genetic differences, but further research is needed to defend this hypothesis.

Seasonal effects were found on the percentage of calves that could not be touched. This result was unexpected as calves are penned and managed in the same conditions throughout the year. A seasonal effect might reflect temperature differences or effects on health. In autumn and winter, calves have a higher risk of lung diseases (Lundborg *et al.*, 2005), which leads to more medical treatments. These treatments can be accompanied with some additional potentially negative handling by the stockperson or the veterinarian explaining potentially the higher number of calves that could not be touched.

In our study, presence of environmental enrichment (hanging objects in the calves' pens) was associated with a lower risk of observing a high percentage of calves avoiding the experimenter. Environmental enrichment was shown to reduce fear of humans in pigs (Pearce *et al.*, 1989) but this impact has not been demonstrated in cattle yet (Raussi, 2003). More research is needed to determine the potential links between hanging objects, general fearfulness and reactivity of animals to humans.

Our study indicates that factors other than the stockperson's behaviour towards their animals can affect calves' reaction during a human–animal relationship test performed in on-farm conditions. Stockperson's characteristics and management such as the number of calves they take care of, or years of experience, influenced calves' reactions; in addition, feeding system and breed also affected the outcome of the tests. More detailed studies are needed to clearly identify the importance of different aspects of the stockperson's behaviour because, next to physical contact, factors such as visual contact or being accustomed to human presence seem to have considerable impact on the animals' reactions to humans. However, as our study did not integrate the observation of the stockpersons' behaviour towards their calves, care should be taken with the interpretation of all potential effects as confounding issues might remain. In future, more research is needed integrating all aspects of the human–animal relationship in field studies to clarify and confirm the different results obtained.

Acknowledgements

The present study is part of the Welfare Quality® research project that has been co-financed by the European Commission within the 6th Framework Programme, contract no. FOOD-CT-2004-506508. The text represents the authors' views and does not necessarily represent a position of the Commission who will not be liable for the use of such information. This research was also financed by the Dutch Ministry of Agriculture, Nature and Food Quality, the Dutch Product Board Animal Feed, the Dutch Product Boards of Livestock, Meat and Eggs and the French Product Board for Calves (Interveaux). The authors would like to thank the veal integrators and farmers who took part in the study, Willem Buist for his help with the data analysis, and Jean-Loup Rault for his help during the observations, and Robin Fisher for proof-reading the English manuscript.

References

Barnett JL, Hemsworth PH, Hennessy DP, McCallum TH and Newman EA 1994. The effects of modifying the amount of human contact on behavioural, physiological and production responses of laying hens. Applied Animal Behaviour Science 41, 87–100.

Boivin X, Garel JP, Mante A and Le Neindre P 1998. Beef cattle react differently to different handlers according to the test situation and their previous interaction with their caretaker. Applied Animal Behaviour Science 55, 245–257.

Boivin X, Le Neindre P, Garel JP and Chupin JM 1994. Influence of breed and rearing management on cattle reactions during human handling. Applied Animal Behaviour Science 39, 115–122.

Boivin X, Le Neindre P, Chupin JM, Garel JP and Trillat G 1992. Influence of breed and early management on ease of handling and open-field behaviour of cattle. Applied Animal Behaviour Science 32, 313–323.

Bokkers EAM, Leruste H, Heutinck LFM, Wolthuis-Fillerup M, van der Werf JTN, Lensink BJ and van Reenen CG 2009. Inter-observer and test–retest reliability of on-farm behavioural observations in veal calves. Animal Welfare 18, 381–390.

Botreau R, Veissier I, Butterworth A, Bracke MBM and Keeling LJ 2007. Definition of criteria for overall assessment of animal welfare. Animal Welfare 16, 225–228.

Coleman GJ, Hemsworth PH, Hay M and Cox M 2000. Modifying stockperson attitudes and behaviour towards pigs at a large commercial farm. Applied Animal Behaviour Science 66, 11–20.

De Passillé AM and Rushen J 2005. Can we measure human–animal interactions in on-farm animal welfare assessment? Some unresolved issues. Applied Animal Behaviour Science 92, 193–209.

English PR 1991. Stockmanship, empathy and pig behaviour. Pig Veterinary Journal 26, 56–66.

GenStat Committee 2000. In Reference manual. Procedure Library PL12 (ed. RG Payne and GM Arnold), VSN International, Oxford, UK.

Hemsworth PH and Barnett JL 1991. The effects of aversively handling pigs either individually or in groups on their behaviour, growth and corticosteroids. Applied Animal Behaviour Science 30, 61–72.

Hemsworth PH and Coleman GJ 2010. Human–livestock interactions: the stockperson and the productivity and welfare of intensively farmed animals. CAB International, Oxford, UK.

Hemsworth PH, Barnett JL and Coleman GJ 1993. The human–animal relationship in agriculture and its consequences for the animal. Animal Welfare 2, 33–51.

Hemsworth PH, Coleman GJ and Barnett JL 1994. Improving the attitude and behaviour of stockpersons towards pigs and the consequences on the behaviour and reproductive performance of commercial pigs. Applied Animal Behaviour Science 39, 349–362.

Hemsworth PH, Coleman GJ, Barnett JL and Borg S 2000. Relationships between human–animal interactions and productivity of commercial dairy cows. Journal of Animal Science 78, 2821–2831.

Hemsworth PH, Coleman GJ, Barnett JL, Borg S and Dowling S 2002. The effects of cognitive behavioral intervention on the attitude and behavior of stockpersons and the behavior and productivity of commercial dairy cows. Journal of Animal Science 80, 68–78.

Jago JG, Krohn CC and Matthews LR 1999. The influence of feeding and handling on the development of the human–animal interactions in young cattle. Applied Animal Behaviour Science 62, 137–151.

Lensink BJ, Veissier I and Florand L 2001. The farmer's influence on calves' behaviour, health and production of a veal unit. Animal Science 72, 105–116.

Lensink BJ, Boissy A and Veissier I 2000a. The relationship between attitude and behaviour towards calves, and productivity of veal units. Annales de Zootechnie 49, 313–327.

Lensink BJ, Boivin X, Pradel P, Le Neindre P and Veissier I 2000b. Reducing veal calves' reactivity to people by providing additional human contact. Journal of Animal Science 78, 1213–1218.

Lensink BJ, Leruste H, De Bretagne T and Bizeray-Filoche D 2009. Sow behaviour towards humans during standard management procedures and their relationship to piglet survival. Applied Animal Behaviour Science 119, 151–157.

Lundborg GK, Svensson EC and Oltenacu PA 2005. Herd-level risk factors for infectious diseases in Swedish dairy calves aged 0–90 days. Preventive Veterinary Medicine 68, 123–143.

Martin P and Bateson P 1993. Measuring behaviour: an introductory guide, 2nd edition. Cambridge University Press.

McCullagh P and Nelder JA 1989. Generalized linear models, 2nd edition. Chapman & Hall, London.

Murphey RM, Moura Duarte FA and Torres Penedo MC 1981. Responses of cattle to humans in open spaces: Breed comparisons and approach-avoidance relationships. Behaviour and Genetics 11, 37–48.

Pearce GP, Paterson AM and Pearce AN 1989. The influence of pleasant and unpleasant handling and the provision of toys on the growth and behaviour of male pigs. Applied Animal Behaviour Science 23, 27–37.

Raussi S 2003. Human–cattle interactions in group housing. Applied Animal Behaviour Science 80, 245–262.

Rousing T, Ibsen B and Sorensen JT 2005. A note on: on-farm testing of the behavioural response of group-housed calves towards humans; test–retest and inter-observer reliability and effect of familiarity of test person. Applied Animal Behaviour Science 94, 237–243.

Rushen J, Taylor AA and de Passillé AM 1999. Domestic animals' fear of humans and its effect on their welfare. Applied Animal Behaviour Science 65, 285–303.

Scott K, Laws DM, Courboulay V, Meunier-Salaün MC and Edwards SA 2009. Comparison of methods to assess fear of humans in sows. Applied Animal Behaviour Science 118, 36–41.

Tallet C, Veissier I and Boivin X 2006. A note on the consistency and specificity of lambs' responses to a stockperson and to their photograph in an arena test. Applied Animal Behaviour Science 98, 308–314.

Waiblinger S, Menke C and Coleman G 2002. The relationship between attitudes, personal characteristics and behaviour of stockpeople and subsequent behaviour and production of dairy cows. Applied Animal Behaviour Science 79, 195–219.

Waiblinger S, Menke C and Fölsch DW 2003. Influences on the avoidance and approach behaviour of dairy cows towards humans on 35 farms. Applied Animal Behaviour Science 84, 23–39.

Waiblinger S, Boivin X, Pedersen V, Tosi MV, Janczak AM, Visser EK and Jones RB 2006. Assessing the human–animal relationship in farmed species: a critical review. Applied Animal Behaviour Science 101, 185–242.

Windschnurer I, Schmied C, Boivin X and Waiblinger S 2008. Reliability and inter-test relationship of tests for on-farm assessment of dairy cows' relationship to humans. Applied Animal Behaviour Science 114, 37–53.