

CAN SOCIAL INTERACTIONS AFFECT FOOD SEARCHING EFFICIENCY OF CATTLE?

T. Ksiksi¹ and E. A. Laca²

¹ Queensland Department of Primary Industries, Charters Towers, 4820, Australia.

Phone: (07) 4754 6110

Fax: (07) 4787 4998

Email: ksiksit@dpi.qld.gov.au

² Agronomy and Range Science, UC Davis, CA 95616 USA

Abstract

Experienced members of a herd of cattle, referred to as social models in this paper, may play an important part in the searching pattern of naive animals. Naive animals may distribute themselves more evenly because their expectations of preferred areas are not as developed as the expectations of experienced animals. We tested three treatments to investigate if social models tend to transmit information about places of grazing to naive ones or if food distribution tends to be more uniform when animals have less experience with the area. A fenced paddock with 192 trays spaced at about 5 m apart was used to conduct this experiment. Treatment one was the clumped distribution treatment (CDT). Food trays were placed as sets of four. Treatment two was the scattered distribution treatment (SDT). Food trays were placed evenly covering different areas of the paddock. In these two treatments, steers were allowed to find 32 trays with feed in the presence of a social model. Treatment three is a control (CT). Steers were allowed to find 32 trays containing feed with no social model present.

The experiment lasted seven days and starting on day four, CDT had a higher FL/NL (ratio of found locations to new locations) than CT ($P < 0.05$). This suggests that naive animals tend to be more efficient in finding preferred food locations in the presence of an experienced model. CDT had a higher FL/NL than SDT on days three, six and seven of the experiment ($P < 0.05$). This suggests that the initial distribution of food affected the searching efficiency of naive animals. Moreover, within three days steers in all three treatments did better than expected by chance in locating food.

Key words: Grazing, searching, distribution, spatial memory

Introduction

Grazing patterns are affected by the degree of familiarity livestock have with a particular paddock (Bailey *et al.* 1996). When familiarity is low, uniform grazing patterns may be expected. On the other hand, when livestock familiarity is high, uneven grazing patterns may occur. Proper grazing distribution within each grazing unit requires the scattering of grazing animals in an area to obtain even use of forages (Holechek *et al.* 1995). Grazing patterns are a result of decisions made by animals at different spatial and temporal scales (Bailey *et al.* 1996). When preferred plant communities are grazed more than others, the impact can result in declining rangeland productivity at all spatial scales. Hence, unwanted and unpalatable forage species may invade the more heavily grazed areas. The impact of increased defoliation on palatable species can consequently be detrimental to a sustainable use of rangelands (Ksiksi *et al.* 1999).

The behaviour of individual animals can be affected by the presence and behaviour of individuals of the same species (Lynch *et al.* 1992, Nicol 1995) as well as past experience (Provenza and Balph 1988). Many species of large herbivores depend on social interactions to adapt to many of their environmental conditions and to meet their day to day needs. The reluctance of animals to try novel foods, for instance, has been shown to be affected by social facilitation (Thorhallsdottir *et al.* 1990) and postingestive consequences (Provenza *et al.* 1993). In addition to trying novel foods, animals can learn where to forage from social interaction (Scott *et al.* 1995). These results are in general agreement with observations of goats (Biquand and Biquand-Guyot 1992) and sheep (Hunter and Milner 1963).

Furthermore, past experience appears to play a prominent role in the choice of foraging sites by grazing animals (Valentine 1990) in order to achieve even grazing distribution. In a herd of livestock, some members may be more experienced in their familiarity with a grazing site, thus affecting the social learning of others in the same herd. The mixing of experienced animals with naive ones may affect the herd's grazing pattern and therefore social interactions develop.

Unlike other traditional animal behaviour studies, the experimental protocol used here consists of grids of plastic trays. In traditional mazes, animals return to the same decision area before making a choice for a particular arm. All arms have the same chance of being chosen at any given time. In real environments, however, animals search for food in two or three dimensions and do not need to return to any decision areas. The protocol we use was similar to that used by Edwards *et al.* (1997) and Laca (1995). It was more focused on using a more realistic testing area for long-term spatial memory. Steers would enter the paddock where the plastic trays were located and try to find a specific set of trays containing feed.

The aim of this study was to determine (1) if animals recently introduced to a grazing area tend to learn the grazing distribution of resident experienced animals; (2) if the grazing distribution tends to be more uniform as animals have less experience with the area; and (3) if the initial distribution of grazing, affects the role of social transmission.

Materials and methods

Table 1. List of acronyms used in the text.

Acronyms	Description
CDT	Clumped Distribution Treatment
CT	Control Treatment
FL	Found Locations
FL/NL	The ratio FL/NL
LFL	Base-10 Logarithm of FL
LNL	Base-10 Logarithm of NL
LTV	Base-10 Logarithm of TV
NL	New Locations
NL/TV	The ratio NL/TV
SDT	Scattered Distribution Treatment
TV	Total Visits
Z1	Z value to test randomness of working memory
Z2	Z value to test randomness of reference memory

Table 1 contains a list of all acronyms used in this paper. Four different approaches were used to test the effects of social models in finding food. First and in order to evaluate the presence of social model and its effects on searching efficiency and pattern, we compared the performance of steers in a control treatment in relation to steers in a clumped distribution treatment. Second, we compared the performance of steers in clumped distribution treatment to steers in a scattered distribution treatment. This allowed the examination of the influence of distribution of loaded trays on the searching efficiency and pattern. Thirdly, a comparison of the average performance of each steer against the performance expected by random search was determined. Standardised values, on the basis of their means and variances, were used to compare treatments. The standardised ratio of new locations to total visits (Z1) was calculated to test if this ratio was better than expected by chance. The standardised ratio of found locations to new locations (Z2) was calculated to test if this ratio was better than expected by

chance. Fourth, we used covariance analysis to investigate if rate of learning was comparable between treatment groups.

Experimental arena

The experimental arena was established in an Old-World bluestems (*Bothriochloa* spp.) pasture at Texas Tech’s Experimental Ranch, Justiceburg, Texas. A paddock containing 192 plastic food trays was used (Fig. 1). The plastic trays were equally placed at about 5 m apart. Trays with food were referred to as loaded trays. Pelleted feed was placed around the loaded trays as a set of four arranged in adjacent trays (two by two). The experiment was conducted from 20 July to 29 October 1996.

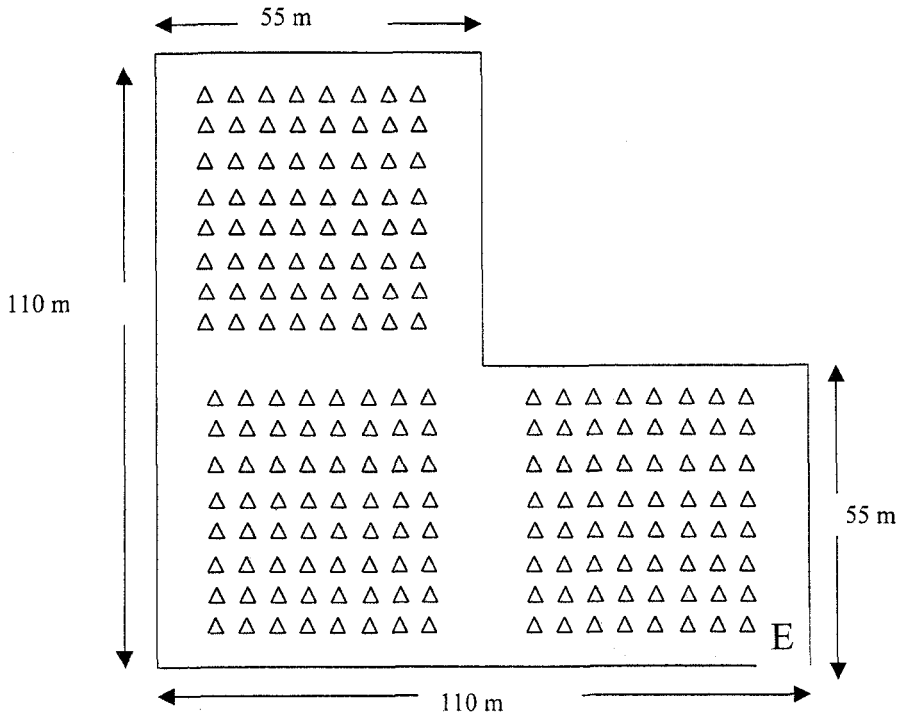


Fig. 1. A diagram of the paddock (E: entrance) with 192 plastic containers (Δ) used for testing searching efficiency of naive steers with or without the presence of a social model over seven testing days.

Animals

Eight steers, aged between 3 and 4 years, were used to conduct the experiment. The average weight was 550 ± 32 kg. These particular steers are familiar with this type of testing as they were experimental subjects for other similar studies. When not tested, the steers were freely grazing an Old-World bluestem dominated pasture. Water was always available and animals were fed 12.5 kg of supplemental feed every other day. The experimental protocol and animal handling were approved by the Texas Tech University Animal Care and Use Committee.

Treatments

Three treatments were tested in this experiment. First, a clumped food distribution treatment (CDT) of 32 out of 192 trays was created (eight sets of four trays). In this treatment an

experienced animal and a naive animal were searching for loaded trays at the same time. An experienced animal is an animal that was familiar with the combination of loaded trays through training. A naive animal is an animal that did not have any prior familiarity with the location of the loaded trays. These trays were placed in sets of four adjacent trays. Second, a scattered distribution treatment (SDT) where an experienced animal and a naive animal were searching for loaded trays at the same time. Thirty-two individual trays were loaded with feed pellets and set-up covering most areas of the paddock. Third, a control treatment (CT) where two naive animals were searching for loaded trays, which were placed the same way as in CDT. Placement of loaded trays for the three treatments was chosen simply to cover most areas of the paddock. In order to assess the impact of experienced animals on the searching pattern of naive animals, CDT and CT were compared. In order to test if the initial distribution of food mattered, CDT and SDT were compared. The combinations of loaded trays for all three treatments were kept the same during the whole experiment.

Training

Before training, 20 trays were chosen for CDT and SDT around which food pellets were placed. Pellets were distributed in a 1m circle around a tray. In other words, trays were used as centres for patches of pellets. This minimised the impact of competition in case more than one steer was feeding around the same tray at the same time. The experienced animals were trained to locate the combination of 20 trays (clumped for CDT and dispersed for SDT). They were trained until they established a very distinct search pattern. On average each of the experienced animals was trained for eight days, three to four sessions daily. By the fifth day the steers adequately learnt the location of loaded trays. Training sessions lasted between 5 and 20 minutes. About 100 g of pelleted food was placed around each loaded tray. For CT the animals did not have any previous experience. They were introduced to the combinations of loaded trays (same combination as that of CDT) for the first time during testing.

Testing

In addition to the 20 trays introduced during training, we included 12 more trays containing feed during testing. The additional 12 loaded trays (a total of 32 loaded trays) were added to give the naive animals the chance to choose trays different from the ones available to the experienced animals during training (i.e. establish their own search patterns). For CDT and CT, we added three sets of clumped trays (two by two loaded trays) and for SDT we added 12 individual loaded trays around the paddock. Pairs of animals (one experienced and one naive for CDT and SDT and two naive ones for CT) were observed until the experienced one (for both CDT and SDT) found 8 loaded trays. The loaded trays found had to be among the training trays. When the experienced animals (within each treatment) found 8 of the training trays, the session was terminated. The session for CT was terminated when a steer found 8 of the loaded trays. The naive animals in each treatment were tested once every day for seven consecutive days. Five testing sessions were conducted daily. Two sessions for CDT (one for each naive animal, using the same experienced steer for both sessions), two sessions for SDT (one for each naive animal, using the same experienced steer for both sessions) and one session for CT. Testings sequence (which treatments/animals were tested first) changed every day.

Measured Variables

All training and testing sessions were observed. A map was used to record data. The map included the locations of loaded trays and trays that did not contain food. The path followed by each steer and trays visited were recorded.

Calculated Variables

Number of locations visited were referred to as NL and is simply the total number of trays visited, excluding revisits. The variable FL refers to the number of found locations where feed

was present. Total visits were referred to as TV and represents the total number of trays visited, including revisits. Two ratios were calculated to test for the presence of working (or short-term) and reference (or long-term) memory as possible searching strategies. The presence of working memory was tested using NL divided by TV (NL/TV) and the presence of reference memory was tested using FL divided by NL (FL/NL). A Z test was performed to examine if locating loaded trays was either at random or based on behavioural mechanisms (for more details please refer to Tillié *et al.* 1996).

Experimental design and analysis

A completely randomised design with a split plot arrangement was used to analyse the data. Treatments were used as main plot and days as sub-plots. When data were not normally distributed and/or their variances were not homogeneous, transformations were done. The variables TV, NL and FL were transformed to their respective base-10 logarithm – thus becoming LTV, LNL and LFL. A least significant difference procedure was used to compare treatment means.

Results and discussion

There was a day by treatment interaction for LTV ($P < 0.05$). CT had a higher LTV than CDT on days one, two, four and six ($P < 0.05$). Animals without the presence of social models develop a more uniform search pattern. SDT had higher LTV on the first four days of the experiment, suggesting that the initial distribution was relevant early during the social interaction period. When preferred food is uniformly distributed, animals tend to have a more uniform grazing pattern.

There was a significant treatment effect, a significant day effect and a significant interaction between day and treatment ($P < 0.05$) for LNL. CT had higher LNL continuously starting on day four ($P < 0.05$). This suggested that social models affected the searching pattern of naive animals. However, LNL was not significantly different between CDT and SDT during the later days of the experiment. This suggested that the initial distribution did not affect the spatial pattern of searching late during the social interaction.

There was a significant treatment by day interaction ($P < 0.05$) for LFL, which was higher for CT than for CDT in the first three days of the experiment. A covariance analysis (LFL by days) showed that the rate of learning was higher when comparing CDT to CT ($P < 0.05$). Steers in CDT started at a low LFL level and then increased over time. However, as days passed, finding food locations did not change for CT and SDT.

The variable FL/NL had a treatment by day interaction $P < 0.05$. Starting on day four, CDT had higher FL/NL than CT (Fig. 2). This suggested that social models affected the searching efficiency of naive animals. When comparing CDT and SDT, we found a significant difference starting on day six suggesting that the initial distribution of food was a decisive factor. A significant covariance analysis (FL/NL by days) was detected ($P < 0.05$). Steers in CDT learned at a faster rate than those a CT. The learning rate for CDT was higher than SDT. Both, presence of social models (because of the significant difference between CDT and CT) and initial distribution (because of the significant difference between CDT and SDT) were important.

There was no significant treatment by day interaction ($P > 0.05$) for Z1. Furthermore, Z1 was not greater than 1.64 (the 0.05 order quantile of a standard normal variable) except for SDT on day one, suggesting random visits to recently located, or working memory. The covariance analysis (Z1 by days) was not significant for all three treatments ($P > 0.05$). Steers in all treatments did not learn to avoid recently visited locations.

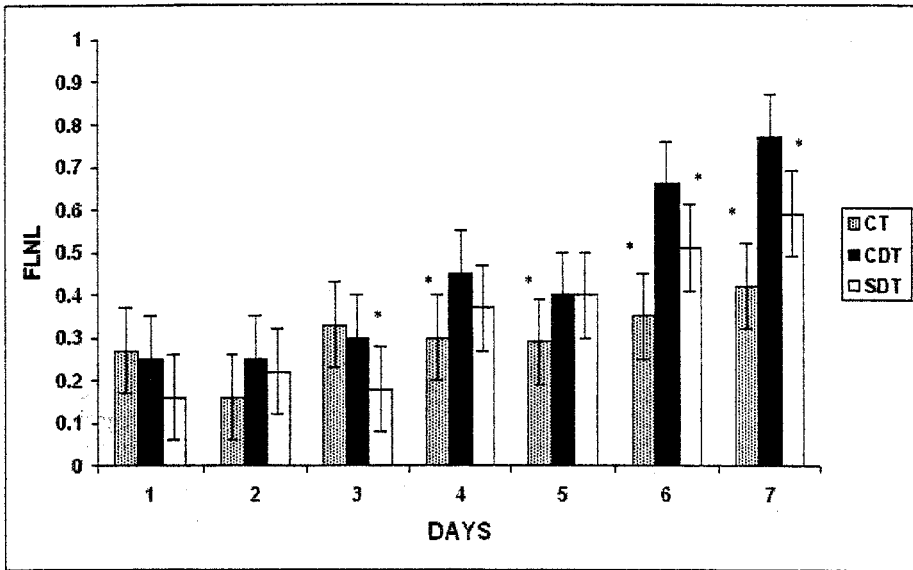


Fig. 2. The ratio of found locations to new locations visited (FL/NL) by naive steers with or without the presence of a social model over seven testing days for control treatment (CT), clumped distribution treatment (CDT) and scattered distribution treatment (SDT). Stars indicate significant difference from CDT ($P < 0.05$). Vertical lines indicate standard error of the mean.

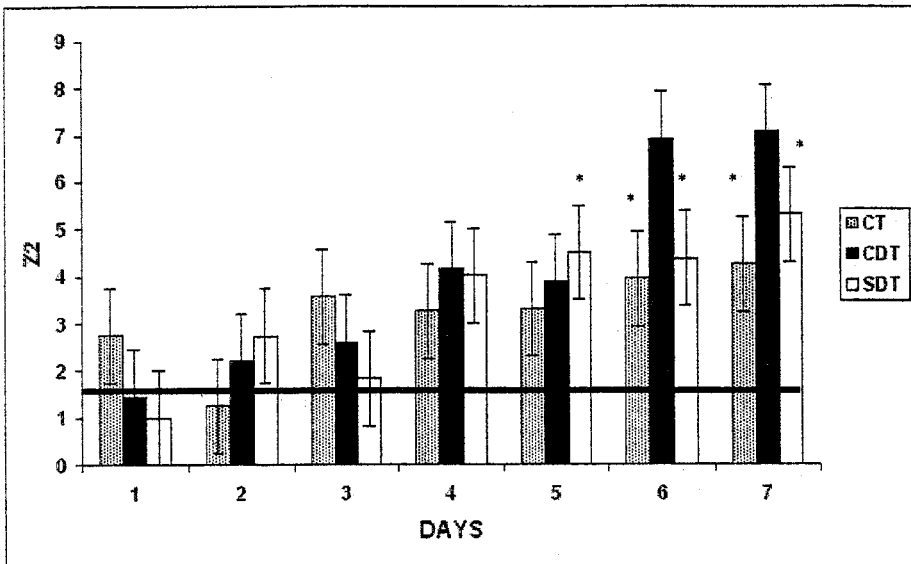


Fig. 3. Z value for the ratio of found locations per new location visited (Z_2) by naive cattle with and without the presence of social models over seven testing days for control treatment (CT), clumped distribution treatment (CDT) and scattered distribution treatment (SDT). Random search can be expected if Z_2 drops below 1.64 (solid horizontal line). Stars indicate significant difference from CDT ($P < 0.05$). Vertical lines indicate standard error of the mean.

There was a significant treatment by day interaction for Z2 ($P < 0.05$). CDT had a higher Z2 than CT starting on day six (Fig. 3). CDT had also a higher Z2 than SDT starting on day 5 of the experiment. All treatments, starting on day 3, had an average Z2 greater than 1.64. Steers were locating loaded trays better than expected by chance. Steers in CDT learned to locate food better than by chance and improved over time ($P < 0.05$).

The presence of social models has been proven to be a major factor in feeding efficiency of animals (Provenza and Balph 1988, Galef *et al.* 1984, Lynch *et al.* 1992, Scott *et al.* 1995). Galef and Whiskin (1994) reported the importance of conspecifics in learning food preferences in rats. Observational learning has been shown to play an important role in feeding behaviour of animals (Chapple *et al.* 1987). Rats, for instance, preferred food that a social model (demonstrator) ate (Galef 1993). The results of this experiment showed that the presence of a social model helped improve the efficiency of locating food. Previous work by Galef *et al.* (1984), Galef 1983, Galef and Wigmore 1983 and Drea and Wallen (1995) did also prove the importance of models in feeding behaviour. In our experiment, naive animals concentrated their search when social models were present. Furthermore, we found that steers in all three treatments did better than expected by chance in most testing days. In other words, steers do not randomly search for food. This supports the findings that sheep (Edwards *et al.* 1994) and cattle (Bailey *et al.* 1996) use some searching mechanisms to efficiently locate preferred food.

Conclusion

We have shown that animals introduced to a grazing area tend to learn the grazing distribution of resident experienced ones. Steers with experience established much shorter and directed search path interacting with a small proportion of the pasture (Laca 1995). We have also shown that the grazing distribution tends to be more uniform as animals have less experience with the area. Most of the available area was searched when animals did not use spatial memory (Laca 1995). Our analysis of the variable FL/NL showed that the initial distribution of grazing affects the role of social transmission.

We believe that this type of research has several practical implications. Mixing experienced and naive animals in a herd may help improve the efficiency of grazing when vegetation is scarce and/or when drought occurs. Consequently, energy expenditure will be minimised. On the other hand, we may need to prevent mixing experienced and inexperienced animals in a given grazing unit, when forage production is abundant. Inexperienced animals widen their searching areas, leading to uniform grazing patterns. In conclusion, this study showed that both food distribution and social models were important factors affecting searching efficiency of grazing animals. In contrary to recommendations by Holechek *et al.* (1995) and in order to limit developing familiarity with an area, our results suggest that animals be supplemented at different times of the day and different places within a field. Supplementation in unpredictable locations may prevent animals from developing high expectations in specific places (Laca 1995). Moreover, changing the time as well as the place of supplementation may promote covering extended grazing ground. Further testing, however, is needed to verify the reported results in real grazing environments.

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