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Alpaca and llama behaviour during handling and its associations with caretaker attitudes and human-animal contact

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ABSTRACT

The behaviour of new world camelids towards humans has received little research attention so far. Our aims were to assess the response of alpacas and llamas to handling, and to investigate its associations with caretaker attitudes and handling practices (i.e., the reported amount of contact to the animals at different ages). Reactions of 116 alpacas and llamas during handling by a familiar person and during a physical examination by a veterinarian were observed on 20 animal holdings. The 20 main caretakers completed or partially completed a questionnaire on their attitudes and their amount of contact to their animals. Data were analysed at farm level by means of Spearman rank correlations. Animals were generally very easy to lead by a familiar person, but a higher proportion showed fear and stress related behaviour, predominantly freezing, during the physical examinations. Associations between caretaker attitudes, amount of contact, and animal behaviour were found. For instance, if the caretakers found tactile contact more pleasant, a lower percentage of animals attempted to flee during leading (r_s = -0.51, $p < 0.05$, n = 18). Likewise, a higher percentage of animals showed no rising or freezing during the physical examination, if the caretakers rated talking to the animals as more important (r_s = 0.57 / 0.49, $p < 0.05$, n = 17), and a higher percentage of animals did not scream and / or squeal, if caretakers rated training as more pleasant (r_s = 0.77, $p < 0.001$, n = 18). Out of the 12 participants rearing young animals, those stroking their animals more frequently in early life had a higher percentage of non-balking animals during leading (r_s = 0.64, $p < 0.05$, n = 12). A higher percentage of animals with handling difficulties and /or attempts to flee was associated with lower frequencies of touching in later life (r_s = -0.80, $p < 0.01$, n = 11). The overall results suggest similar sequential relationships between caretaker attitudes, amount of gentle contact with the animals and the animals' behaviour, as in other species.

1. Introduction

Alpacas and llamas, i.e., domesticated new world camelids, enjoy increasing popularity amongst smallholders and farmers. Reasons for keeping them range from fibre production, landscape management, animal-assisted activities such as trekking, to keeping them as a hobby (Gauly, 2004; Gunsser, 2009; Lambacher et al., 2015). They sometimes do, however, show aggressive behaviours that can result in injuries to humans, as reported for llamas (*Lama glama*) (Grossman and Kutzler, 2007). Despite of this, studies on potential effects of management and handling practices (e.g., castration, shearing, training and frequency of contact to humans) on their behaviour towards humans and their ease of handling are scarce. Some information is available on effects of castration and training on the aggressive behaviour of male llamas (Grossman and Kutzler, 2007) and on the effects of different methods of restraint during shearing on physiological and behavioural responses (Wittek et al., 2017; Waiblinger et al., 2020). Defensive and offensive aggressive behaviours in alpacas and llamas include biting, bumping, or kicking (McGee Bennett, 2014) and can put both handlers as well as animals at risk. Grossman and Kutzler (2007) reported that 71 % of male llamas with a history of aggressive behaviour towards humans had already injured a person.

A common handling recommendation found in popular literature warns against engaging into too intensive contact when the animals are young, e.g., by petting the animal, since this could lead to 'mis-imprinting' and viewing the human as a conspecific, resulting in

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inappropriate behaviours including human-directed aggression, or in females rejecting male conspecifics and not allowing to be bred. In this context, also the terms 'berserk male syndrome' or 'aberrant behaviour syndrome' can be found (Lambacher et al., 2015; McGee Bennett, 2014; Paul, 2007). However, this is not a scientific term, but was originally used by a llama breeder for behavioural problems in bottle-fed animals or animals petted and stroked in young age that later did not hesitate to initiate contact to humans, in the extreme form by bumping with their chest against humans (for review, see McGee Bennett, 2014). Therefore, some recommend against starting the halter and obedience training in alpacas and llamas before the age of ten months (Lambacher et al., 2015). However, in other animal species early gentle contact to humans is beneficial for the animal's relationship with humans and thus for the ease of handling later in life (for review, see Waiblinger, 2017). For instance, in cattle early gentle contact to humans (brushing, leading with a halter) has shown to be beneficial for later ease of handling because it had a positive impact on the human-animal relationship (Boissy and Bouissou, 1988). Rearing cattle with frequent and regular visual and tactile contact to humans in the course of farm routines (e.g., leading them, regular weighing) during their first three months of life prevented aggression towards humans (Boivin et al., 1994). 'Mis-imprinting' comparable to the 'berserk male syndrome' would be rather expected to occur in case of very close contact to humans, i.e., when hand-rearing animals, under isolation from conspecifics (Price and Wallach, 1990; Sambraus and Sambraus, 1975; Steinbacher, 1939).

In other species such as pigs, cattle, and horses, caretakers' attitudes affected their behaviour towards the animals and their decisions on housing and management (e.g., Coleman et al., 1998; Hemsworth, 2012; Waiblinger, 1996; Waiblinger et al., 2006a). Both human behaviour and husbandry decisions are related to human attitudes and have an impact on animal behaviour and welfare (for review, see Waiblinger, 2019). In cattle, behaviour of caretakers was reflected in the animals' behaviour, including their fear of humans (e.g., Breuer et al., 2000; Hemsworth et al., 1989, 1994; Waiblinger et al., 2002), and their health (Chesterton et al., 1989; Ivemeyer et al., 2011).

In alpacas and llamas, no study ever investigated aspects of the human-animal relationship including human attitudes and handling practices such as the frequency of different types of contact at different ages and associations with alpaca and llama behaviour during handling. Interestingly, there is also little information on behavioural reactions of these animals to handling procedures. To our knowledge, only one study looked into behavioural reactions such as flight attempts and vocalisations of alpacas during shearing and during restraint and into behaviour such as lying or ruminating after the procedure, comparing different methods of restraint (Waiblinger et al., 2020).

The aims of the present study were 1) to assess the response of alpacas and llamas to handling and 2) to investigate associations between caretaker attitudes, handling practices and the behaviour of alpacas and llamas during handling.

2. Methods

All experimental procedures applied during the course of this study were discussed and approved by the institutional ethics and animal welfare committee in accordance with guidelines for Good Scientific Practice and with national legislation (ETK-17/10/2015). All human participants signed a written information and consent form. The participants were informed that the study aimed to collect information on housing conditions and management practices of domesticated new world camelids, experiences with and opinions about these animals and to identify possible influencing factors on animal behaviour and ease of handling.

2.1. Study participants

Twenty Austrian alpaca and llama holdings (farms and smallholders), located in the regions Vienna, Upper Austria, Lower Austria, Styria, Salzburg, and Burgenland were visited once between November 2015 and June 2016. The participants were contacted and recruited in the course of a parallel project on transabdominal ultrasonography in alpacas and llamas. The aim of the parallel study was to establish a protocol for ultrasound examinations of different abdominal organs and to describe the normal sonographic appearance of the examined organs in healthy animals.

As evaluated via the questionnaire described in 2.3., participants were between 21 and 66 years of age (mean, std.dev: 46.8 ± 10.8, n = 20). Nine of the 20 participants were female (45 %), 11 were male (55 %). They had experienced working with alpacas and/or llamas from two to 13 years (6.3 ± 3.3, n = 20). Nearly half (47.4 %, 9 out of 19) indicated to keep their new world camelids as a hobby, whereas 47.4 % (9) kept them as a source of additional income, and one farmer (5.3 %) kept them as main source of income. Of the 19 respondents, 31.6 % (6 / 19) had grown up with farm animals and out of 18 of them, 72.2 % grew up with other animals (two non-responders). To obtain information on new world camelids, 75 % (15 / 20) reported to attend courses or seminars, 60 % reported to attend congresses, and 65 % reported to read journals or books on new world camelids.

2.2. Animals and husbandry

2.2.1. Animal holdings and husbandry

Overall, the 20 participants kept 1–52 animals (mean, std.dev: 17.5 ± 14.5). Five participants kept only llamas (mean ± std.dev., min – max: 5.0 ± 4.2, 1–10), 13 kept only alpacas (22.2 ± 15.2, 2–52), one kept both types (10 alpacas and 14 llamas), and another kept eight llamas and three llama-alpaca crossbreds. Thus overall, seven participants kept llamas, and 14 kept alpacas.

On the 14 holdings with alpacas, 85.7 % (12) kept alpacas for breeding, 78.6 % (11) for fibre production, 28.6 % (4) as hobby, 35.7 % (5) for trekking and 28.6 % (4) for other animal-assisted activities. On the seven holdings keeping llamas, 14.3 % (1) kept llamas for breeding, 42.9 % (3) for fibre production, 71.4 % (5) as hobby, 85.7 % (6) for trekking, and 42.9 % (3) for other animal-assisted activities. Llama-alpaca crossbreds (three animals) were kept as hobby, for trekking, and for other animal-assisted activities.

All animal holdings were family-run without additional employees. On 85 % (17 out of 20) of the holdings, children had contact to the animals. On 65 % (13) of the holdings, unfamiliar people could make contact to the animals. Overall 1–14 people (3.7 ± 3.2) were involved in the routine care for the animals. In terms of family, 1–4 adult family members (2.4 ± 1.0), and 0–3 (0.4 ± 0.8) children of the family helped with routine care. In terms of people outside the family, 0–10 (0.9 ± 2.4) adults, and 0–2 (0.2 ± 0.5) children were said to help.

Nineteen participants answered questions about housing and pasture access. On 73.7 % (14) of the animal holdings, the animals had a barn whereas on 52.7 % (10 / 19) they had a shelter. At 68.4 % (13) of the holdings, the participants allowed constant access to the pasture (24 h per day, the whole year), 21.1 % (4) provided access to the pasture throughout the year, but less than 24 h per day, and 10.5 % (2) did not allow access to the pasture for part of the year. Out of 18 caretakers who provided information, half of them kept their animals in one group, whereas seven caretakers kept the animals in two groups, one in three groups, and another kept five groups.

2.2.2. Animals included in the study

Only clinically healthy adult alpacas and llamas over one year of age, in total 116 animals (81 alpacas, 32 llamas, and 3 llama-alpaca crossbreds), were included in our study. They were aged 1–17 years (mean, std.dev: 6.3 ± 4.1 years, n = 115). The majority, 69.8 %, were female (n = 81) whereas 30.2 % (n = 35) were male. Ten males were castrated. At the time of testing, the animals had been with the owner between 1.5 months and 13 years (mean, std.dev: 4.2 ± 2.9 years). The

percentage of examined animals based on all new world camelids kept on the respective animal holdings ranged from 12.5%–100% (mean, std.dev: 52.5 % ± 33.5 %) animals, corresponding to 1–17 animals (mean, std.dev: 5.8 ± 3.9).

2.3. Data acquisition

2.3.1. Visit protocol and examination procedures

Prior to visiting the 20 participants, a separate farm was used for a pilot visit to practice the protocol and the behavioural observations, and to refine the questionnaire. During the main study, the protocol for visits was always the same. After the arrival at the animal holding, a suitable location for the sonographic examination was chosen. This had to be a location that was familiar to the animals, dark, calm, roofed, and had a socket for the ultrasonic device within reach. Animals in the last trimester of gestation were excluded from the examination. Otherwise, healthy animals (according to caretaker reports and visual inspection) older than one year of age were included in the study. The physical examination proved that these animals were indeed healthy. Due to time constraints, not all animals could be examined on the largest farms, and in these cases animals were randomly selected.

A familiar person took the animals to the chosen examination location. Except for the physical examination of one animal, familiar caretakers were always present during the examinations. In 86.2 % (100) out of the 116 cases, examined animals had visual contact to conspecifics and 91.4 % had auditory contact to conspecifics. In 9.5 % of the examinations (11 out of 116 animals, on 3 animal holdings) conspecifics were deliberately brought with the examined animals as means of social support. However, this was not the case for every animal on the respective animal holdings.

Most animals were restrained with a halter and rope tied to a wall and additionally held by a familiar person around the neck or over the head. Animals were never sedated. The physical examination was performed as gentle as possible by the same veterinarian. The physical examination lasted 3–4 minutes and consisted of an examination of the general behaviour, including the body posture, and an examination of the eyes, ears, mouth and teeth, an auscultation of the heart, lung, and stomach, an examination of the skin and its elasticity, and an assessment of the body condition (Baumgartner et al., 2014). After that, the main caretaker filled in a questionnaire on housing conditions, management practices and his or her attitudes (described below). In the meantime, the veterinarian recorded herd data and was present for questions. Caretakers had to complete the questionnaire after they had participated in handling the animals in order not to sensitise them and by this alter their behaviour towards their animals.

2.3.2. Behavioural observations

Always the same veterinarian (female, 170 cm tall) carried out the physical examinations and recorded the animals' behaviour while the animals were led towards her and during the standardised physical examinations. Since the observer also carried out the physical examination, we decided to use behavioural scores (see also Lindahl et al., 2016) instead of quantitative behaviour recording to keep the assessment feasible.

2.3.3. Behaviour during leading

The examiner used a 3-point score (= *leading score*) to rate the animals' behaviour and the amount of effort needed when leading, from the moment that the animal was led within 3–4 m from the examiner. *Score 1*: animal allows to be led or light tap on the rump is given ('non-balking'); *Score 2*: pulling and / or pushing are necessary ('balking'); *Score 3*: several attempts to bring the animal into the correct position are necessary and /or the animal attempts to flee ('strongly balking').

2.3.4. Scoring of behaviour during the physical examination

Occurrences of the following animal behaviours were noted down by the veterinarian (= unfamiliar examiner) on pre-prepared evaluation sheets: vocalisations (squealing and / or screaming, snorting and / or clicking sounds, moaning); kicking directed at the examiner; kicking and stomping that was not directed at the examiner; spitting; collapsing deliberately, i.e., abruptly lying down on the belly (and lying on the ground); rising (with the front legs off the ground); and freezing of at least five seconds. To keep the observation simple and feasible, the occurrence of the different vocalisations, as well as of abruptly lying down (and lying on the ground) and of freezing were scored as 1) never, 2) 1–3 times during the examination, 3) more than three times but less often than half of the time, 4) continuously, defined as during at least half of the examination time or longer. The occurrence of kicking directed at the examiner, kicking and stomping not directed at the examiner, spitting and rising were scored as 1) never, 2) 1–3 times during the examination, or 3) more than three times. As a means of preparation, audio files with the different types of vocalisations had been given to the veterinarian.

2.3.5. Questionnaire

The main caretaker was asked to fill out a questionnaire after the examination of the animals. To respect the participants' anonymity, we refrained from controlling the questionnaires for missing answers. This did result, however, in a varied sample size per question.

By means of single-choice, multiple-choice and open questions, we collected the following information: type of new world camelids (alpacas, llamas, mix), number of animals, age and castration status, reasons for keeping the domesticated new world camelids, housing (type of shelter, pasture access), management (e.g., number of animal groups, number of caretakers) and handling practices (e.g., the amount of contact during daily care). The latter comprised questions about the frequency of going to the animals in order to care for them or check on them (frequency of controls / day), the number of hours per day working in the animals' living zone (h / day work), and the frequency of visual, vocal and tactile contact of the main caretaker to male and female animals at different ages (in the first week of life, in the 2nd to 4th week of life, in the 2nd to 10th month of life, after the 10th month of life). Participants could indicate the frequency on a 5-point scale ranging from never to several times per day. The number of participants was too small for variable reducing analyses such as principal component analysis. Instead, based on Windschnurer et al. (2018) the 'frequency of contact' questions were reduced to: 1) *Stroking in week 1–4*: comprising the frequency of stroking females and males in the 1st week and 2nd to 4th week; 2) *Touching in week 1–4*: comprising the frequency of touching females and males in the 1st week and 2nd to 4th week; 3) *Touching after 10th month*: comprising touching females and males after the 10th month; 4) *Talking to the animals*: comprising talking to the animals in the 1st week, 2nd to 4th week, 2nd to 10th month of life, after the 10th month of life; 5) *Visual contact*: comprising visual contact in the 1st week, 2nd to 4th week, 2nd to 10th month of life, after the 10th month of life.

Attitudes towards interactions with the animals (*behavioural beliefs*) were assessed, adapting questions originally used to inquire beliefs about working with dairy cows (Waiblinger et al., 2002). This section of the questionnaire consisted of questions such as "How important is it to talk to animals while approaching them?", "How important is it to stroke the animals?", "How important is it to walk regularly through a group of animals?", always to be answered for five different age / sex categories (young < 10 months, young > 10 months, adult females, adult males, and adult geldings). Participants could respond to each statement on a 7-point Likert scale, with answers ranging from 'very important' to 'not important at all'. The questionnaire also comprised questions assessing *affective attitudes*, i.e., the degree of comfort or discomfort felt during contact with the animals in different situations. The participants could respond to each statement on a 7-point Likert scale, with answers ranging from feels 'very pleasant' to 'very unpleasant'.

In accordance with the *'frequency of contact'* questions, attitude questions were reduced, based on Windschnurer et al. (2018), to three *behavioural beliefs* components: 1) *Importance of talking*: comprising talking to the animals (all five age / sex categories) while approaching / while walking through the group; 2) *Importance of walking through the herd*: comprising regular walking through a group, also asked separately for all five age / sex categories; 3) *Importance of stroking animals*: comprising stroking of all five age / sex categories. Two *affective attitudes* were distinguished: 1) *Pleasantness of training*: comprising habituation to halter, leash training, treatment of sick animals; 2) *Pleasantness of tactile contact*: comprising physical contact while feeding and caring for the animals, stroking the animals. The last section of the questionnaire aimed at collecting demographic data (e.g., gender and age) and information about the participants' experience in animal husbandry.

2.4. Data analysis

Component values for frequency of contact and attitude components were calculated for each participant by averaging the items included. In case a component had > 20 % of missing items (which corresponded to a maximum of two items) then this component value was excluded. Taking a more conservative approach, we assumed that if more than a fifth of the relevant items was missing, this might not reflect the attitude or the actual frequency of contact so well. This resulted in the exclusion of three participants from analysis for the behavioural belief questions and one participant for the frequency of contact questions relating to *Touching in week 1–4, Touching after 10thmonth, Talking to the animals,* and *Visual contact*. Further, eight caretakers did not raise young animals, which reduced the sample size for frequency of contact to 12 (*Stroking in week 1–4),* or 11 (all other frequency of contact components), respectively.

The data were analysed at animal holding level (n = 20), using the percentage of animals with a certain score in relation to the total number of animals assessed on the holding. The data were analysed using the statistical software package IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, N.Y., USA).

Most measures showed non-normality during visual exploration (confirmed by Shapiro Wilks tests). Therefore, associations between caretaker attitudes, amount of different types of contact, and animal behaviour were analysed calculating Spearman rank correlations. For the analysis of associations with animal behaviour during the physical examination, only the lowest and the highest behaviour score categories were used for each behaviour (e.g., % of animals that showed no freezing and % of animals freezing ≥ half the time on the respective holding), given sufficient occurrence, i.e., scores occurred on at least 4 holdings. This was done to reduce the number of tests and by this the increased risk of a type I error due to multiple testing and because we considered the extremes the most interesting categories. In the discussion, correlation coefficients of 0.2 – 0.4 are referred to as low, 0.4 – 0.7 as moderate, and above 0.7 as high (Martin and Bateson, 2007). Regarding significance levels, $p < 0.05$ is referred to as significant whereas $p \leq 0.1$ is interpreted as a trend. Owing to the explorative nature of this study, no correction was done for multiple testing. Hence, especially trends should be interpreted with caution. Trends are mentioned though, since the small sample size likely resulted in a low statistical power.

3. Results

3.1. Animal behaviour

Variation in animal behaviour during leading, and in vocalisations during physical examinations, are shown in Table 1. Variation in the other behaviours during the physical examination is depicted in Table 2. Both during leading and during the physical examination, a high percentage of animals received the lowest score for the different behaviours. For example, 76.6 % ± 28.69 (mean ± std.dev., median: 90 %, Table 1) of the animals per holding were 'non-balkers', i.e., allowed to be led without any effort or only needed a light tap on the rump (*Leading score 1*). However, the range shows a large variation between animal holdings in the leading score as well as most of the behaviours during the physical examination (Tables 1 and 2).

Table 1
Overview on *leading score* and on vocalisations during the physical examination. Percentages of animals per animal holding (n = 20) are given with minimum (Min), lower quartile (25 %), median (Med), upper quartile (75 %), and maximum (Max) for score 1 (non-balking), score 2 (balking) and score 3 (strongly balking), as well as for the frequency of vocalizations.

Animal behaviour	Min	25 %	Med	75 %	Max
Animal behaviour during leading and effort needed					
% score 1	0.00	51.47	90.00	100.00	100.00
% score 2	0.00	0.00	0.00	18.33	100.00
% score 3	0.00	0.00	0.00	10.00	50.00
Vocalisations during examination					
Squealing / Screaming					
% none	40.00	88.19	100.00	100.00	100.00
% 1–3 times	0.00	0.00	0.00	0.00	20.00
% > 3 times but < half the time	0.00	0.00	0.00	0.00	25.00
% ≥ half the time	0.00	0.00	0.00	0.00	20.00
Snorting / Clicking					
% none	50.00	96.88	100.00	100.00	100.00
% 1–3 times	0.00	0.00	0.00	0.00	50.00
% > 3 times but < half the time	0.00	0.00	0.00	0.00	6.25
% ≥ half the time	0.00	0.00	0.00	0.00	20.00
Moaning					
% none	50.00	77.50	90.28	100.00	100.00
% 1–3 times	0.00	0.00	0.00	15.56	50.00
% > 3 times but < half the time	0.00	0.00	0.00	0.00	0.00
% ≥ half the time	0.00	0.00	0.00	0.00	40.00

Table 2
Behaviour during the physical examination. Percentages of animals per score per animal holding (n = 20) are given, with minimum (Min), lower quartile (25 %), median (Med), upper quartile (75 %), and maximum (Max).

Behaviour during examination	Min	25 %	Med	75 %	Max
Kicking at examiner					
% none	0.00	94.44	100.00	100.00	100.00
% 1–3 times	0.00	0.00	0.00	0.00	100.00
% > 3 times	0.00	0.00	0.00	0.00	50.00
Kicking / Stomping					
% none	0.00	100.00	100.00	100.00	100.00
% 1–3 times	0.00	0.00	0.00	0.00	100.00
% > 3 times	0.00	0.00	0.00	0.00	0.00
Spitting					
% none	0.00	80.00	100.00	100.00	100.00
% 1–3 times	0.00	0.00	0.00	16.25	100.00
% > 3 times	0.00	0.00	0.00	0.00	20.00
Lying down on the ground					
% none	40.00	64.58	100.00	100.00	100.00
% 1–3 times	0.00	0.00	0.00	0.00	50.00
% > 3 times but < half the time	0.00	0.00	0.00	0.00	20.00
% ≥ half the time	0.00	0.00	0.00	18.33	50.00
Rising					
% none	50.00	88.56	100.00	100.00	100.00
% 1–3 times	0.00	0.00	0.00	4.17	50.00
% > 3 times	0.00	0.00	0.00	0.00	25.00
Freezing					
% none	0.00	57.78	75.00	100.00	100.00
% 1–3 times	0.00	0.00	11.11	27.21	100.00
% > 3 times but < half the time	0.00	0.00	0.00	0.00	50.00
% ≥ half the time	0.00	0.00	0.00	2.94	40.00

3.2. Caretaker attitudes and amount of contact to the animals

Descriptive statistics of the participants' attitudes and frequency of

Table 3
Overview of caretakers' behavioural beliefs, affective attitudes, and frequency of contact to their animals, with minimum (Min), lower quartile (25 %), median (Med), upper quartile (75 %), and maximum (Max). For behavioural beliefs, the scale ranged from 1: totally disagree to 7: completely agree. For affective attitudes, the scale ranged from 1: very unpleasant to 7: very pleasant. For frequency of contact, the scale ranged from 0: never to 4: several times per day.

Attitudes & contact components	Min	25 %	Med	75 %	Max	n
Behavioural beliefs						
Importance of talking	1.00	5.29	6.50	7.00	7.00	17
Importance of walking through the herd	5.00	6.00	7.00	7.00	7.00	17
Importance of stroking animals	1.00	2.40	4.20	5.00	6.60	17
Affective attitudes						
Pleasantness of training	3.00	3.67	5.50	6.42	7.00	18
Pleasantness of tactile contact	4.00	5.50	7.00	7.00	7.00	17
Frequency of contact						
Stroking in week 1–4	0	0.00	0.00	0.88	2	12
Touching in week 1–4	0	0.00	1.50	2.50	3	11
Touching after 10th month	0	1.00	1.50	2.00	4	11
Talking to the animals	1	2.00	3.00	4.00	4	11
Visual contact	2	3.00	4.00	4.00	4	11

contact at different ages, categorized by the components *Stroking in week 1–4*, *Touching in week 1–4*, *Touching after the 10th month*, *Talking to the animals*, and *Visual contact*, are depicted in Table 3. For details on frequency of contact provided by participants keeping young animals, including frequencies of visual contact, talking to the animals, touching males / females, and stroking males / females across different ages, see supplementary material Table S1. Regarding further variables of amount of contact, the 20 participants reported to work 0.5–8 hours / day in the living zone of the animals (*h / day work*: mean ± std.dev., 25 %, med., 75 %: 2.85 ± 1.92, 1.50, 2.75, 4.00 h). They stated to go to the animals to care for or check on them at least 1–6 times per day (*frequency of controls / day*: mean ± std.dev., 25 %, med., 75 %: 2.10 ± 1.33, 1.00, 2.00, 2.00 times / day).

There were several moderate to high correlations between attitudes and the frequency of contact, especially with regard to *Stroking in week 1–4* and *Touching after 10th month* (Table 4). The more caretakers agreed on the *Importance of stroking* the animals, the more frequently they stroked animals in the first 4 weeks of life (r_s = 0.60, $p < 0.05$) and touched them later in life, after the 10th month (r_s = 0.80, $p < 0.01$). The more pleasant caretakers rated training of the animals, the more frequently they touched them in later life (r_s = 0.65, $p < 0.05$). Similarly, the more they agreed on the *Importance of talking to the animals*, the more frequently they indicated to stroke and touch the animals during the first 4 weeks of life (*Freq. stroking week 1–4*: r_s = 0.61, *Freq.touchingweek 1–4*: r_s = 0.63, both $p < 0.05$), to talk to the animals (r_s = 0.66, $p < 0.05$), and to go to the animals to care for or check on them (r_s = 0.61, $p < 0.01$). Interestingly, *Importance of walking through the herd* was negatively correlated to *Stroking in week 1–4* (r_s = -0.60, $p < 0.05$) and *Importance of stroking* was negatively correlated to the number of hours per day working in the living zone of the animals (r_s = -0.49, $p < 0.05$, Table 4).

3.3. Associations between attitudes and animal behaviour

Participants who found tactile contact more pleasant, had a lower percentage of animals that attempted to flee during leading (*Leading score 3*, r_s = -0.51, $p < 0.05$, Table 5). There were also significant associations between caretaker attitudes and animal behaviour during the physical examination. For instance, caretakers who rated talking to the animals as more important had calmer animals, which was reflected in fewer rising and freezing animals (% no rising: r_s = 0.57, % no freezing: r_s = 0.49, both $p < 0.05$). Moreover, the animals of caretakers who had higher values in *Pleasantness of training* did not scream and / or squeal as often (% no squealing / screaming: r_s = 0.77, $p < 0.001$ Table 5). Caretakers who rated stroking of the animals as more important had a higher percentage of animals that did not moan during the clinical examination (% no moaning: r_s = 0.74, $p < 0.001$). In line with this, caretakers who found tactile contact more pleasant had lower percentages of animals moaning half the time or longer during the examination (% moaning ≥ half the time: r_s = -0.50, $p < 0.05$), in addition to lower percentages of animals lying down on the ground for half of the time or longer (% lying down on the ground ≥ half the time: r_s = -0.50, $p < 0.05$). These patterns aligned with non-significant trends (Table 5).

3.4. Associations between the amount of caretaker contact and animal behaviour

Significant associations were found between the reported amount of caretaker contact and animal behaviour during leading and the physical examination (Table 6). Participants who reported to stroke their animals more frequently in weeks 1–4 had fewer balking animals (higher percentage of *Leading score 1*, r_s = 0.64, $p < 0.05$), and in case of more frequent touching in weeks 1–4, they had a higher percentage of animals that did not rise during the clinical examination (% no rising: r_s = 0.64, $p < 0.05$). Lower frequencies of *Touching after the 10th month* were correlated to more difficulty in handling (*Leading score 3*), reflected in more attempts to bring them into the correct position and attempts to flee (r_s = -0.80, $p < 0.05$). Interestingly, more working time spent in the living zone of to the animals correlated to lower percentages of animals that showed no spitting and moaning (% no spitting: r_s = -0.56, % no moaning: r_s = -0.49, both $p < 0.05$). These

Table 4
Associations (Spearman rank correlations r_s) between caretaker attitudes and reported amount of different types of contact. High attitude scores reflect high agreement, i.e., a positive attitude.

		Amount of contact						
Attitude components		Freq. stroking week 1–4[1]	Freq. touching week 1–4[1]	Freq. touching > 10th month[1]	Freq. talking[1]	Freq. visual contact[1]	Freq. controls / day	h / day work
Importance of talking	r_s	**0.61***	**0.63***	0.44	**0.66***	−0.15	**0.61****	−0.07
	n	12	11	11	11	11	17	17
Importance of walking through the herd	r_s	**−0.60***	0.03	−0.33	−0.31	0.41	−0.19	< 0.01
	n	12	11	11	11	11	17	17
Importance of stroking	r_s	**0.60***	−0.20	**0.80****	0.11	−0.03	0.17	**−0.49***
	n	12	11	11	11	11	17	17
Pleasantness of training	r_s	0.54[t]	0.22	**0.65***	−0.05	−0.36	0.22	−0.03
	n	11	10	10	10	10	18	18
Pleasantness of tactile contact	r_s	0.51	−0.20	0.46	−0.16	0.48	−0.06	−0.36
	n	9	9	9	9	9	17	17

[t] $p \geq 0.05 < 0.1$, * $p < 0.05$, ** $p < 0.01$; Significant correlations are depicted in bold.
[1] in caretakers keeping young animals.

Table 5
Associations (Spearman rank correlation coefficients r_s) between caretaker attitudes and animal behaviour during leading and the physical examination. Percentages of animals per score per animal holding were calculated. For the behaviours during the physical examination, only results for the lowest and the highest score categories are depicted. High attitude scores reflect high agreement, i.e., a positive attitude.

Animal behaviour	Importance talking[1]	Importance walking through[1]	Importance stroking[1]	Pleasantness training[2]	Pleasantness tactile contact[1]
Leading % score 1	0.43 ^{t}	−0.09	0.07	0.13	0.31
Leading % score 2	−0.31	0.06	−0.03	0.19	−0.10
Leading % score 3	−0.25	0.19	−0.29	−0.45^t	**−0.51***
% no squealing / screaming	0.33	0.16	0.32	**0.77*****	0.13
% squealing / screaming ≥ half the time	−0.12	−0.24	0.09	**−0.49***	< 0.01
% no snorting / clicking	0.34	0.06	0.28	0.04	0.02
% no moaning	0.33	−0.12	**0.74****	0.27	0.34
% moaning ≥ half the time	−0.32	0.12	−0.48^t	−0.43^t	**−0.50***
% no kicking at examiner	−0.20	0.22	−0.27	−0.38	−0.18
% no spitting	0.05	−0.19	0.19	0.19	0.40
% no lying down on the ground	0.41	0.08	0.16	−0.01	0.34
% lying down on the ground ≥ half the time	−0.41	−0.19	−0.16	−0.26	**−0.50***
% no rising	**0.57***	0.09	0.11	−0.18	−0.09
% no freezing	**0.49***	−0.09	0.20	−0.06	0.27
% freezing ≥ half the time	**−0.53***	−0.24	−0.06	0.02	−0.13

^{t} p ≥ 0.05 < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001; Significant correlations are depicted in bold.. [1] n = 17, [2] n = 18;

overall patterns aligned with several non-significant trends (Table 6).

4. Discussion

To our knowledge, this is the first study to analyse behavioural reactions of new world camelids (NWC) to leading and to veterinary examination. Moreover, we showed a sequential relationship of caretaker attitudes, their behaviour (including the amount of contact with the animals) and NWC behaviour during handling. Although 116 animals across 20 animal holdings were examined, results need to be regarded with caution due to the relatively low number of farm respondents in the questionnaire (n = 20). The associations were, however, in line with results of previous studies in other species (for review, see Hemsworth and Coleman, 2011) supporting their validity. On most of the animal holdings, all animals were very easy to lead by a familiar person, and people used at most light taps. As many of the holdings used their animals for trekking or other animal assisted activities, animals were probably trained well to be led. However, on 25 % of the animal holdings, one or more of the tested animals were difficult to lead to the examination location, i.e., several attempts were needed to bring these animal into the correct position and /or the animals attempted to flee. In contrast, during the physical examinations, the proportion of animals showing behaviour being potentially dangerous to handlers and / or indicative of fear and stress was higher. Freezing was the most prevalent of these behaviours, followed by rising and abruptly lying down with subsequent lying on the ground. Kicking was rarely observed. Freezing is a sign of fear in many species (for review, see Forkman et al., 2007; Fureix and Meagher, 2015), while abruptly lying down and subsequent lying on the ground is a natural defence behaviour in NWC (Pollard and Littlejohn, 1995), and rising indicates escape attempts. These fear responses do not only reflect stress, but can have a negative impact on humans, as well as on animal

Table 6
Associations (Spearman rank correlation r_s) coefficients between amount of contact and animal behaviour during leading and the physical examination. Percentages of animals per score per animal holding were calculated. For the behaviours during the physical examination, only results for the lowest and the highest score categories are depicted.

	Amount of contact						
Animal behaviour	Freq. Stroking week 1–4[1]	Freq. Touching week 1–4[2]	Freq. Touching after 10th month[2]	Freq. Talking[2]	Freq. Visual contact[2]	Freq. controls / day [3]	h / day work[3]
Behaviour during leading							
Leading % score 1	**0.64***	0.31	0.48	0.34	−0.24	0.27	0.03
Leading % score 2	−0.48	0.05	−0.20	0.20	0.20	−0.06	0.31
Leading % score 3	−0.48	−0.20	**−0.80****	−0.33	0.07	−0.20	−0.12
Behaviour during physical examination							
% no squealing /screaming	0.29	−0.02	0.23	−0.20	−0.20	−0.09	−0.25
% squealing / screaming ≥ half the time	−0.12	−0.10	0.55^t	0.20	0.15	0.02	0.22
% no snorting / clicking	0.14	0.58 ^{t}	−0.03	0.43	0.57^t	0.30	−0.26
% no moaning	0.34	−0.38	0.34	−0.20	0.44	−0.05	**−0.49***
% moaning ≥ half the time	−0.48	0.33	−0.05	0.27	0.09	−0.11	0.42 ^{t}
% no kicking at examiner	−0.26	0.15	0.05	< 0.01	0.58^t	−0.19	0.25
% no spitting	0.27	−0.34	0.07	−0.28	0.46	0.09	**−0.56***
% no lying down on the ground	0.50 ^{t}	0.15	−0.14	−0.06	0.30	0.40 ^{t}	−0.29
% lying down on the ground ≥ half the time	−0.46	−0.10	0.11	0.09	−0.42	−0.26	0.43 ^{t}
% no rising	0.28	**0.64***	−0.07	0.52^t	0.46	0.32	−0.14
% no freezing	0.53^t	0.02	0.06	0.06	−0.34	0.14	−0.23
% freezing ≥ half the time	−0.39	−0.60^t	0.10	−0.56^t	−0.17	−0.15	0.38

^{t} p ≥ 0.05 < 0.1, * p < 0.05, ** p < 0.01; Significant correlations are depicted in bold.
[1] n = 12, [2] n = 11, [3] n = 20.

safety and ease of handling (Boivin et al., 1994; Lindahl et al., 2016).

The moderate to high significant associations between caretaker attitudes and the reported amount of contact, and the subsequent moderate to high significant associations with alpaca and llama behaviour, are in line with earlier studies proofing sequential relationships between caretaker attitudes, their behaviour, and animal behaviour in cattle or pig farming (e.g., Breuer et al., 2000; Coleman et al., 1998; Hemsworth et al., 1989; Lensink et al., 2000; Waiblinger et al., 2002). These patterns aligned with several trends that were found. Accordingly, in our study, caretakers that rated close contact to the animals as more important (*Importance of stroking animals*), stroked young animals, and touched older animals significantly more often. Thus, this behavioural belief affected behaviour towards animals across different age classes. Regarding affective attitudes, caretakers who rated close and likely work-intensive contact as more pleasant (*Pleasantness of training*) reported to touch their animals when aged over 10 months significantly more often, and tended to stroke them more often in the first month of life.

Attitudes and behaviours of caretakers also were associated with a higher percentage of easy-to-handle alpacas and llamas, showing no fear responses during the veterinary examination. Concretely, more tactile contact in young age (stroking and touching in the first month), seems to have positive effects on the ease of handling, i.e., a higher percentage of non-balking animals during leading and a higher percentage of non-rising animals during the physical examination, respectively. These significant patterns also aligned with trends that were found. For instance, the percentage of non-freezing animals and of animals that did not lie down were, numerically, but not significantly, higher in case of more frequent stroking in the first month of life. This is in line with studies in cattle, showing a link between gentle contact in early life and later avoidance distances (reflecting fear of humans) and ease of handling (Boissy and Bouissou, 1988; Boivin et al., 1994; Probst et al., 2012). Based on our study, including 12 animal holdings that rear young animals, gentle handling in early age does seem to improve the docility, which is in contrast to some handling recommendations that associate early gentle handling with human-directed aggression. Hence, other factors, such as longer-lasting isolation from conspecifics in combination with intensive contact to humans (e.g., during hand-rearing) might promote human-directed aggression in new world camelids and other species (e.g., bulls: Price and Wallach, 1990; rams, billy goats, boars: Sambraus and Sambraus, 1975; deer: Steinbacher, 1939). McGee Bennett (2014) suggests that human-directed aggression in new world camelids is caused by 'a variety of factors coalescing'. It must be pointed out that none of the animals in our study was considered a 'berserker'. This warrants further investigations and comparisons of animals with and without such behavioural problems.

In the present study not only early gentle contact, but also tactile contact in later life seems to play an important role, since there was a high and significant negative correlation between the frequency of *Touching after 10 months* and the percentage of animals that where most difficult to handle during leading (*Leading score 3*). This is in line with the concept of the human-animal relationship, which is a dynamic process, built up on earlier human-animal interactions but modified by new experiences and interactions (Waiblinger et al., 2006b).

While one may have expected a better human-animal relationship in case of more hours presence of the humans close to the animals, the number of hours per day working in the living zone of the animals showed a significant negative correlation with the *Importance of strokinganimals*, and with the percentages of animals without moaning or spitting. This pattern was also reflected by the trend of a higher percentage of animals abruptly lying down and lying on the ground more than half of the time during the veterinary examination in case of longer working hours in the animals' living zone. Other factors such as the type of barn system or herd size might have a stronger impact on the working time than attitudes towards the animals. In addition, time pressure due to increased working load, might reduce favourable attitudes and gentle behaviours towards the animals as shown in caretakers of dairy cows and calves (Lensink et al., 2000; Waiblinger and Menke, 1999; for review see also Waiblinger, 2019). Regarding associations with animal behaviour, our results underline that the quality of human-animal interactions rather than (only) quantity play the most important role (Waiblinger, 2019).

In general, the moderate to high associations between caretaker attitudes and alpaca and llama behaviour support earlier findings in other animals, such as dairy cows, veal calves, fattening bulls, and goats, that demonstrated a relationship between more favourable attitudes towards animals (or interacting with animals) and a lower occurrence of behaviours indicative of fear and stress such as lower avoidance distance, less stepping and kicking (Breuer et al., 2000; Mersmann et al., 2016; Windschnurer et al., 2009).

Regarding our investigation of associations with the animals' behaviour, one must bear in mind that only the main caretaker per animal holding completed the questionnaire, thus only his or her attitudes and reported amount of contact could be considered. Although there were on average two caretakers (of the same family) per animal holding, we could still find significant associations. Further factors that could have had an impact on animal behaviour are e.g., genetics, prior experience with the location of handling and with unfamiliar people such as veterinarians, or the presence or absence of conspecifics (Boivin et al., 1994; Boissy et al., 1998; Rault et al., 2011; Rushen et al., 1998). The large majority of the alpacas and llamas in our study had visual and auditory contact to their conspecifics. Since we wanted the caretakers to feel comfortable and act according to their usual practices, we could not control for a potential effect of social isolation. In our setting, there might have been even variation in the degrees of visual and auditory contact due to different distances and spatial structures on the various animal holdings. Future experimental studies should investigate effects of the presence and absence of conspecifics or of different degrees of social isolation on the behaviour of new world camelids during handling. In line with earlier findings, we would expect new world camelids to perceive social isolation, but also the presence of stressed conspecifics as stressful, which could affect behavioural and vocal responses (Boissy and LeNeindre, 1997; Boissy et al., 1998; Siebert et al., 2011).

Regarding the order of data collection, with questionnaires filled in after the handling of the animals, one might argue that this could have biased the caretakers' responses, depending on how animals behaved. We would only expect, if at all, affective attitudes at risk to be biased. However, the situations for which they were asked to rate the degree of pleasantness included in *Pleasantness of tactile contact* and *Pleasantness of training* were not comparable to the situations during the current study, i.e., leading to and handling during a veterinary examination of healthy animals. In fact, it had been a deliberate decision to ask caretakers to complete the questionnaire after the handling in order not to sensitise them and by this potentially alter their behaviour, which in turn could have affected their animals' behaviour.

Another aspect regarding the order of data collection is that it was not possible to exchange and thus balance the order of leading and physical examination during the visits to the holdings since all animals had to be led to the examination location. This might have introduced a confounding carry-over effect (Waiblinger et al., 2006b). Animals that were more "difficult" to lead might have shown stronger reactions during the physical examination. On the other hand, the significant associations between several behavioural parameters, both during leading and during the physical examination, and the reported caretaker behaviours and attitudes, support the idea that the animals' behaviour in both situations (leading and physical examination) reflected the animals' relationship to humans.

As usual for on-farm surveys, the present data only allowed assessment of associations and thus no conclusion about causal relationships could be drawn. Furthermore, results should be interpreted in line with the small sample at farm level. This holds especially for reports on

the frequency of contact to animals at different ages, which only people rearing animals themselves reported on. On the other hand, the fact that the study was performed in a commercial setting should increase the practical relevance of our findings.

5. Conclusion

The overall pattern of associations between the amount of caretaker contact and alpaca and llama behaviour pointed into a direction consistent with the concept of the human-animal relationship. That is, more gentle tactile, auditory, and visual contact related to a higher percentage of calm animals showing no sign of fear and that were easier to handle. The overall results suggest similar sequential relationships between caretaker attitudes, amount of contact with the animals, including the frequency of gentle interactions, and the animals' behaviour, demonstrated for other species. Attitude serves as a major concept to explain and predict behaviours of people (Ajzen and Fishbein, 1980). Since attitudes are learnt and can be altered by new experiences or information (Ajzen, 1988), targeting the attitudes of alpaca and llama caretakers might ultimately help to improve handling practices and consequently animal behaviour and ease of handling. Approaches such as cognitive behavioural intervention programs have been successfully used for caretakers of other species (Coleman et al., 2000; Hemsworth et al., 1994, 2002) and similar training material can be developed to improve the handling of alpacas and llamas.

Declaration of Competing Interest

All authors declare that they have no conflict of interests.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.applanim.2020.104989.

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