Comparison of video and direct observation methods for measuring oral behaviour in veal calves

Maria Vittoria Tosi, Valentina Ferrante, Silvana Mattiello, Elisabetta Canali, Marina Verga

Istituto di Zootecnica. Università di Milano, Italy

Corresponding author: Dr. Valentina Ferrante. Istituto di Zootecnica. Facoltà di Medicina Veterinaria, Università di Milano. Via Celoria 10, 20133 Milano, Italy – Tel. +39 02 58358044 – Fax: +39 02 58358030 – Email: Valentina.Ferrante@unimi.it

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ABSTRACT

Measuring behaviour, especially oral behaviour, has always been a debated issue: therefore the aim of this paper is to closely examine the study of oral behaviour in calves and the approaching methodology. Behavioural observations were conducted by two media (direct observations by check sheets and indirect observations by videotapes recorded by cameras connected to a digital field switcher and a time-lapse video recorder) in order to compare data and assess the reliability and validity of the two methods in identifying some oral behavioural patterns in calves.
The study was carried out on 54 Polish Friesian calves housed in group pens and in individual crates. The behaviour of the calves was investigated during the fattening period on the 2nd, 7th, 13th, 18th and 23rd week, one hour before and one hour after each of the two meals. Two experienced observers checked the behaviour of the calves, including oral behaviours on structures and buckets and oral stereotypies, by direct observations using a scan sampling every 2 minutes. The calves' behaviour was also video recorded on the same days in which the direct observations were carried out and analysed by the same two observers. Percentages of time spent on each type of behaviour were calculated and analysed by Chi-square test. Regardless of the housing system, the comparison between direct and indirect observations revealed significant differences in almost every behavioural category. Licking, biting and nibbling structures, nibbling and sucking the bucket, playing with the bucket and the teat, chewing and oral stereotypies were significantly higher in direct observations compared to indirect ($P < 0.001$), while inactivity was higher in video recorded observations ($P < 0.001$). In conclusion, regardless of the type of housing, our results revealed an objective difficulty in analysing videotapes with very detailed behavioural categories, like oral behaviours. Although video recording can certainly represent a useful and practical alternative to direct observations in many situations, the video recording system used in this study for investigating calves' oral behaviour, in spite of the use of multiple cameras, could not replace direct observations, probably due to the restricted field of view, the low depth of focus, the black and white vision, the lack of audio and the time-lapse feature.

Key Words: Measuring behaviour, Methodology, Veal calves, Oral behaviours, Stereotypies.

RIASSUNTO

CONFRONTO DI METODI DI OSSERVAZIONE DIRETTA ED INDIRETTA PER QUANTIFICARE I COMPORTAMENTI ORALI IN VITELLI A CARNE BIANCA

Il metodo più efficace per la quantificazione del comportamento, soprattutto per quanto riguarda i comportamenti orali, è oggetto di discussione nell'ambito della ricerca. In questo contesto lo scopo del presente lavoro è di esaminare nel dettaglio i comportamenti orali dei vitelli a carne bianca mediante differenti approcci metodologici, al fine di evidenziare pregi e difetti di ciascun metodo. Le osservazioni comportamentali sono state svolte con due differenti approcci: osservazioni dirette da parte di due operatori muniti di una scheda, o tramite l'analisi di videoregistrazioni effettuate con metodo time-lapse.

Per la sperimentazione sono stati utilizzati 54 vitelli da ristallo Frisoni polacchi allevati in box di gruppo ed individuali. Durante il periodo di ingrasso sono state effettuate le osservazioni comportamentali alla 2ª, 7ª, 13ª, 18ª e 23ª settimana, un'ora prima ed un'ora dopo ognuno dei due pasti. Le osservazioni dirette sono state condotte da due osservatori che registravano su una scheda tutti i comportamenti, incluse le attività orali rivolte al secchio o alle strutture e le stereotipie. Le videoregistrazioni sono state effettuate negli stessi giorni delle osservazioni dirette e le cassette sono state decodificate dai medesimi osservatori. Sono state calcolate le percentuali di tempo trascorso nei differenti comportamenti. Il confronto tra le osservazioni dirette ed indirette, effettuato con il metodo del Chi-quadrato, ha mostrato differenze significative per quasi tutte le categorie comportamentali considerate (leccare: 6,25% vs *4,71%; P<0,001; mordere strutture: 0,67%* vs *0,30%; P<0,001;* nibbling *verso le strutture: 0,50%* vs *0,02%; P<0,001;* nibbling *verso il secchio: 1,93%* vs *0,01%; P<0,001; succhiare il secchio: 0,71%* vs *0,03%; P<0,001; giocare con il secchio e la tettarella: 6,90%* vs *0,06%; P<0,001; rispettivamente per le osservazioni dirette ed indirette). Le attività collegate alla masticazione (5,15%* vs *0,86%; P<0,001) e le stereotipie orali (3,19%* vs *0,25%; P<0,001) sono risultate significativamente più alte nelle osservazioni dirette rispetto a quelle indirette, mentre l'inattività è stata più elevata nelle osservazioni videoregistrate (45,20%* vs *54,11; P<0,001). Dai risultati ottenuti si può concludere che, quando si devono osservare nel dettaglio categorie comportamentali collegate ai comportamenti orali, la videoregistrazione presenta delle difficoltà oggettive di interpretazione. Sebbene la videoregistrazione rimanga uno strumento estremamente valido ed utile in molte situazioni, qualora si vogliano analizzare nel dettaglio alcune categorie comportamentali, tale strumento sembra non poter sostituire l'osservazione diretta probabilmente a causa del campo visivo ridotto, della scarsa profondità di campo, della visione in bianco e nero e dell'assenza di audio nel sistema* time-lapse *utilizzato.*

Parole chiave: *Valutazione del comportamento, Metodologia, Vitelli a carne bianca, Comportamenti orali, Stereotipie.*

Introduction

The choice of the medium used to record behavioural observations is very important and is strictly connected to sampling rules and data validity (Altmann, 1974). Observations may be conducted directly in the field by the observer, or may be carried out with the aid of a video recording system. Several studies indicate that the presence of humans during direct observations can affect the behaviour of the animals (Götmark and Ahlund, 1984; Davis and Balfour, 1992). This problem may be overcome by using video recording systems. The major advantage of video recordings is the possibility of observing animals without the presence of humans and with very little changes in the animal's environment (de Wilt, 1985; Martin and Bateson, 1993). Another advantage of video recordings is having available a complete and permanent registration of behavioural patterns which occurred during the period of observation, and which can be subsequently analysed in different ways. By using a time-lapse video recorder, it is even possible to record various days on one tape, although in this case it is not possible to have audio recording (Gavinelli *et al.*, 1994). In spite of these advantages, video analysis can also present some disadvantages, depending on technical media and the type of camera adopted (e.g. manual camera or totally automated video recording systems). Video recording, in fact, does not always guarantee a high image resolution for some details of behavioural patterns. Another potential drawback of video taping is the restricted field of vision and depth of focus. Other disadvantages are due to the fact that the video analysis often requires a longer period of time compared to the real length of the behaviour and sometimes there might be the temptation to analyse the recording repeatedly and in even greater detail (Martin and Bateson, 1993; Gavinelli *et al.*, 1994). On the contrary, direct observations do not require additional time afterwards for video tape analysis; however, one of the main disadvantages may be the long time and labour required which may lead to fatigue of the observers.

From the above-mentioned issues, we can resume that both direct and video recorded observations may present advantages and disadvantages, and the choice of the methodology to adopt must be carefully evaluated depending on the specific aim of the behavioural study and on the type of behaviour that we wish to record. One type of behaviour which has been used as an indicator in order to assess farm animal welfare is oral behaviour, and this has been approached in different ways by various researchers. For example, several studies on oral behaviour have been carried out by direct observations on cattle, especially veal calves (Kopp *et al.*, 1986; de Passillé *et al.*, 1992; Bøe and Havrevoll, 1993; Sato *et al.*, 1994; Veissier *et al.*, 1994; de

Table 1. Time schedule for direct observations in each of the five weeks. On each day, each observer looked at the calves for four hours (one hour before and one hour after each of the two meals).

	day 1	day 2	day 3	overall
observer 1	8 individual stalls	2 group pens (10 calves)	8 individual stalls	26 calves
observer 2	2 group pens (10 calves)	8 individual stalls	2 group pens (10 calves)	26 calves
overall	18 calves	18 calves	18 calves	54 calves

Passillé and Rushen, 1997; de Passillé *et al.*, 1997; Morisse *et al.*, 1999), while various video recording systems, ranging from manual video cameras with audio recording to completely automated and time-lapse recording systems, have instead been used for studying oral behaviour of veal calves by others (Dellmeier *et al.*, 1985; Miller *et al.*, 1986; Hammel *et al.*, 1988; McFarlane *et al.*, 1988; Veissier *et al.*, 1997; Verga *et al.*, 2000).

In light of these considerations, the aim of this paper is to compare the two possible approaching methodologies for studying oral behaviour of veal calves (direct observations with check sheets and indirect observations by videotapes), in order to provide indications about the more suitable method to approach this problem.

Material and methods

Animals and management

This study was carried out in a commercial farm in Northern Italy in 1998. Fifty-four 10-day old male Polish Friesian calves were observed. We provided two housing systems: individual crates (24 calves) *vs* group pens (six pens, 30 calves). All the housing structures used in the study were located in the same building. The individual stalls (0.83 x 1.80 m) were wooden made with slatted floors and lateral partitions provided with fences to allow social contact between neighbouring calves. The group pens were also wooden made with slatted floors and they housed five calves each, with a space allowance of 1.8 m^2/calf. The calves were allocated to three feeding treatments (a traditional all-liquid diet vs the same diet plus 250 g/d of wheat straw or 250 g/d of dried beet pulp in addition to the milk replacer) and two levels of provision of water (water, no water). Regardless of the type of housing system, all the calves were bucket-fed the milk replacer diet twice a day at 07:00 in the morning and at 19:00 in the evening. The group pens had individual feeding gates to separate the animals during the meal.

After their arrival, the calves in the multiple pens were marked on their backs and flanks with a visible dye in order to allow a better individual identification.

Measurements

Calves were observed during the 24 weeks of breeding on the 2nd, 7th, 13th, 18th and 23rd week of the fattening period. In each week, observations were carried out according to the time schedule reported in Table 1, and they lasted four hours per day around the meals (one hour before and one hour after milk feeding in the morning and in the evening), since the oral activities are generally performed in the hours immediately before and after meals (Sambraus, 1985; Wierenga, 1987; de Passillé *et al.*, 1992). Observations were suspended for half an hour during milk distribution. All the calves were observed directly and, at the same time, their behaviour was video recorded on tapes.

During direct observations, the data were collected by two experienced observers who had been previously trained together, in order to guarantee an accurate inter-observer agreement. The observers were on raised platforms placed in the

Table 2. Relative frequencies of oral behaviours observed directly and indirectly in veal calves (total samples 32,400). Absolute frequencies are given in parenthesis.

Behaviours	Direct observations	Indirect observations	P
Inactivity	44.72% (n = 14,491)	51.75% (n = 16,767)	***
Chewing	5.09% (n = 1,650)	0.82% (n = 266)	***
Licking structures	6.18% (n = 2,003)	4.51% (n = 1,460)	***
Biting structures	0.66% (n = 215)	029% (n = 95)	***
Sniffing structures	3.29% (n = 1,065)	6.41% (n = 2,076)	***
Nibbling structures	0.48% (n = 154)	0.02% (n = 6)	***
Licking bucket	2.80% (n = 909)	15.87% (n = 5,142)	***
Biting bucket	1.13% (n = 367)	1.22% (n = 394)	ns
Nibbling bucket	1.91% (n = 619)	0.01% (n = 2)	***
Sniffing bucket	0.56% (n = 182)	1.64% (n = 533)	***
Sucking bucket	0.71% (n = 229)	0.02% (n = 8)	***
Playing with the bucket and the teat	6.83% (n = 2,213)	0.06% (n = 19)	***
Oral stereotypies	3.15% (n = 1,022)	0.24% (n = 79)	***
Licking calves	3.78% (n = 1,226)	2.72% (n = 883)	***
Cross-sucking	2.59% (n = 840)	1.46% (n = 472)	***
Others behaviour	16.09 (n = 5,215)	12.96% (n = 4,198)	[1]

*ns: P > 0.05; *** : P < 0.001; [1] not considered for the analysis.*

middle of the feeding aisle, in order to have a better view and to be partly out of the animals' sight (Davis and Balfour, 1992).

Video recordings were carried out for 24 hours on the same days in which direct observations were performed. In order to compare the two methods, only the same four hours of direct observations were considered for videotape analysis. Videotapes were analysed by the same two observers who had directly observed the animals, after a common training period. Video recording of the individual behaviour of calves on videotapes was made with a system of 11 Panasonic WV-BP310/G black and white CCTV cameras, equipped with zoom optics from 2.8 to 6.0 mm focal length and 1:1.4 maximum aperture ratio. The cameras were connected to two digital field switchers (Panasonic WJ-FS218 video multiplexer), in order to monitor images from different cameras and record them simultaneously on a VHS time-lapse videocassette recorder (Panasonic AG-6040). The recording was made using the 24 hour mode, with a video recording interval of 0.18 seconds. The use of a time-lapse mode did not allow audio recording. In order to observe the animals from different points of view, two cameras were placed for every two individual crates (one frontal camera and one aerial) and three cameras were placed for every two group pens (two frontal and one rear). The windows of the shed were darkened using a thick net in order to avoid problems with the light.

Both for direct and indirect observations, a scan sampling method (every 2 minutes) was used (Martin and Bateson, 1993). Therefore, a total of 32,400 scans was performed, divided as follows: 18,000 on group pen calves (30 scans/h x 4 h/week x 5 weeks x 30 calves) and 14,400 on calves in individual crates (30 scans/h x 4 h/week

Table 3. Relative frequencies of oral behaviours observed directly and indirectly in multiple pens (total samples 18,000). Absolute frequencies are given in parenthesis.

Behaviours	Direct observations	Indirect observations	P
Inactivity	43.44% (n = 7,819)	44.4% (n = 7,992)	***
Chewing	4.93% (n = 888)	0.64% (n = 116)	***
Licking structures	4.73% (n = 852)	3.14% (n = 565)	***
Biting structures	0.32% (n = 58)	0.08% (n = 14)	***
Sniffing structures	3.20% (n = 577)	5.89% (n = 1,060)	***
Nibbling structures	0.03% (n = 6)	0.00% (n = 0)	***
Licking bucket	2.26% (n = 406)	16.94% (n = 3,050)	***
Biting bucket	0.53% (n = 96)	0.14% (n = 25)	***
Nibbling bucket	0.52% (n = 93)	0.00% (n = 0)	***
Sniffing bucket	0.40% (n = 71)	0.77% (n = 138)	***
Sucking bucket	1.03% (n = 186)	0.01% (n = 1)	***
Playing with the bucket and the teat	10.17% (n = 1,830)	0.00% (n = 0)	***
Oral stereotypies	2.83% (n = 509)	0.20% (n = 37)	***
Licking calves	4.30% (n = 774)	3.02% (n = 543)	***
Cross-sucking	4.58% (n = 825)	2.62% (n = 472)	***
Other behaviour	16.72 (n = 3,010)	22.15%(n = 3,987)	[1]

*ns: P > 0.05; *** : P < 0.001; [1] not considered for the analysis.*

x 5 weeks x 24 calves).

The activities were classified as follows, according to the definitions set by de Wilt (1985) and Veissier *et al.* (1998): (i) inactivity: the head and all legs were immobile; (ii) chewing: calf's mouth moved laterally and repeatedly; (iii) eating solid food: the calf took some straw or beet pulp in its mouth; (iv) feed trough activity: the calf's head was in the trough; (v) licking structures/bucket: the calf licked a part; (vi) biting structures/bucket: the calf bit a part; (vii) nibbling structures/bucket: the calf prehended a part; (viii) sniffing structures/bucket: the calf sniffed a part; (ix) sucking bucket: the calf sucked the edge of the bucket or the teat; (x) playing with the bucket or the teat; (xi) oral stereotypies: tongue playing (the calf made circular movements with its tongue outside its mouth) and tongue rolling (the calf made circular movements with its tongue in its mouth); (xii) licking calf: the calf licked a part of another calf; (xiii) cross sucking: the calf sucked a part of another calf. During our analysis, the oral activity towards structures and the ones related to the bucket were kept separated.

A few behaviours not concerning oral activities (such as movement, standing/lying, playing with a calf, scratching oneself, urinating, defecating, vocalisations, turning in the crate) were recorded but not considered in this study and are shown in tables as other behaviour.

Data analysis

Percentages of every behavioural pattern were calculated and statistical analysis were carried out by Chi-square test (SAS, 1989) on pooled data (individual pens + group pens), comparing the frequency of presence of each behavioural pattern observed directly and indirectly. The same analy-

Table 4. Relative frequencies of oral behaviours observed directly and indirectly in individual crates (total samples 14,400). Absolute frequencies are given in parenthesis.

Behaviours	Direct observations	Indirect observations	P
Inactivity	47.00% (n = 6,672)	51.42% (n = 7,404)	***
Chewing	5.36% (n = 762)	1.04% (n = 150)	***
Licking structures	8.10% (n = 1,151)	6.22% (n = 895)	***
Biting structures	1.10% (n = 157)	0.56% (n = 81)	***
Sniffing structures	3.43% (n = 488)	7.06% (n = 1,016)	***
Nibbling structures	0.86% (n = 123)	0.04% (n = 6)	***
Licking bucket	3.54% (n = 503)	14.53% (n = 2,092)	***
Biting bucket	1.91% (n = 271)	2.56% (n = 369)	***
Nibbling bucket	3.70% (n = 526)	0.01% (n = 2)	***
Sniffing bucket	0.78% (n = 111)	2.74% (n = 395)	***
Sucking bucket	0.30% (n = 43)	0.05% (n = 7)	***
Playing with the bucket and the teat	2.70% (n = 383)	0.13% (n = 19)	***
Oral stereotypies	3.61% (n = 513)	0.29% (n = 42)	***
Licking calves	3.18% (n = 452)	2.36% (n = 340)	*
Other behaviour	15.59% (n = 2,245)	10.99% (n = 1,582)	[1]

*ns: P > 0.05; * : P < 0.05; *** : P < 0.001; [1] not considered for the analysis.*

sis was performed within each housing system, in order to verify whether the shape of the box/crate or the angle of vision could affect the results.

Results and discussion

The comparison between direct and video recorded observations showed significant differences for almost each behavioural category (Table 2), both in group pens and in individual crates (Table 3 and 4).

Considering both housing systems together, periods of video recorded inactivity were higher than those from direct observations (Table 2). Chewing represented 5.15% of total direct observations; oral stereotypies also were undoubtedly more visible directly. These results are probably due to the fact that many behavioural patterns were not clearly visible on the screen due to the video resolution and to the depth of focus: in fact the focus could not be changed, because cameras were fixed to the ceiling with a wooden structure. Besides, the presence of blind spots (in spite of the use of multiple cameras) could also lead to record behavioural patterns like tongue rolling, tongue playing and chewing as inactivity. This is probably the reason that these behaviours were present with lower frequencies in indirect observations. In fact, chewing and oral stereotypies were more visible during direct observation sessions, both in individual crates and in group pens (Table 3 and 4): these behaviours, and in particular tongue rolling, are distinguishable by single details clearly visible if near the animal, but not on a black and white screen, and many details may have been lost during video recording also due to the time-lapse fragmentation. Furthermore, it was almost impossible to video record all the calves frontally and fairly near the mouth to see key details of the behaviour.

Concerning activities towards structures, frequencies of licking, biting and nibbling were higher in direct observations compared to indirect ones (Table 2), while sniffing structures had higher frequencies in video recorded observations.

Nibbling is, without a doubt, one of the most difficult oral behaviours to record accurately, and its incidence recorded by indirect observations was almost zero in both housing systems (Table 3 and 4). These behaviours, distinguishable by details visible to the naked eye, are instead easily confused if observed by a time-lapse video recorder and on a black and white screen. Licking, biting and nibbling structures, during videotape analysis, may have been confused, for the reasons described above, with the behaviour of sniffing structures, which were recorded at about a double amount in indirect observations. The confusion may have also been due to the lack of audio, which was helpful for distinguishing those behaviours during direct observations.

As regards activities towards the bucket, licking and sniffing seemed higher in indirect observations (Table 2) and this difference was particularly remarkable for licking, while the differences between direct and indirect observations for biting the bucket were not significant. Suckling and nibbling the bucket and playing with the bucket and the teat were observed with a higher frequency during direct observations. These behaviours, observed on a monitor, are not very well distinguishable and they are easily confused. As for the activities to the structures, also the confusion between nibbling, sucking and playing with the bucket was probably due to the fact that video recordings were without sound (due to the equipment for the 24-hour video recordings): during direct observations, noises produced by the calves playing with buckets and teats helped in distinguishing oral activities. The high percentage of licking the bucket in video recorded observations is probably justifiable by the fact that the behaviours towards the bucket were not clearly visible and may have flowed together in this category, which is more generic than the others.

Oral behaviours towards other calves were higher in direct observations: 3.82% *vs* 2.85% for licking calves (limited to ears and nose in individual crates) and 2.57% *vs* 1.52% for cross sucking (only in group pens). These behaviours were sometimes difficult to discern from videotapes because the calves' coats, which are black and white, on the screen mix with the structures and deceive the observer, who may think they are just sniffing one another or the floor.

Data analysis within each housing system confirmed the results obtained from the first general investigation. In general, the comparison between direct and indirect observations in individual crates and in group pens was not different from that conducted on pooled data, thus suggesting that the type of housing structure did not affect the results of the observations carried out according to the described methodologies.

Conclusions

Regardless of the type of housing, in our field situation, the video recording system used in this study for investigating the oral behaviour of calves could not replace direct observations. In fact, in spite of the use of multiple cameras, our time-lapse video recording system connected to a digital field switcher could not guarantee a perfect image resolution, precluding the possibility of observing some behavioural details. Several factors contributed to reduce the effectiveness of data gathered from video recordings, such as the restricted field of view, the low depth of focus, the black and white vision, the lack of audio and the time-lapse feature. We cannot exclude that, under different circumstances, an adequate video view may be achieved to obtain reliable data on oral behaviour, for example observing more stationary animals with equipment which allows colour, audio and good focus and depth of field. This is the case of McDonnell *et al.* (1999), who studied the behaviour of horse mares in tie-stalls, including some oral behaviours, by placing a camera on a tripod directly in front of the horses and recording their behaviour continuously for 24 hours (real-time recording), using three long-recording videotapes per day. Of course, in this case, observations were facilitated by the fact that the animals were tethered, and therefore they could not turn into their stalls.

Video recording used as an alternative to direct observations is undoubtedly useful and practical. Under certain situations, video record-

ing can guarantee numerous advantages, such as a low level of disturbance for the animals observed and a permanent record of behaviours. Additionally, the use of a time-lapse system makes it possible to carry out longer uninterrupted observation periods with no need of human intervention, except for the start and stop of the videotape at the beginning and at the end of the observation period. These systems can be successfully adopted for studying less detailed behaviours, such as periods of activity/inactivity, postures, types of lying or more generic behavioural categories, as shown by different studies (Dellmeier *et al.*, 1985; Miller *et al.*, 1986; McFarlane *et al.*, 1988; Stull and McDonough, 1994; Gottardo *et al.*, 1997). In any case, our results revealed an objective difficulty in analysing videotapes with very detailed behavioural categories, such as oral behaviours. Therefore, if the aim of the research is to observe details in the development of stereotypies for comparing the types of housing or different levels of food provision, direct observations seem to be more reliable and the presence of an observer in the field is advisable.

As already stated, there are several video recording systems, and the researchers must carefully evaluate the advantages and disadvantages of each system and, depending on the objective of the research, they must choose which system they need or, in case that no system is able to satisfy their needs, they can opt for direct observations. In any case, if the objectives of the research are more than one, one must not fall into the temptation of forcedly adapting one method for all purposes. For example, if we need to monitor the rhythm of activity of veal calves, a time-lapse video recording system without sound and with black and white vision can be adequate. If we additionally need to observe oral behaviour, we will have to change the type of video recording system in order to have a higher quality of tapes or, alternatively, we will have to add some direct observations, possibly concentrated around the periods in which oral activities are performed with higher frequencies (i.e. around the meals).

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