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Measuring sociability in dairy cows

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ABSTRACT

Sociability is the relative preference of individual animals to seek out close contact with conspecifics. The aim of this study was to develop suitable tests that could be used to measure the sociability of individual cows on commercial farms. A standardised runway test was used as a "gold standard" test of social motivation and was repeated three times on 46 focal cows. In the runway test, the average latency to reach 5 m and 2 m from the herd and the time spent in these areas were recorded and analysed for repeatability. Latency to reach the 5 m line over the three tests was the most repeatable variable (0.54) and was taken as a measure of social motivation against which to assess other measures of sociability shown by the cows in their home-pen. The home-pen measures were the distance of each cow to the two nearest neighbours, location of the cow in the cow shed, and the level of synchrony based on individual behaviour of each focal cow compared with the rest of the herd's behaviour. Cows that had high latencies to reach the 5 m line had fewer recordings with two near neighbours ($W_1 = 5.31$, $P = 0.021$), were less synchronised with the herd ($W_1 = 4.82$, $P = 0.028$), were not present at the feedface during peak feeding ($W_1 = 4.13$, $P = 0.042$) and stood at the periphery of the cow shed ($W_1 = 4.03$, $P = 0.045$). These results indicate that these measures could be used to assess the sociability of individual dairy cows in on-farm studies.

1. Introduction

Breeding goals used by livestock breeders have been broadened in most farm animal species to include multiple traits. So an opportunity now exists to investigate if the addition of traits to breeding goals may have any possible consequences on animal behaviour or temperament. Before this can be achieved, behaviour and temperament tests need to be validated. Temperament traits are inter-individual propensities to behave in certain ways and are consistent within individuals across time (Sih et al., 2004; Réale et al., 2007). An important aspect of characterising temperament traits is to investigate the extent to which they show consistency across time and across situations (Bates, 1986). It is important to highlight that within-individual consistency does not mean that trait values cannot change with age or environmental conditions but that differences between individuals are largely maintained (D'Eath, 2004; Réale et al., 2007).

It is known that there is considerable individual variation in sociability of domestic chicks (Jones and Mills, 1999; Jones et al., 1999), cattle (Boissy and Le Neindre, 1997; Fisher et al., 2000) and sheep (Sibbald and Hooper, 2004). Sociability is a term that is used to describe the motivation of individuals to remain close to conspecifics (Sibbald et al., 2006). In previous research, sociability has been assessed at a group level as well as on individual animals. At the group level, sociability measures include behavioural synchrony or social cohesion (Cattle: Benham, 1982; Miller and Woodgush, 1991; Rook and Huckle, 1995) and inter-individual distance of individuals within a group (Sheep: Sibbald et al., 2005; Cattle: Dudziński et al., 1982). On an individual level, the motivation to be close to social companions has been assessed by measuring how hard animals will work to gain access to conspecifics (Calves:

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Holm et al., 2002; Silver fox: Hovland et al., 2008), and in behavioural responses to isolation (Cattle; Hopster and Blokhuis, 1994; Ball, 2003). A frequently used test is the runway test which measures the distance or speed that animals run towards conspecifics (Birds; Mills and Faure, 1991; Sheep: Sibbald et al., 2000; Horses: Lansade et al., 2008). Runway tests involve moving an animal to one end of a corridor and then measuring the time it takes the subject to approach a small group of conspecifics held at the opposite end. For example, Japanese quail chicks ran more in a treadmill apparatus when the goal box contained a small group of conspecifics chicks than when it was empty (Mills and Faure, 1990).

In order to investigate if multi-trait breeding affects sociability, we first need to design tests to measure specific social behaviour traits in individuals. The social behaviour of cattle is characterised by a tendency to form and maintain cohesive social groups. Aspects of social behaviour such as social motivation and synchrony may be used in breeding programmes in order to breed animals that can thrive in group housing and cope well with social challenges (e.g. regrouping). The focus of this study was to develop reliable and valid tests to assess sociability of individual dairy cows that can be practically and easily recorded on commercial farms. In this study, the responses of animals in a runway test were compared to observations of spontaneous behaviours indicative of sociability in the home-pen. A runway test was used as a 'gold standard' as it is a commonly used test that shows consistency across time and is suitable for use in dairy cows (Ball, 2003). The specific aims of the work described here were to: (1) assess intra-test consistency of social motivation measures in a standardised runway test and (2) validate sociability measures by investigating the relationship between social responses of individual cows to a runway test with individual measures of proximity, synchrony and location within the cow shed.

2. Materials and methods

2.1. Animals and management

Ethical approval was obtained for the experiment from SAC animal experimental committee. The study was carried out during the winter period while the cows were housed in a cubicle shed at the SAC Dairy Research Centre (Dumfries, Scotland, UK). The group structure was dynamic with cows entering and leaving the group depending on calving dates, illness and culling. The experimental herd contained 54 lactating Holstein–Friesian cows. Forty-six of these cows (10 primiparous and 36 multiparous) were used as the focal cows in the study. These 46 cows were specifically chosen as they were in good health and were not due to enter their non-lactating period (dry-period) prior to calving before the end of the study. The cows were (mean $\pm$ S.D.) 144.8 $\pm$ 94 days in milk, had an average parity of 3.2 $\pm$ 2.1 and produced 31.5 $\pm$ 6.7 kg of milk per day.

The housing system was a cubicle system in which cows were able to move about freely. The housing consisted of two feedfaces (25.2 m each). Adjacent to each feedface was two rows of cubicles facing one another open at the front ('head-to-head'). Each row contained 14 cubicles. The cubicles (2.13 m $\times$ 1.19 m) were bedded with a saw-dust covered mattress and were provided at a ratio of 1 cubicle per cow. The feed (25.2 m $\times$ 3.2 m) and cubicle (25.5 m $\times$ 2.10 m) passageways were concrete with automatic scrapers. All cows were subjected to the same husbandry procedures and fed a total mixed ration composed of 59% grass silage and 41% concentrate on a dry matter basis. There was enough space for all cows to comfortably feed at the feedface. Cows were fed at 10:00 h and feed was pushed at 04:30 h and 21:00 h daily. The cows fed from a diagonal railed feed barrier (2 m $\times$ 25.2 m) with 108 individual head-bails (0.3 m wide $\times$ 0.9 m high). The cows were routinely milked three times daily at 05:00, 13:00, and 21:00 h in a herringbone milking parlour. Cows were painted using exterior gloss paint in black (B&Q©, Renfrewshire, UK) with their lactation number and an allocated experimental letter (A–V) on their back for the ease of identification.

2.2. Test procedure

Test days were Tuesday, Wednesday and Thursday for 3 consecutive weeks and involved making instantaneous behavioural scan sampling of the whole herd including the 46 focal cows in the mornings (10:00–13:00 h). On the same days, the runway tests were carried out on the focal cows in the afternoons (15:00–18:00 h). The behaviour scans and runway tests were carried out by one observer who was unfamiliar to the cows at the start of the experiment. During behaviour scans, the experimenter observed the cows from the perimeter of the housing area.

2.2.1. Behavioural scans

On test days, after morning milking, the entire herd was prevented having access to the feedface until feed was delivered. The first of the instantaneous behavioural scan samples was taken once feed had been delivered and cows allowed access to the feedface. Pilot studies on non-test cows showed that 20 min scan intervals were necessary to record all behavioural variables on all cows. For each scan, position (feedface, passageway, and cubicle) and posture (standing or lying) for each cow was recorded as well as its two nearest neighbours. A cow was considered occupying the feedface when her head was under the feed barrier. A cow was scored as occupying the cubicle area when at least her two front hooves were in the cubicle bed. A cow was considered occupying the passageways when she was standing or walking in any of the passageways adjacent to the feedface or cubicles. Measures of sociability were calculated from the data as follows.

2.2.1.1. Nearest neighbour (N). The distance in meters from each focal cow to the nearest two neighbours was measured by eye using cubicle width (approx. 1 m) as a guide. Cows were considered neighbours when they were not separated by a visual or physical barrier. To ensure a common reference point when measuring inter-cow distances, the mid point on the spine between the cow's shoulder and tail head was used. The nearest neighbours were defined as the two cows with the shortest distance to the focal cow at the time of the scan; there was no requirement for either individual to spend a particular period of time in the vicinity of the focal cow. There was no limit to how far each nearest neighbour could be from the focal cow. For each individual focal cow a proportion of the total 81 scan points that the cow had two near neighbours less than 1 m away (NN), two far neighbours greater than 1 m away (FN), one near neighbour less than 1 m away and one far neighbour greater than 2 m away (NFN) and two neighbours greater than 2 m away (NN2) was calculated. However, only four cows fell into the category with two neighbours greater than 2 m away (NN2) and therefore, these data are not presented.

2.2.1.2. Location (L). For each scan, the location of each individual focal cow was categorised as 1–3 according to the cow's proximity to the outside edge of the shed. A cow was considered occupying one of three locations when at least her two front legs were within 1 cow length of the outside edge of the shed (L1), within 1–2 cow lengths from the outside edge of the shed (L2), more than 2 cow lengths from the outside edge of the shed (L3). For each individual focal cow the proportion of time spent in each location was calculated from the total of the 81 scan points.

2.2.1.3. Synchrony index (SI). The behavioural scan data gave a representation of the herd behavioural activity which showed us how many cows were performing a standing or lying in which position of the housing area. This allowed us to identify the dominant posture and position of the herd behaviour and calculate the level of synchrony within the herd. The behavioural scan data were grouped into four categories for analysis: feeding at the feedface, standing in the cubicle, lying in the cubicle and standing in the passageway. For every scan point the proportion of cows performing each behavioural category was calculated. From this calculation, the behaviour that the majority of cows within the herd were performing at any given scan point was identified as the primary behaviour. The second step was to identify scans where herd synchrony was present (i.e. when the primary behaviour dominated all other behaviours). Across all scans, the mean proportion of cows performing the primary behaviour was 0.63 ± 0.19 (mean $\pm$ S.D.) (Fig. 1). Herd synchrony was defined as occurring when $\geq$60% of the herd were performing the same primary behaviour. Analysis was carried out on a total of 40 scans where synchrony (by this definition) occurred. A synchrony index was used to determine whether focal animals displayed herd synchrony or not. The synchrony index was calculated as follows: no. of scans performing dominant herd behaviour/no. of scans performing dominant herd behaviour + no. of scans not performing dominant herd behaviour. The synchrony index ranged from 0 to 1 which corresponds to complete asynchrony to complete synchrony, respectively.

2.2.1.4. Feeding index (FI). Presence at the feedface during peak feeding was calculated. Peak feeding was defined as the first hour (first three scans) after delivery of fresh feed. The mean proportion of cows feeding during peak feeding was 0.81 ± 0.12 (mean $\pm$ S.D.). Fig. 1 shows the percentage of cows present feeding, standing and lying during the nine scan points. A feeding index was used to determine whether focal animals were present at peak feeding, and was calculated as the no. of scans the cow was present at peak feeding/no. of scans present at peak feeding + no. of scans absent at peak feeding. The feeding index ranged from 0 to 1, which corresponds to always absent and to always present at peak feeding, respectively.

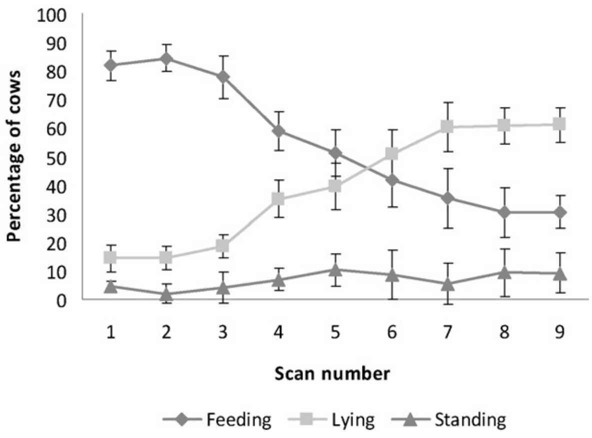

Fig. 1. Mean ($\pm$S.D.) percentage of cows present feeding, lying or standing at each scan point.

2.2.2. Runway test

This test was based on a similar principle as the treadmill test (Mills and Faure, 1990). The 46 focal cows were subjected to a runway test, once per week over a 3-week period. Each week, the 46 focal cows were randomly assigned to one of three groups (n = 15, 15 and 16). Over the 3 test weeks, this equated to a total of nine test groups. One group was tested on each experimental day to coincide with the scan sampling test days (Tuesday, Wednesday and Thursday). The groups were balanced for parity (lactation 1, 2, 3, 4, 5+). This design allowed the group composition to vary from week to week to control for effects of social hierarchy. This was done because a subordinate animal's motivation to return to its herd may be affected by the presence of a dominant animal (Beilharz and Zeeb, 1982). By altering the group composition, the influence of dominant cows was randomised across test groups.

The runway (18 m $\times$ 6.6 m) was a concrete floored passageway situated between the cow's home-pen and the milking parlour. This passageway was part of the collecting area for the parlour and the cows walked through the passageway to and from milking three times daily. To ensure the cows were completely habituated to the test area, the cows were held in this area for a further 15 min before each milking for 5 days prior to the start of testing.

On test days, the test group of cows were penned at one end of the runway (Fig. 2). In turn, each cow was removed from its test group and gently moved up to the start line of the raceway by two familiar experimenters dressed in blue overalls. The cow was held behind a gate in a holding pen, allowed to settle for 30 s, and then released, allowing the cow the freedom to move out of the holding pen and move up and down the passageway. The test duration was 300 s

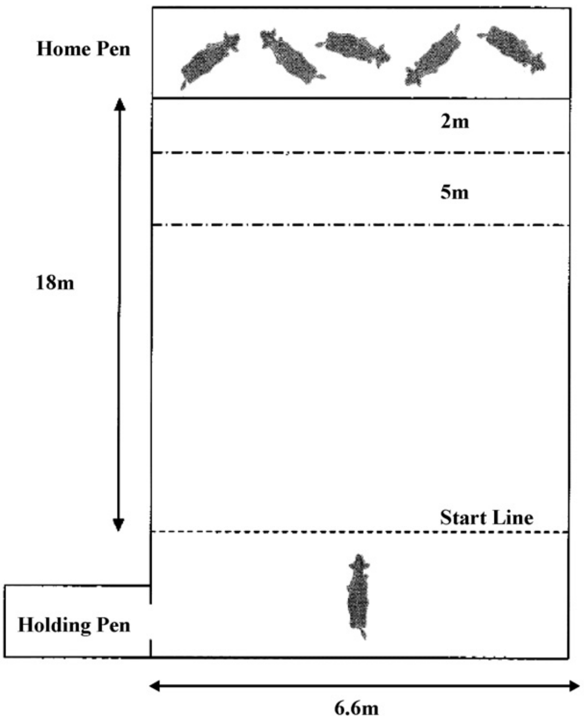

Fig. 2. Experimental set-up used to study social motivation in cows using a standardised runway test.

from when the cow crossed the start line. Following the test, the test animal was then put back into the test group and the next animal selected. Animals were selected in a predetermined random test order. All test sessions were recorded by a digital camcorder (Canon XM2 mini DV camcorder, Canon Ltd., London, UK). The latency to reach the 5 m and 2 m marks from the test group and duration of time spent in the 5 m and 2 m areas of the runway test were taken from video recordings and used as measurements of social motivation. A cow had reached the 5 m and 2 m marks when her front legs had crossed the marks.

2.3. Statistical analysis

All statistical tests were run using GenStat® for Windows™ 7th (2004; Laws Agricultural Trust, Rothamsted Experimental Research Station, Harpenden, Hertfordshire, UK). All data were checked for normality.

2.3.1. Intra-test consistency of runway test measures

Two approaches were used to assess the consistency of the sociability measures from the runway test: (1) repeatability estimates and (2) Kendall's coefficient of concordance. To assess consistency of cows' responses to the runway test, we calculated repeatability estimates (r) for duration and latency across the three-test repetitions. Latencies of 300 s (indicating that the cow did not reach the 5 m or 2 m line within the allocated time (300 s)) were treated as censored data. The censored data was replaced by estimated values using the GenStat® CENSOR procedure before calculating repeatability estimates (r). The CENSOR procedure assigns a value greater than 300 s by estimating the expected value of each censored observation. Latencies to the 5 m and 2 m lines were transformed by natural logarithm transformation, and durations were transformed by angular transformation to meet assumptions of normality. Repeatability is an estimate of the proportion of variation among individuals that is due to individual differences (Boake, 1989). To estimate repeatability, variance components were computed from a Linear Mixed Model (LMM) using Restricted Maximum Likelihood (REML: Paterson and Thompson, 1971). In the LMM, animal ID number and test repeat were fitted as random effects. Repeatability then can be estimated using the within and between animal variance components following Lessells and Boag (1987):

$$\text{repeatability} = \frac{\text{variation between cows}}{\text{variation between cows} + \text{variation within cows}}$$

A cut-off value of ≥ 0.5 was used to distinguish those social measures that gave the most repeatable results, and indicates that 50% of the variance occurs between cows rather than within individuals (Lessells and Boag, 1987), signifying a level of consistent individual responses across test repeats. Repeatability estimates close to 0 would indicate that all the animals respond differently to each test repeat and a repeatability approaching 1 would indicate that repeated measurements of the same individuals gave identical estimates.

Kendall's coefficient of concordance (W) analysis was used on the un-transformed data as a conservative test of consistency as the repeatability estimate (r) is very sensitive to the average value of traits (Falconer and Mackay, 1996). The level of concordance (W) was used to investigate the within-individual consistency across test repeats using rank orders (Siegel and Castellan, 1988). If individuals were consistently ranked the same among tests then the concordance coefficient equals one, whereas if ranks varied randomly from test to test then the concordance coefficient equals zero. No threshold figure for W exists above which a variable maybe considered consistent. Napolitano et al. (2005) suggests an interpretation of W coefficient of less than 0.4, between 0.4 and 0.6 and greater than 0.6 to indicate low, moderate and high agreement, respectively.

In addition, Friedman's test (S) was used on the un-transformed data to determine if there was a significant difference in social motivation between cows in the runway test.

2.3.2. Inter-test consistency of sociability measures in behavioural scans and runway test

The effect of the most repeatable measure from the runway test (latency to 5 m line) on eight behavioural scan variables (i.e. NN, FN, NFN, L1, L2, L3, SI, and FI) were investigated with Generalized Linear Mixed Models (GLMM) using REML. The behavioural scan variables were each fitted as the response variable with the latency to 5 m line as the fixed effect. Runway test repeat and cow were fitted as nested random effects. The behavioural variables were proportion data and a binomial distribution (number of occurrences out of 81 scans) was assumed with a logistic

Table 1
Medians, 1st and 3rd quartiles, repeatability estimates, estimated variance components between cows and within-cows for runway test sociability measures.

Statistic	Test measure			
	Latency		Duration	
	5 m	2 m	5 m	2 m
Median (s)	116.5	205.5	124	73
Q1 (s)	42	72	0	0
Q3 (s)	300	300	266	204
Repeatability estimate[a] across 3 tests	0.54	0.49	0.42	0.39
Estimated variance component:				
Between cows	0.58	0.44	356.2	314.9
Within-cow	0.50	0.46	499.0	484.3
Kendall's coefficient (d.f. = 45)	0.74***	0.71***	0.57**	0.59***
Friedman's test				
Day effect (d.f. = 2)	3.43 NS	1.68 NS	5.52 NS	1.70 NS
Cow effect (d.f. = 45)	100.04***	96.12***	82.62**	80.42**

Significant levels: *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. NS: non-significant. (s): seconds.
[a] Repeatability = variance between cows/variance within-cows + between cows.

link function added. Five-metre latency was transformed using natural log transformation before it was fitted as the fixed effect. Statistical significance of terms in GLMMs was tested using the Wald statistic (W).

2.3.3. *Age effect*

The effect of age on social motivation was also tested. The experimental herd was not entirely balanced for lactation groups (1, 2, 3, 4, 5+) so GLMM using REML was used to determine whether there were any effects of lactation number on the sociability measures. The behavioural scan variables were fitted with a binomial distribution and the runway measures with a poisson distribution in the models and logistic and logarithm link functions were used, respectively.

3. Results

Six of the 46 animals did not cross the 5 m line and 11 of the 46 animals did not cross the 2 m line in all three-test repeats. There was variation in the repeatability estimates for the social motivation variables. The within-cow repeatability for latency to the 5 m line showed a moderate repeatability estimate (0.54) and a highly significant concordance (0.74). The rest of the variables were moderately repeatable (Table 1). There were significant differences between cows for all measures as shown by the Friedman's test (Table 1). Significant correlations for measures recorded during the behavioural scans are shown in Table 2. Cows that had high latencies to the 5 m line had fewer recordings with two near neighbours ($W_1 = 5.31$, $P = 0.021$), were less synchronised with the herd ($W_1 = 4.82$, $P = 0.028$), were less likely to be present at peak feeding ($W_1 = 4.13$, $P = 0.042$) and more likely to stand at the outside edge of the shed ($W_1 = 4.03$, $P = 0.045$) (Table 3). All other relationships were not significant. There were no effects of age on behavioural scan variables.

4. Discussion

4.1. *Intra-test consistency of runway test*

Responses of dairy cows to the runway test were shown to be low to moderately repeatable. The repeatability of the latency to reach the 5 m line in the runway test was the most repeatable of the measures recorded, it exceeded 0.5 across all three tests and was significant by Kendall correlation of concordance. Our findings are similar to previous work carried out by Hopster and Blokhuis (1994) who examined the repeatability of behavioural responses

Table 2
Matrix of spearman rank correlations (r_s) between the behavioural scan variables of sociability. Only significant results shown.

Behavioural scan variable	1	2	3	4	5	6	7
1. 2 neighbours <1 m away (NN)	–						
2. 2 neighbours >1 m away (FN)	−**0.795**						
3. 1 near and 1 far neighbour (NFN)							
4. Feeding index (FI)	**0.770**	−**0.622**					
5. Synchrony index (SI)	**0.742**	−**0.602**		**0.988**			
6. Location 1[a]	−0.419			−**0.507**	−**0.516**		
7. Location 2[b]	*−0.361*	**0.484**		−**0.476**	−0.451		
8. Location 3[c]	−**0.494**	**0.703**		*−0.357*	*−0.350*		

Column numbers in the top row correspond to the numbered variables in the first column. Significant levels: **P < 0.001**, P < 0.01, *P < 0.05*.
[a] Within 1 cow length of the outside edge of the shed.
[b] Within 2 cow lengths from the outside edge of the shed.
[c] More than 2 cow lengths from the outside edge of the shed.

Table 3
The relationship between sociability behavioural variables and latency to 5 m line.

Response variable	Mean (±S.E.)[a]	Effect (SE)	Wald statistic	P-value
2 neighbours <1 m away (NN)	0.70 (±0.01)	−0.001 (0.0008)	5.31	0.02
2 neighbours >1 m away (FN)	0.21 (±0.01)	0.0011 (0.0021)	0.29	0.59
1 near and 1 far neighbour (NFN)	0.09 (±0.01)	0.0021 (0.0031)	0.46	0.03
Synchrony index (SI)	0.73 (±0.02)	−0.0024 (0.0010)	4.82	0.53
Feeding index (FI)	0.36 (±0.01)	−0.001 (0.0005)	4.13	0.04
Location 1[b]	0.13 (±0.01)	0.0022 (0.0010)	4.03	0.04
Location 2[c]	0.18 (±0.01)	−0.0003 (0.0023)	0.02	0.88
Location 3[d]	0.01 (±0.01)	0.0013 (0.0020)	0.23	0.63

[a] Means (±S.E.) shown as proportion of total scans.
[b] Within 1 cow length of the outside edge of the shed.
[c] Within 2 cow lengths from the outside edge of the shed.
[d] More than 2 cow lengths from the outside edge of the shed.

of dairy cattle to social isolation and found repeatability values of between 0.58 and 0.69 for several behavioural measures. However, Fisher et al. (2000) repeated a test of sociability three times on the same cows at monthly intervals, and found a repeatability estimate of 0.34 for the time taken to join conspecifics.

There is often difficulty in interpreting repeatability estimates. Repeatability is computed as a ratio of within-cow to between-cow variation. Understanding whether individuals show consistent behaviours in repeated trials however, is difficult to ascertain from the repeatability ratio. This is because low repeatability values can indicate either a consistent response (low variation between and within-cows) or a random response (high variation between and within-cows; Hayes and Jenkins, 1997; Widemo and Sæther, 1999). To provide further support, we present both repeatability estimates and Kendall's coefficient of concordance. The highly significant concordance for latency to the 5 m and 2 m line suggest high rank-order consistency over the three repeats. To date one of the largest difficulties in assessing consistency of behaviour is the lack of clear criteria to decide when consistency is adequate. Finding statistically significant concordance and moderate repeatability estimates for the 5 m line instilled confidence that the animal's response was consistent and therefore, their behaviour was indicative of an underlying sociability trait.

4.2. Inter-test consistency of latency to 5 m line and sociability scan variables

Individual differences in social motivation in sheep (Syme, 1981) and in chickens (Faure et al., 1983) have been assessed by response to social isolation and by the speed at which birds run towards conspecifics (Saurez and Gallup, 1983) such measures are complicated by the fearfulness induced by the experimental set-up. Our study investigates the relationship between an individual animal's responses to a social motivation experiment to social behaviour measures in the home-pen. The animal's performance in the runway test appears to predict a range of social behaviours occurring spontaneously in the home-pen. Given the infeasibility of carrying out runway tests on-farm due to time and logistical constraints, social behaviour observations in the home-pen represent a more practical method of recording sociability of individual cows under farm conditions. The presence of neighbours less than 1 m away, the extent of behavioural synchrony, the presence at the feedface during peak feeding and the position of the animal within the housing area can be considered more practical measures to assess cattle sociability under commercial conditions.

Synchrony of behaviour is important in the cohesion of social bonds (Clayton, 1978) and is recognized as central in sustaining good welfare for herd-living animals such as cattle (Miller and Woodgush, 1991). It is logical to expect the measures of sociability from the behavioural scan observations to significantly correlate with each other as some of these measures are highly related. In particular, the high correlation between measures of synchrony and presence during peak feeding indicate that in future studies recording one of these measures would be sufficient. Location of a cow within its home-pen gives additional information regarding its sociability. This study highlights the fact that animals that remain on the periphery of the pen are more likely to have a lower social response in a standardised runway test and therefore indicative of lower sociability.

This study also demonstrated that presence at the feedface during peak feeding is related to social motivation in a runway test. Therefore, presence at the feedface during peak feeding may reflect the sociability of an individual animal. However, animals that choose not to feed at the time of greatest feed availability could also be those animals that are not highly motivated to feed. Alternatively, these animals may choose not to feed at peak feed availability because they are choosing to avoid their herd mates (Miller and Woodgush, 1991). These animals may be adopting a coping strategy that minimises the level of social stress in their daily routine. Further research is required to investigate factors affecting trade-offs made by individuals.

The analysis showed that the number of observations in which an animal was observed with less than 1 m to two neighbours (NN) is a better indicator of an individual's sociability compared to the other nearest neighbour measures taken in this study. However, it is important to consider that within the context of this study the animals had very little possibility to keep larger distances while feeding and or lying in cubicles. Unfortunately, the nature of our data does not allow us to discuss the length of scan intervals, but a recent study recommend recording all neighbours of housed dairy cows at intervals of 2, 8 and

17 min (Neisen et al., 2009). In the present study, the NN measure correlated to all other sociability scan variables recorded and had the highest significant relationship with latency to the 5 m line. At present, we cannot determine with certainty whether this reflects a genuine relationship between nearest neighbour and social motivation. There has been some previous research with sheep indicating that the inter-animal distance is dependent on the amount of space provided (Sibbald et al., 2000). Kondo et al. (1989) found that the distance to the nearest neighbour increased with increased floor space allowance in dairy cattle. Extrapolating the results we observed in group-housed dairy cattle to extensive production systems or to feral cattle would be risky because too much difference exists in terms of space availability as well as social and grazing behaviours.

Modern production systems involve a lot of regrouping so that the group dynamics are constantly changing. Individual animals differ in their ability to cope and adapt to their social environment. Further research could investigate if sociability is heritable. If sociability is found to be heritable, then it may be accessible to genetic selection. This may allow us to select for animals that have the ability to cope and adapt to changes in her social environment (e.g. regrouping) with the minimum amount of stress. In future studies, it would prove useful to investigate the relationship between an individual's sociability and health, production and adaptability to social challenge and change. This could influence the ability of animals to adapt to their environment, therefore enhancing the welfare of dairy cows.

The social structure of dairy cattle can be described as a series of dominance relationships and social bonds characterised by aggressive and positive social interactions. Confined housing conditions (as opposed to grass based conditions) may impose a space constriction for less social individuals to move away from the rest of the herd. Additionally, further questions need to be addressed before making specific recommendations. The first questions is how social motivation changes over a longer time frame, additionally, it would be interesting to examine how the nature and strength of social motivation change with reproductive status.

5. Conclusion

A runway test was used to assess sociability and it produced results that revealed considerable variation in responses between animals, and good consistency within animals. Latency to reach the 5 m line in the runway test was then used to find reliable measures of sociability that are applicable to on-farm conditions. The analysis suggests that reliable and practical behavioural indicators of sociability are a measure of an individual's level of synchrony with the herd, position in the shed and presence at the feedface during peak feeding.

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