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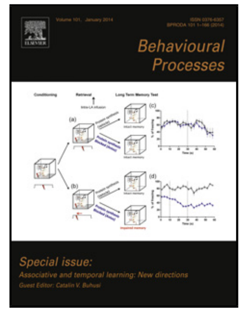

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Temperament, age and weather predict social interaction in the sheep flock

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Highlights:

- Sheep appear to have temperament-related social preference for specific individuals within a flock.
- Age, rainfall and temperature all affected social interactions of the sheep flock.
- Vocalisations and movement scores in the isolation box test are well correlated over time, but the two types of behaviours were poorly correlated with each other, suggesting they reflect different things.
- Multiple Membership Multiple Classification modelling is a useful way to analyse social structures of the flock and make predictions on how animal or environment circumstances affect social behaviour.

Abstract

The aim of the current study was to investigate the social relationships between individual sheep, and factors that influence this, through the novel application of the statistical multiple membership multiple classification (MMMC) model. In study one 49 ewes (ranging between 1 and 8 years old) were fitted with data loggers, which recorded when pairs of sheep were within 4 m or less of each other, within a social group, for a total of 6 days. In study two proximity data were collected from 45 ewes over 17 days, as were measures of ewe temperament, weight and weather. In study 1 age difference significantly influenced daily contact time, with sheep of the same age spending an average of 20 min 43 s together per day, whereas pairs with the greatest difference in age spent 16 min 33 s together. Maximum daily temperature also significantly affected contact time, being longer on hotter days (34 min 40 s hottest day vs. 18 min 17 s coolest day), as did precipitation (29 min 33 s wettest day vs. 10 min 32 s no rain). Vocalisation in isolation, as a measure of temperament, also affected contacts, with sheep with the same frequency of vocalisations spending more time together (27 min 16 s) than those with the greatest difference in vocalisations (19 min 36 s). Sheep behaviour in the isolation box test (IBT) was also correlated over time, but vocalisations and movement were not correlated. Influences of age, temperature and rain on social contact are all well-established and so indicate that MMMC modelling is a useful way to analyse social structures of the flock. While it has been demonstrated that personality factors affect social relationships in non-human animals, the finding that vocalisation in isolation influences pair social contact in sheep is a novel one.

Key words: Isolation box test; Multiple membership multiple classification; Personality; Proximity; Sheep; Sociality

Introduction

Sheep are highly social and have evolved to live in large groups within a home range (Lawrence and Woodgush 1988). A variety of factors affect the sociability of the sheep within the flock including hierarchy, food availability, defence strategy and behavioural ontogeny (Le Pendu et al. 1996). In a production setting the complexity and size of the paddock influences group formation, with sheep clustering together in smaller paddocks, but preferring to spread out when space is available (Dwyer and Lawrence 1999). Group activity, age difference and breed differences also contribute to group dynamics; with sheep dispersing when grazing and staying closer together when resting (Michelena et al. 2009), and sheep of similar ages associate together and spend time apart from those different in age (Lawrence 1990).

Since spatial proximity is highly correlated with social affinity, proximity can be used to understand social relationships in the flock (Le Pendu et al. 1996). Visually observable 'nearest neighbour distance' is one way social dynamics can be identified (Dwyer and Lawrence 1999; Shank 1982; Festa-Bianchet 1991).. This is an effective way to assess flock dynamics because it records both social relationships and motivations without interference (Sibbald et al. 2005); however, it can be time consuming and often limited by visibility of the individual animals. More recently, proximity loggers, a remote sensing technology, have been used to quantify social dynamics within a group of animals. To date, proximity loggers have been used in sheep to identify ewe-lamb interactions (Broster et al. 2010), stocking rates (Broster, Rathbone, et al. 2012) and feed availability (Freire, Swain, and Friend 2012), but they have not been used to identify individual social interactions within a stable adult flock.

The aim of the current research was to intensively study the social relationships between individual sheep, and factors that influence this, through the use of a multiple membership multiple classification (MMMC) model (Browne, Goldstein, and Rasbash 2001). The MMMC model allows the variation of an individual parameter on an individual or group response to be assessed (Tranmer, Steel, and Browne 2014), and thus allows parameters influencing variability between individual pairs in a social group to be analysed, and importantly, predictions on how modifications may affect social behaviour can be made. While this method has been used in some examples of human social network research (Tranmer, Steel, and Browne 2014), this is the first time it has been applied to animals. This aim was fulfilled in two studies; the first investigated the effect of age on social interactions, and the second study investigated the effects of sheep temperament and weather conditions.

The isolation box test (IBT) was used to measure temperament in study two. Published studies commonly use an automated measure of agitation, which pools both movements and vocalisation (Plush et al. 2011). As we were using a manual observation of this, we investigated relationships between these behavioural indicators as well in an effort to maintain consistency with published data.

Materials and Methods

Both studies were conducted in Wagga Wagga, New South Wales, Australia (35°3’S, 147°20’E). Two different flocks of sheep were used for study one and two. For both studies sheep were kept in their respective mobs for one month before the commencement of the data collection period. This was done to ensure a relatively stable flock social structure. Both studies were approved by the Charles Sturt University animal ethics committee.

Proximity Loggers

Proximity loggers (SirTrack Ltd., Havelock North, New Zealand) were used to record social interactions between pairs of sheep within the flock. Each logger was fixed to a leather collar and attached to the ewes (total weight 425 g). The proximity loggers use an ultra-high frequency (UHF) transceiver that transmits a code unique to each logger. They receive and log signals from all other proximity loggers within a predetermined distance. For this study the proximity loggers were set to record all contacts within a maximum range of approximately 4 m between ewes as this distance has been previously validated (Broster, Rathbone, et al. 2012). This distance of 4 m cannot be determined exactly as the radio waves can be reflected, refracted and/or absorbed by a number of naturally occurring objects (Mullen et al. 2004). The distance at which contact is recorded is affected by both antenna height and the orientation of the animals, with the animal's body reducing the distance at which contact is recorded, ie. two animals facing each other will record contact at a distance greater than one animal facing another which is turned away from it and this will be further than two animals facing away from each other.

The output from each proximity logger provides a record of the date and time of the start of every contact with any of the other proximity loggers, each of which has its own individual identification number, and the duration of each contact. Loggers had to be separated, i.e. further than 4 m apart, for longer than 20 s before this was recorded as a new contact. Proximity loggers can capture multiple interactions at the same time, and so it is possible for total daily contact times to exceed 24 h (e.g. if one sheep had 5 h of contact with six different sheep the daily contact time would be 30 h). The ewes were observed for 10 mins each time the collars were attached to confirm they weren't displaying signs of discomfort from the collars.

Study details

In study one 49 pregnant adult Merino ewes (ranging between 1 and 8 years old, approximately 1-2 months pregnant).were kept in a 3.04 ha paddock. The paddock contained several shade trees and a water trough, and pasture was the only feed source available. A total of six days of data were collected, separated into three groups of two consecutive days between November and December, 2012. Due to collar malfunction no data were recorded by two collars in the first two day group and by one collar for each of the second and third groups of two days.

In study two 45 pregnant Merino x Border Leicester ewes (4 years old, approximately 2-4 months pregnant) were kept in a 3.9 ha paddock. The paddock contained several shade trees and a dam providing water, and pasture was the only feed source available. A total of 17 days of data, separated into seven two consecutive day groups and one with three consecutive days, were collected between January and March, 2014. For a total of 6 days one collar did not transmit or record data. During the course of the second experiment, maximum and minimum daily temperature were taken for each day using temperature loggers (Hastings Data Loggers, Port Macquarie, NSW, Australia) and the total daily rainfall for each day over the study period was taken from the Australian Bureau of Meteorology (Bureau of Meterology 2014). Pasture quality and volume was assessed weekly in the second experiment, but no differences were noted throughout the data collection period, and so these data are not included.

Before the start of study two the ewes were weighed, and again 62 days later. The temperaments of the ewes were also tested in an IBT, before the start of the study and again

79 days later. For both IBTs, ewes were individually drafted into the isolation box (105 cm × 75 cm × 42 cm) and their behaviours scored for 1 min. Their vocalisations were scored manually and their movements were recorded with cameras (Paynter Security, Lavington NSW) for later analysis. The following movements were recorded: steps with the front right hoof (‘steps’), 180° turns, single leg contact with the walls of the IBT (‘pawing’) and ‘jumps’ (lifting both front feet from the ground at the same time).

Statistical analyses

For each possible animal pairing in the flock data for the number and length of contacts per day were collected from each animal’s collar and the mean used for analyses. For one deployment in 2012 the memory of three collars were full before removal; these collars were still useful as they continued to transmit their unique identification number and this information formed part of a contact recorded on any other collars that formed part of a paired contact enabling the reciprocal data to be used in analyses (Swain and Bishop-Hurley 2007; Broster, Swain, et al. 2012). When both collars in a pair recorded data for the full day (24 hours) the mean for both collars was determined and this used for the analyses. When only one collar of a pair recorded a full day’s data then only that collar was used for analysis and when neither collar from a pair recorded a full day’s data then that pair of animals was excluded from the analysis for that day. From these data the total daily contact time with all sheep (h), the average duration of contact (min), the total number of daily contacts and the average number of daily contacts were calculated.

A multiple membership multiple classification (MMMC) model was used to identify predictive factors that influence the interactions between individual pairs of sheep (Browne et al., 2001). The MMMC model had the repeated daily measurements of individual pair interactions (measured in seconds) nested within pairings of sheep, which themselves are nested in a multiple membership of two sheep each of which might influence the length of interaction. The data were analysed in the statistical program MLwiN (Rasbash et al. 2009). In order to meet the model's requirements for normality and homogeneity the data were logged, adding an offset of 1 (in study 2) to avoid logging 0 (i.e. log(s+1)). The MMMC model was fitted in a Bayesian framework using flat priors and Monte Carlo Markov chain (MCMC) methods (as in Browne et al., 2001).

In study one the predictor variables analysed were: day, average age of pairs and difference in age of pairs; in study two the predictor variables analysed were daily maximum temperature (°C), daily rainfall (mm), differences for the pair in total movement in an IBT, differences for the pair in vocalizations in an IBT and average pair starting weight. The predictor variables were deemed to be significant by looking at whether the 95% credible intervals contained 0 or not for each predictor when introduced into a model (Browne, Goldstein, and Rasbash 2001). When using Bayesian estimation, credible intervals are the equivalent of confidence intervals in a standard frequentist approach. When using MCMC estimation credible intervals can be estimated from the chains the method produces i.e. a 95% credible interval can be found by sorting the chain of parameter values and picking the values that appear at positions 2.5% and 97.5% in the sorted chain. If the value 0 is outside this credible interval that shows little support for the value 0 and thus that the predictor variable is significant.

Each predictor was first tested in a univariable way by adding it to a base model and then the multivariable model was built up based on the significance of the predictors (here using the posterior mean estimate/posterior standard deviation to evaluate relative significance) in the univariable analysis.

Spearman's rank correlations were performed to investigate the relationship between the behaviours recorded (count data) between and within the two IBT tests in study two. Analyses were performed in R (R Core Team 2015) for the following behaviours: vocalisations, pawing, jumps, steps, turns and total movements. Correlation coefficients were deemed strong if the r value was greater than 0.5 and moderate if between 0.3 and 0.49 (Cohen 2013).

Results

Descriptive results

In study one a total of 686,719 contacts between the 1,176 pair combinations were recorded over the 6 days (6,674 pair/days excluding pair/days with missing data). In study two 954,001 contacts between 990 pair combinations were recorded over the 17 days (16,566 pair/days excluding pair/days with missing data). The duration of daily contact was longer in study one as was the frequency of daily contacts compared to study two (Table 1).

In study one, all sheep recorded some contact with each member of the flock each day, however some of these were very brief (maximum = 6h 15mins; minimum = 2s). Across all days 267 (4.0%) pair interactions were for less than 10 mins, 78 (1.2%) of these were less than 5 mins and three were less than 5s.

In study two, there were eight incidences across all days where no interaction was recorded between a pair on a specific day. Of the remaining interactions (maximum = 10h 12mins), 2,963 (17.2%) were less than 10 mins, and of these 1,191 (6.9%) were less than 5 mins and 20 (0.1%) were less than 5s.

MMMC Results

For study one, two significant predictor variables, day and difference in age of pairs, were included in the final model. For study two, three significant predictor variables, maximum temperature (°C), rainfall (mm) and pair difference in vocalisations, were included in the final model.

In study one sheep spent the greatest amount of time together on day 4 of the study and the least amount of time on day 1 (Table 2; Figure 1). In study one sheep spent the greatest amount of time together on day 4 of the study and the least amount of time on day 1 (Table 2). Looking more closely at the parameter chains from MCMC we see three significantly different periods with sheep spending similar amounts of time together on days 4 to 6, and also similar (but significantly less) amounts of time together on days 2, 3 and 7 while spending significantly less time on day 1 than any other in the study. There was also an inverse relationship between contact and age difference. As the age difference between pairs increased, the duration of time they spent in close proximity to each other decreased.

The influence of these factors on the average contact time between pairs of sheep can be calculated using the information in Table 2, and Figure 1. For example, on day 1 of the study, sheep that were of the same age spent on average 20 min 43 s together ($\exp(7.125 - (0 \times 0.032)) = 1{,}243$ s); whereas sheep that had the greatest difference in age (7 years) spent on average 16 min 33 s together ($\exp(7.125 - (7 \times 0.032)) = 993$ s). .

In study two there were three factors that were predictors of interaction between pairs of sheep: the maximum daily temperature (°C); rainfall (mm); and pair difference in vocalisations in the IBT (Table 2). Pairs of sheep spent increasingly more time in contact with one another as the maximum temperature (°C) increased, rainfall (mm) increased, or the number of vocalisations both sheep made in the IBT became progressively similar. The estimated amount of time pairs spent in contact with each other (on day with average temperature (35 ºC), average rainfall (1mm) and pair with average difference in vocalisations (4)) was 25 min 10 s (exp(6.249 + 0.032 × 35 + 0.032 × 1 – 0.020 × 4) – 1 = 1510 s). The predicted contact time on the hottest day (holding other predictors constant) was 34 min 40 s (exp(6.249 + 0.032 × 45 + 0.032 × 1 – 0.020 × 4) – 1 = 2081 s), and 18 min 17 s on the mildest day (exp(6.249 + 0.032 × 25 + 0.032 × 1 – 0.020 × 4) – 1 = 1097 s). On the wettest day (holding other predictors constant), predicted contact was 29 min 33 s (exp(6.249 + 0.032 × 35 + 0.032 × 6 – 0.020 × 4) – 1 = 1773 s), whereas it was 10 min 32 s on days with no rain (holding other predictors constant; exp(6.249 + 0.032 × 35 + 0.032 × 0 – 0.020 × 4) – 1 = 632 s). Sheep that scored the same number of vocalisations (holding other predictors constant) in the IBT spent 27 min 16 s together per day (exp(6.249 + 0.032 × 35 + 0.032 ×1 – 0.020 × 0) – 1 = 1636 s), and those with the greatest difference in vocalisations spent 19 min 36 s together (exp(6.249 + 0.032 × 35 + 0.032 × 1 – 0.020 × 16.5) – 1 = 1176 s).

IBT: Study 2

A total of 17 significant correlations were identified between the individual behaviours performed in the IBT and across the two days of testing (Table 3). Vocalisations were moderately correlated between the first and second tests ($p < 0.001$, $r_s = 0.49$), but were not associated with any other behaviour. In test one turns, steps, pawing and total movements were all correlated with each other. In test two turns, steps and total movements were correlated with each other.

Discussion

Between the two studies, several sheep-related and environmental factors were identified as predictors for close pair proximity. In study one, age was an influential predictor of close proximity, with sheep that were closer in age spending more time together. Similarlity in age has been associated with strong social attraction in both wild (Le Pendu et al. 1996) and domesticated sheep flocks (Lawrence 1990) previously, where over time and after weaning juvenile ewes spent more time in each other's company, and these loose social groups remained. Lawrence (1990) hypothesised that "there has been a selection for behaviour that increases group size in sheep and the formation of peer groups might allow juvenile ewes to develop social bonds that will help maintain the future cohesiveness of larger social groups." As the findings from our study support previously published findings, it helps to validate the MMMC model as an effective way to analyse these social relationships.

While age was a clear predictor of pair contact, it cannot be established if this was independent of dominance or familiarity. As dominance hierarchy in sheep is influenced by both age and size (Côté and Festa-Bianchet 2001), the influence of hierarchy on age-related social contact is hard to separate. While we did not measure social rank, weight (as an indicator of size) did not influence close proximity of sheep in study 2, and so it is possible that age alone may be a greater driver of social contact in the flock than dominance, or that age may be a bigger driver of dominance than weight. Measuring dominance and then assessing how this affects contact time in the MMMC model would be a useful way to quantify this.

In the second study, pairs of sheep that had similar levels of vocalisations in isolation were more likely to spend time in close proximity. Behaviour in the IBT reflects temperament and in this context vocalisations are reflective of fear in isolation, and a desire to re-establish social contact (Boissy 1995; Boissy et al. 2005). Vocalisations are used by sheep to locate and recognise conspecifics (Dwyer and Lawrence 2008), but in the current study contact was not associated with frequency of vocalisations, as according to the MMMC model the more vocal sheep did not necessarily spend more time with all sheep. Rather sheep with a similar reaction during isolation were more likely to spend time together; reflecting a preference for increased social interactions between sheep with a similar reaction during isolation. A number of studies in non-human species demonstrate that personality factors affect social relationships, with animals with common personality dimensions having stronger social bonds (capuchin monkeys Morton et al. 2015; eastern bluebirds Harris and Siefferman 2014). The influence of temperament on social behaviour within a flock of sheep has been well reported before (e.g. Michelena et al. 2010; Sibbald et al. 2009), with it being shown that the boldness or shyness of individual sheep influences their grazing behaviours. Our set of results builds on this by indicating that sheep have temperament-related social preference for specific individuals within a flock; the temperament of both sheep within a pair, specifically their responsiveness in isolation, appears to be a factor driving social contact.

As identified by Morton et al. (2015), most of what is known about the effects of personality on sociality comes from studies of affiliative behaviour, particularly reproductively-influenced connections and/or human-based. Of the limited data that exists for sheep, previous research has shown that boldness affects grazing behaviour, with bolder animals being more willing to venture from the flock (Michelena et al. 2009). This supports the idea that temperament can influence sociality, but the current study demonstrates this for the first time in individual preference. While this finding is novel, caution is needed for interpretation as only one of the two temperament components was a predictor of social contact. Further investigation of this novel finding using different temperament or personality dimensions would be an important step to quantify the strength and breadth of this relationship.

In the current study vocalisations were not correlated with any of the movement scores in the IBT. This finding suggests vocalisations and movements reflect different behavioural responses to isolation. The IBT is a well-established and robust measure of temperament in sheep (Beausoleil et al. 2012; Plush et al. 2011; Bickell et al. 2011). Our results support this as strong correlations were seen between in the two IBT tests conducted 11 weeks apart (Table 3). While the measures used in the current study are the same as those previously recorded the way they were collected differed. Previously an automated measure of agitation was collected, which pooled both movements and vocalisation. It has been repeatedly demonstrated that the automated measure is less sensitive to vocalisations than movements (Beausoleil et al. 2012; Plush et al. 2011). As vocalisations have not been recorded in these previous studies, it is not possible to know if movements and vocalisations are unrelated, as has been shown in the current study, or if this is a novel finding.

Two weather conditions were significant predictors of contact, with sheep spending more time in contact with each other as the maximum daily temperature increased and as daily rainfall increased. A previous study measured shelter use by placing proximity loggers in the main shaded location of a paddock (Broster and Doyle 2013). Clustering under the resource was highest during the hottest part of the day and coincided with the greatest amount of contact between individuals, supporting the hypothesis. Other studies have also demonstrated that nearest neighbour distance is greater on cooler days (Le Pendu et al. 1996; Michelena et al. 2009). It has also been noted that during heavy persistent rainfall sheep will cease grazing, significantly reduce their activity and seek shelter (Champion et al. 1994), and ewes spend more time with their young when they are resting, rather than grazing (Morgan and Arnold 1974). For both factors it seems that the pair interactions are reflecting shelter use.

Proximity loggers are useful at identifying social interactions at specific distances, and the data presented in this study highlight the detailed information that can be obtained. There are limitations however in what can be measured. For example, it is likely that shade and shelter explains the increased contact on hot and wet days, but this cannot be confirmed without either direct behavioural observations, or other remote technologies, such as GPS to identify if the animals are under shade and activity loggers to record standing, lying or grazing behaviours. Similarly, the valence of the interaction cannot be determined by proximity loggers alone. It is reasonable to assume that sheep will spend more time in close contact with conspecifics they have affiliative relationships with. Indeed goats spend more time in close contact with conspecifics they have a positive relationship with, rather than an agonistic one (Aschwanden et al. 2008), and sheep on pasture graze closer to familiar conspecifics than to unfamiliar sheep (Boissy and Dumont 2002). However, behavioural observations are needed to confirm this.

Sociability of the sheep in this study was based around the duration of time individuals spent within 4 m of each other, measured using the proximity loggers. Most of the other studies reported here visually identify closest proximity (Lawrence 1990; Côté and Festa-Bianchet 2001; Le Pendu et al. 1996), rather than have a set distance by which sociality is determined. The restrictive rules that apply to our data likely miss sheep that are still in a socially important proximity to each other, but outside of the 4 m radius. This means that comprehensive conclusions about sociality cannot be drawn here, but as our results seem to validate the published literature, it suggests that the proximity data collected is at least representative of the complex social behaviours that occur in a sheep flock. The arbitrary distance of 4 m was chosen because it has been validated in previous studies. Further studies could continue to utilise proximity loggers for this however as the distance can be adjusted from 4 m.

Both groups of sheep were pregnant at the time of testing, and at different stages of pregnancy. Ewes change their social behaviour before, during and after parturition (Hinch and Brien 2014), however both flocks of ewes in this study were a minimum of 1 month away from lambing during data collection. There are no data, which we know of, that identify early to mid-pregnancy as being particularly influential on social behaviour, but this may still be affecting our results. Nutrition is a driver of grazing behaviour and thus proximity, so the potential for this to also be influenced by pregnancy is possible.

In conclusion, MMMC modelling is a useful way to analyse social structures of the flock and make predictions on how pair contact would change with modified animal or environment circumstances. This was supported by the identification of well-established influences of age, rainfall and temperature on pair contact. In addition to this, sheep displayed a temperament-based preference for social interactions, which is the first time this has been reported in a domesticated species.

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Figure 1: The influence of age difference on predicted pair contact over the course of Study one. Pair contact was greatest on day 4 and lowest on day 1, and as the age difference between pairs increased, the duration of time they spent in close proximity to each other decreased.

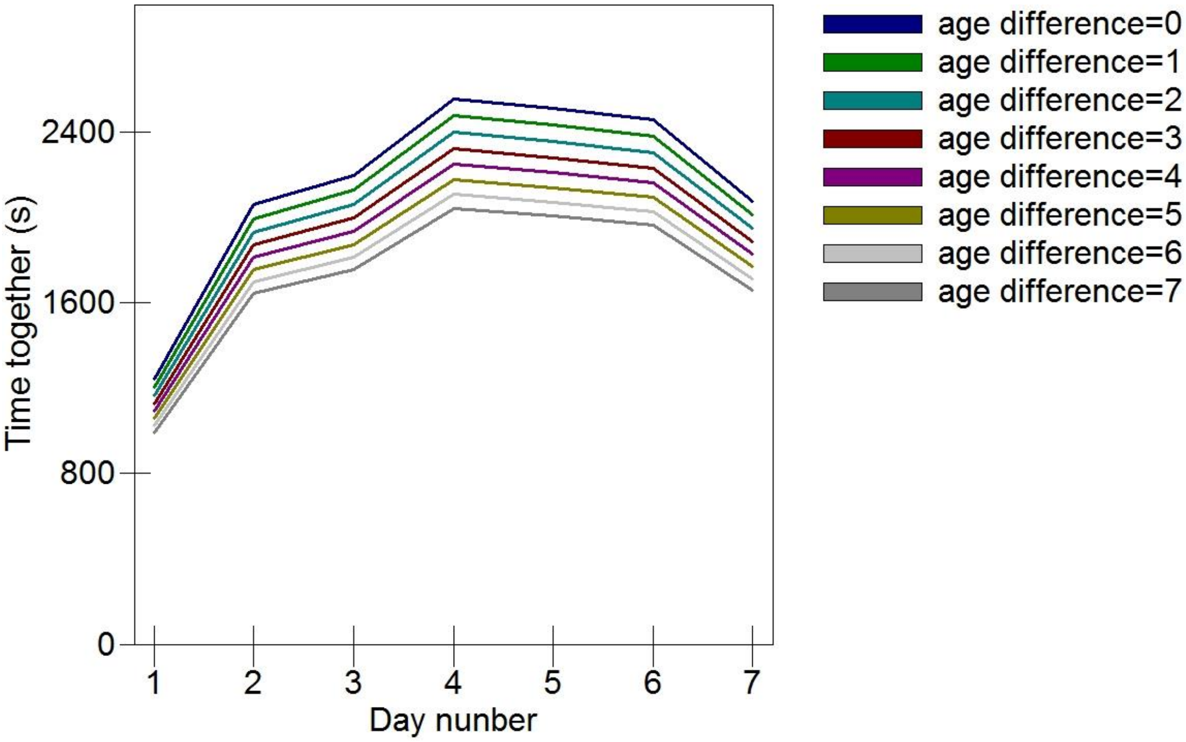

Table 1: Mean (and range) of social interactions for individual sheep in study one and two.

Measure	**Study 1**	**Study 2**
Total daily contact (hh:min)	40:27 (18:11 – 60:08)	28:53 (10:52 – 37:58)
Mean daily contact (min)	46 (21 – 60)	39 (14 – 52)
Total daily contact count	5,221 (2,555 – 7,124)	2,511 (1,080 – 3,286)
Mean daily contact count	109 (53 – 149)	58 (25 – 75)
Mean duration of a single contact (s)	25 (13 - 40)	40 (35 – 50)

Table 2: Main effects MMMC models for study one and study two

Study one		**Study 2**	
Parameter	*Effect*	*Parameter*	*Effect*
Constant	7.125 (0.069)	Constant	6.249 (0.107)
Day 2	0.506 (0.033)	Maximum daily temperature	0.032 (0.002)
Day 3	0.571 (0.034)	Rainfall	0.032 (0.005)
Day 4	0.722 (0.032)	Difference in vocalisation	-0.02 (0.005)
Day 5	0.704 (0.032)		
Day 6	0.682 (0.033)		
Day 7	0.514 (0.033)		
Difference in age	-0.032 (0.008)		

Table 3: Spearman's rank correlation coefficients between the behaviours of the two IBTs.

		IBT one						**IBT two**				
	Averages	*Vocalisations*	*Turns*	*Steps*	*Pawing*	*Jumps*	*Total Movement*	*Vocalisations*	*Turns*	*Steps*	*Pawing*	*Jumps*
IBT one												
Vocalisations	3 (0 - 22)											
Turns	1.5 (0 - 6)	0.17										
Steps	13.1 (1 - 40)	0.23	**0.72****									
Paws	0.2 (0 - 4)	0.06	0.16	**0.38***								
Jumps	0.3 (0 - 4)	0.17	0.27	0.15	0.02							
Total Movement	15.2 (1 - 47)	0.26	**0.79****	**0.98****	**0.39***	0.28						
IBT two												
Vocalisations	5.4 (0 - 15)	**0.49***	0.12	0.23	-0.07	-0.06	0.23					
Turns	2.4 (0 - 10)	0.17	**0.34***	0.25	0.1	-0.09	0.27	0.22				
Steps	16.8 (3 - 41)	0.15	0.09	**0.38***	0.13	-0.18	**0.31***	0.18	**0.37***			
Paws	0.2 (0 - 4)	0.27	0.01	0.15	**0.50****	**0.35***	0.22	-0.01	0.03	0.03		
Jumps	0.2 (0 - 3)	0.1	0.08	-0.01	0.06	**0.52****	0.08	-0.08	-0.02	0.04	0.15	
Total Movement	19.6 (3 - 51)	0.18	0.1	**0.34***	0.14	-0.14	0.29	0.21	**0.52****	**0.97****	0.07	0.1

Bold text indicates statistically significant correlation ($p<0.05$), * indicates a correlation of moderate strength, and ** indicates strong correlation