The effect of housing on the diurnal behavioural profile of beef heifers

Mary Clare Hickey[1], Padraig French[1,2] and Aidan P. Moloney[1]

[1]Teagasc, Animal and Grassland Research & Innovation Centre, Grange, Dunsany, Co. Meath, Ireland

[2]Teagasc, Animal and Grassland Research & Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland

e-mail: aidan.moloney@teagasc.ie

The objectives were to determine 1. the behaviour of heifers at pasture or housed on slats, and 2. the effect of housing on behavioural adaptation when moved to pasture. Forty-five continental crossbred heifers were assigned to either housing on slats at 3 m^2 $head^{-1}$ for 5 months (H), grazing for 5 months (G) or housing for 4 months, prior to grazing (HG). Lying and eating behaviour was recorded periodically for H, G and for HG post-turnout. Per day, G animals spent longer ($p<0.01$) eating and had a greater ($p<0.001$) number of daily lying bouts than H animals. While there were minor differences between G and HG animals in the 24 h period after turnout, there was no difference between G and HG animals in time spent eating, lying or in the number of lying bouts on day 1, 2, 3 or 10 post turnout. While abnormal lying behaviour was observed in 3 animals before turnout, there was no abnormal lying behaviour in HG animals by 48 h post turnout. The alteration in behaviour due to housing was not permanent.

Key words: Grazing, eating, lying, heifers, housed

Introduction

Cattle are classed as grass and roughage eaters (Hoffman 1989). Behavioural adaptation by cattle to cope with changing environmental factors during the grazing season is not unusual (Linnane et al. 2001). The relative consistency in grazing and activity profiles between studies would suggest that the behavioural pattern is inherent to, and controlled by the animal (Linnane et al. 2001). Due to climatic and forage constraints animals are confined periodically in Western Europe. O'Connell et al. (1989) reported that the behavioural pattern of grazing dairy cows was altered when housed in cubicle accommodation the following winter. We hypothesised that the alteration in the daily behavioural activity profile during housing, when compared with grazing counterparts is an adaptive process that is non-permanent in nature. Therefore if the welfare of the animal, as reflected in its behaviour, is considered to be impaired due to housing, housing has no permanent consequence to the animal. Modifications in behaviour during housing may therefore be viewed as coping strategies to sustain animal well-being. The objectives of this study were to examine (i) the differences in the daily behavioural profile of heifers at pasture or when housed in a slatted floor shed and (ii) the effect of housing on slats on their behavioural adaptation when subsequently moved to pasture.

Manuscript received May 2013

Materials and methods

Animal management

In mid-April, forty-five Charolais crossbred heifers (335 kg bodyweight [BW] sd 36.2), which had been housed in a slatted floor shed for the previous winter, were assigned to fifteen blocks based on BW. Within each block animals were randomly assigned to one of three treatment groups. Animals were either: housed in a different slatted floor shed in groups of 5 at 3 m^2 $head^{-1}$, based on Fisher et al. (1997) and fed *ad-libitum* grass silage (dry matter = 178 g kg^{-1}, dry matter digestibility = 620 g kg^{-1}, pH = 3.9) and 3.5 kg concentrate (rolled barley = 430 g kg^{-1}, molassed sugar beet pulp = 430 g kg^{-1}, soyabean meal = 80 g kg^{-1}, molasses = 45 g kg^{-1}, mineral/vitamin mix = 15 g kg^{-1}) $head^{-1}$ (H), grazed outdoors in groups of 5 and were offered an initial daily herbage allowance of 9 kg grass dry matter $head^{-1}$ above a 4 cm cutting height (G) or housed in the same shed and managed similarly to H for 4 months after which they were moved to pasture and managed as for G (HG). Four months was chosen to allow the animals to adapt to the new shed and pen-mates. Fresh feed was offered to indoor animals between 9 and 11 am daily while G animals were moved to a new paddock at 11.00 daily. Pre-grazing herbage mass was estimated by cutting three strips (each 5 x 1.2 m to a stubble height of 4 cm) from the area to be grazed by the heifers. Daily herbage allowances were achieved by varying the size of the allocated grazing area. As the season progressed, the daily herbage allowance was increased to supply sufficient grass to match the target average daily gain of the H group. The HG animals were turned out to the same pasture as G animals between 11:00 and 12:00. The space allowance for animals grazing outdoors ranged from 16 to 60 m^2 $head^{-1}$, as the grazing season progressed due to declining herbage growth (details in Noci et al. 2005).

Animal behaviour

Animal behaviour was recorded automatically indoors using Eneo (black and white, day and night) cameras (Lynx Security. Co. Meath, Ireland). One camera was fixed in front of the individual pen so as to give a clear view of the whole pen. The video cameras were connected to a video tape recorder (Panasonic AG6040) via a multi-vision system (Panasonic WJ-FS109 video multiplexer), which allowed pictures from all cameras to be viewed on one screen at a time. The pictures from all the cameras were marked with individual pen number and calibrated with time and date settings. Infrared lighting was used at night (Hickey et al. 2002). Animal behaviour was recorded manually outdoors. Animals within a group were individually identified by distinct paint marks on their backs. An adaptation period of 5 weeks was allowed prior to the commencement of all behavioural measurements in the G and H groups. The diurnal pattern of lying, standing and eating (head down, actively biting grass) for any group was recorded by scan sampling individual animal behaviour every 15-min for 24 h by one observer per 3 hours The daily behavioural profiles of H and G animals were recorded once weekly for three consecutive weeks. The behavioural profiles of HG animals were recorded on day 1 (starting at 00:00), 2, 3 and 10 following turnout. The activities of G animals were also recorded at these times. The lying behaviour of HG animals was observed 2 days prior to turnout and subsequently for 3 days post turnout. Observational periods were from 9:00 to 21:00. The lying posture of each animal (n=15) was recorded as normal or abnormal as defined by Ruis-Heutinck et al. (2000).

Statistical analysis

Data were analysed using the General Linear Model Procedure (Proc GLM) of SAS (SAS/STAT, 1988). Animal group was the experimental unit. The daily behavioural profile consisted of the percentage of time spent by each animal within a group at a particular activity each hour. The duration of time spent at any activity within a 24 hour period was calculated for each animal, averaged within group and expressed as hour/head/day. For objective 1, data were averaged for each group across all observational days. For objective 2, data were averaged for each group and analysed for each day. Data describing duration of activities were analysed using single factor analysis of variance. Daily behavioral profiles were analysed using a model appropriate to a split-plot design with treatment in the main plot and hour in the sub plot. Within significant interactions, means were compared using the LSD test.

Results

G animals spent more time eating within the period 11:00 to 17:00 than H animals resulting in a treatment x time interaction (p<0.001, Fig.1). G animals spent more time lying immediately prior to feeding, and less time lying post-feeding than H animals resulting in a treatment x time interaction (p<0.001, Fig. 2).

Averaged over 24 h, G animals spent longer (p<0.01) eating, had a greater (p<0.001) number of daily lying bouts than H animals but there was no difference between treatments for time spent lying (Table 1).

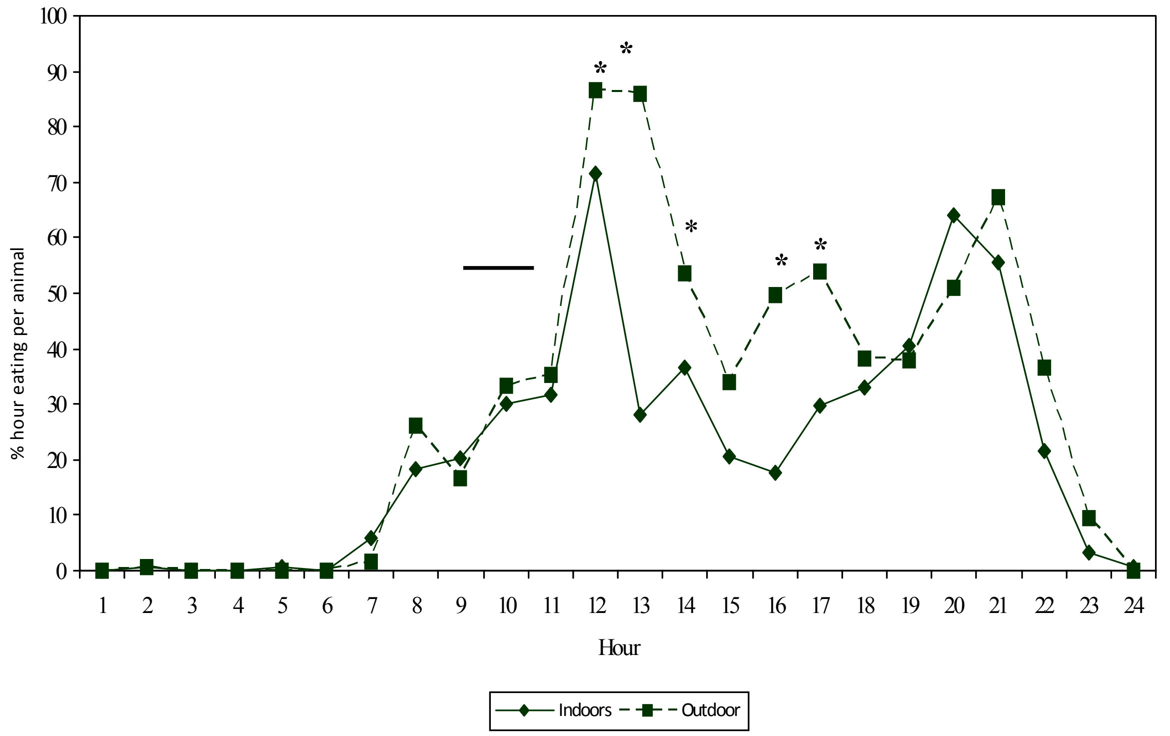

Fig. 1. The effect of housing indoors in a slatted floor shed at 3 m^2 head^{-1} or grazing outdoors on the hourly percentage of time spent eating (SED = 5.68, * = p <0.05). Solid horizontal line indicates time of feeding of indoor animals or moving of outdoor animals.

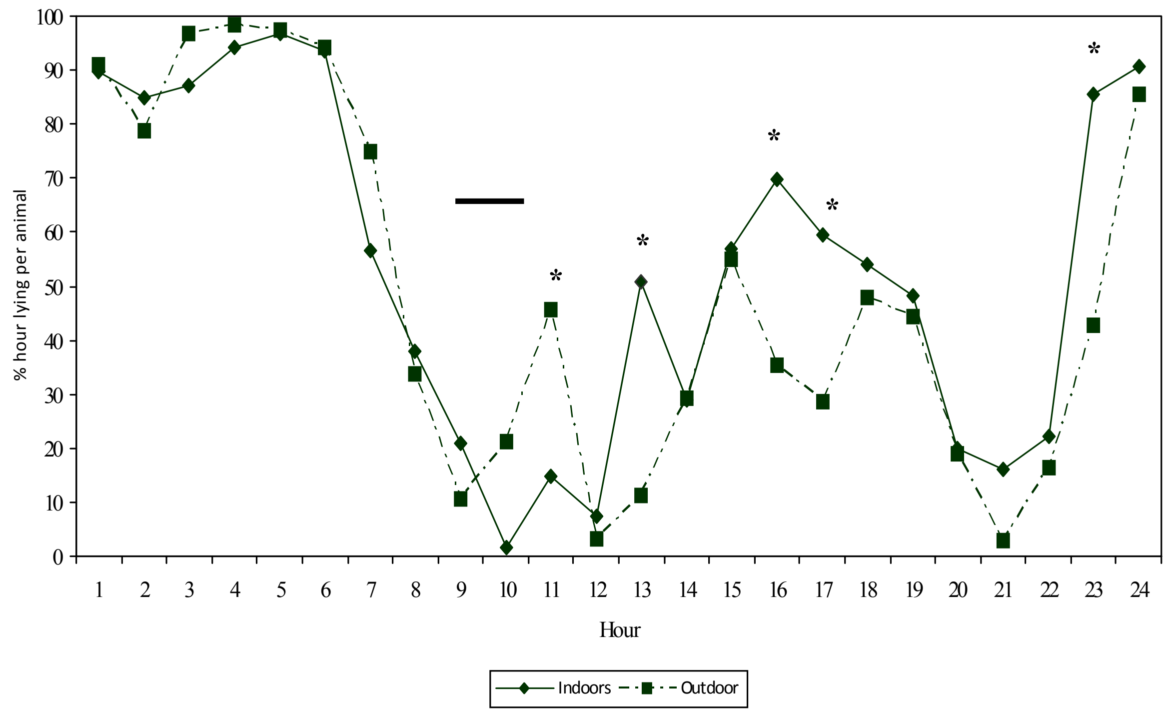

Fig. 2. The effect of housing indoors in a slatted floor shed at 3 m^2 head^{-1} or outdoors grazing on the hourly percentage of time spent lying (SED = 7.61, * = p <0.05). Solid horizontal line indicates time of feeding of indoor animals or moving of outdoor animals.

Table 1. The effect of housing indoors in a slatted floor shed at 3 m^2 head^{-1} or outdoors grazing on the behaviour of heifers.

	Management[a]			
Behaviour[b]	Indoors	Outdoors	Significance[a]	SED
Time spent eating (h day^{-1})	5.3	7.2	**	0.25
Time spent lying (h day^{-1})	12.8	11.7	ns	0.44
No. of lying bouts day^{-1}	6.7	9.2	***	0.22

[a] Animals were housed indoors on slats at 3 m^2 head $^{-1}$ (Indoors) or grazed a daily allowance of fresh herbage allocated on body weight (Outdoors).
[b] Observations were made on 3 consecutive days after a 5 week adaptation period.
[a] ns= not significant, ** =$p < 0.01$; *** = $p < 0.001$

During the first 24 h after turnout, HG animals spent less time grazing two hours prior to the rotation for day 2 at 11.00, but more time grazing during the final grazing period of the day resulting in a treatment x time interaction (p<0.001, Fig. 3). This difference was not evident on day 2 (Fig. 4), day 3 or day 10. A similar pattern (not shown) was evident in diurnal lying and standing activities.

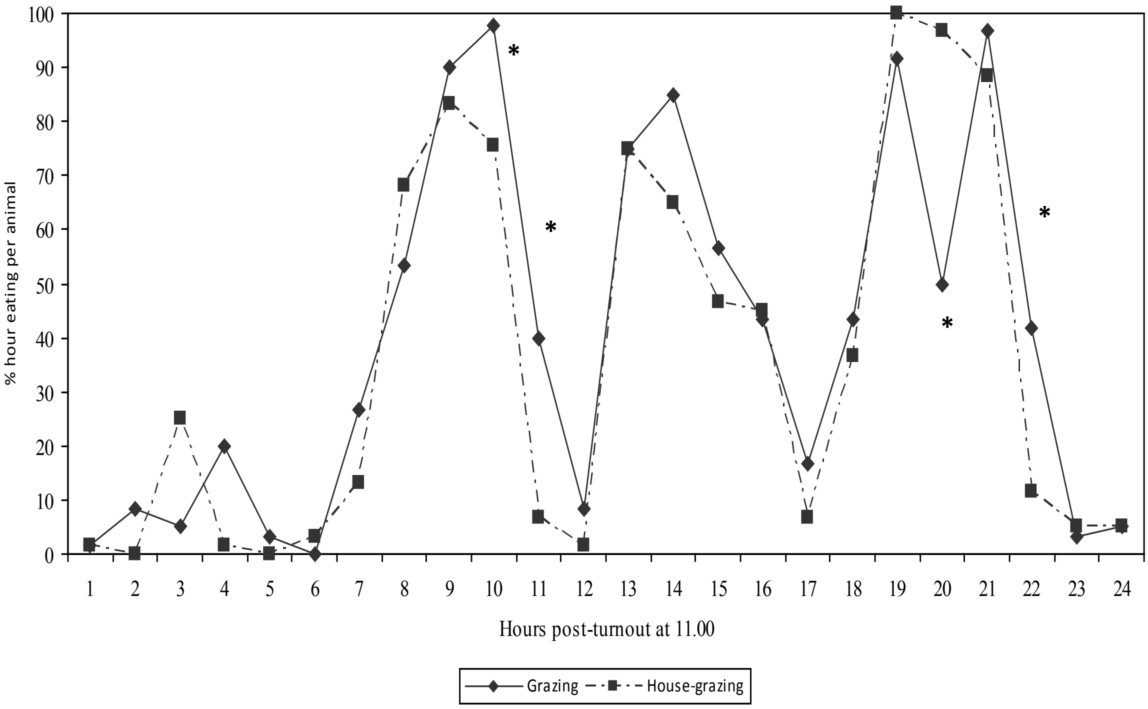

Fig. 3. The hourly percentage of time spent eating by heifers rotational grazing (grazing) and of heifers on day 1 post turnout (house-grazing) (SED = 9.74).

There was no effect of previous housing on time spent lying which was greater (p<0.05) on day 1 post-turnout than subsequently, on time spent eating which was lower (p<0.01) on d 2 than on d 10 or on the number of lying bouts displayed (Table 2). On both days pre-turnout, three out of 15 animals were observed to lie abnormally on more than 75% of occasions. At pasture two of the previously identified animals immediately lay normally on all occasions. For the third animal abnormal lying mechanisms were recorded for 50%, 32% and 0% of their recorded lying motions for day 1, 2 and 3, respectively.

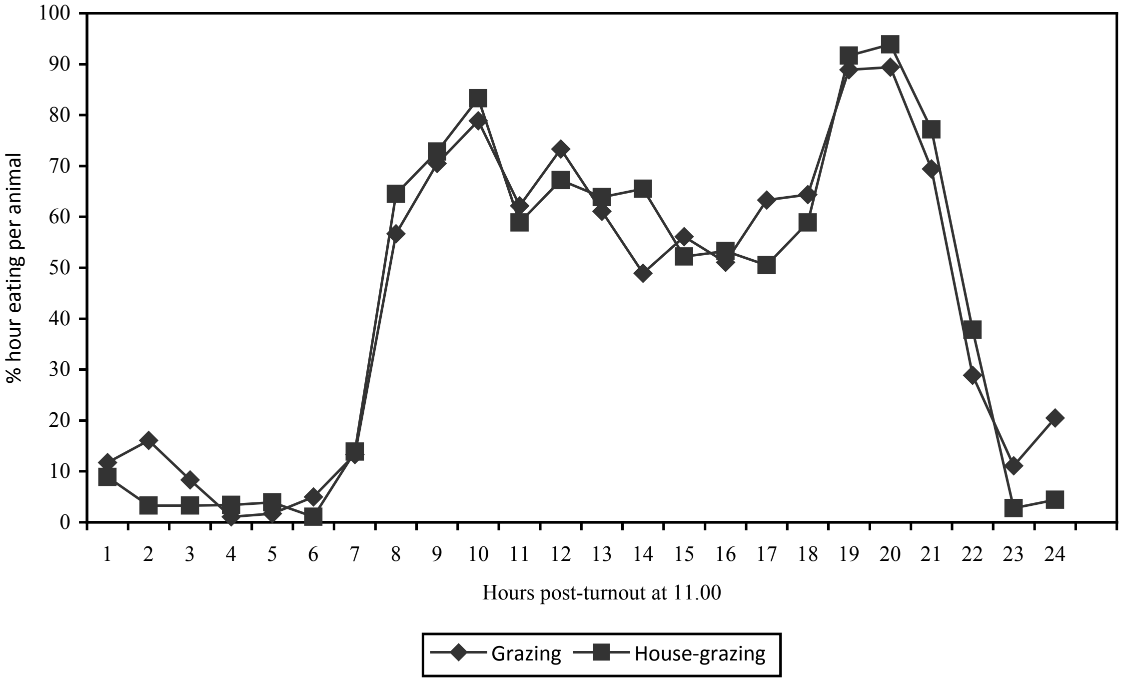

Fig. 4. The hourly percentage of time spent eating by heifers rotational grazing (grazing) and of heifers on day 2 post turnout (house-grazing) (SED = 14.73).

Table 2. The effect of housing in a slatted floor shed for 4 months on animal behaviour up to 10 days after turnout compared with heifers that grazed continually.

Variable [a]	Treatment (T)[b]	Day (D)				Significance					
		1	2	3	10	T	SED	D	SED	T x D	SED
Lying	Grazing	14.9	12.6	12.0	12.3	ns	0.59	*	0.91	ns	1.30
	House-Grazing	15.4	13.0	12.0	12.5						
Eating	Grazing	7.2	6.4	7.6	8.1	ns	0.21	**	0.29	ns	0.41
	House-Grazing	7.9	7.0	8.2	8.1						
No. of lying bouts	Grazing	10	8	7	10	ns	0.3	ns	0.7	ns	0.90
	House-Grazing	8	8	8	9						

[a]The lying and eating behaviour for any group was recorded by conducting scan sampling. Animals within a group were observed every 15 min for 24 h and the activity at the instance of observation recorded. The duration of time spent at any activity was calculated for each animal, averaged within group and expressed as hour day^{-1} $head^{-1}$.
[b]Animals were housed for 4 months at 3 m^2 $head^{-1}$ and then released to grass (House-grazing). Their counterparts remained outdoors throughout the grazing season (Grazing). All animals were offered a fixed daily herbage allowance on a body weight basis.

Discussion

The behaviour of late lactation dairy cows, being removed for milking twice daily differed when they were at pasture or confined to a cubicle shed during their non-lactating phase (O'Connell et al. 1989). As there is little information on the behaviour of beef heifers *per se*, the first objective was to determine if behaviour differed between animals, which were either housed in a slatted floor shed or were managed under a rotational grazing system. The diurnal pattern of animal behaviour was influenced by management. When compared with housed animals the greater time spent eating at grass could be attributed to the need to forage for feed in an environment of reducing herbage mass as the day progressed (Cazcarra and Petit 1995). Linnane et al. (2001) studied the effect of changing daylight length over a grazing season on the diurnal behavioural patterns of animals grazing in an extensive system with minimum human contact. The two main grazing bouts were dictated by sunrise and sunset with several smaller bouts during daylight periods. When compared with Linnane et al. (2001), the daily allocation of fresh feed in the current experiment controlled the timing of the first eating peak rather than sunrise. However a secondary peak coincided with sunset, with a minor grazing peak in the late afternoon. Total time spent foraging was comparable to that recorded by Linnane et al. (2001). Similarly, Aharoni et al. (2013) observed two main peaks of foraging activity in grazing beef cows. The mean time spend lying in the grazing group (11.7 hours) was similar to that reported by Ahroni et al. (2013) (10 hours) for beef cows grazing in Israel in June and September. The need to forage outdoors influenced the daily profile of lying behaviour in the early afternoon in the present study, as in the absence of this need animals indoors were afforded more time to lie during this period. The lying of animals indoors appeared to be disrupted earlier in the morning than that of animals outdoors which may be attributed to the anticipation of feeding time due to increased movement of machinery and personnel around the housing area. A reduction in the number of daily lying bouts, which was recorded for animals housed on slats, was suggested to be an indicator of animal discomfort (Ruis-Heutinck et al. 2000). However in the present study the daily allocation of time to lying was not different between indoors and outdoors, which is supported by other studies (Hickey et al. 2002).

The second objective of this study was to determine if the altered behaviour observed during housing would revert to that of grazing animals post turnout. During the first 24 hours post turnout, the behaviour of animals did not indicate an anticipation of movement to fresh pastures, as animals spent a greater percentage of time lying prior to the move and spent a greater length of time grazing during the final foraging bout of the day. The presence of these animals also disrupted slightly the daily grazing pattern of the G animals, as both groups displayed three very distinct grazing bouts, one prior to movement at 11:00, and two subsequent to movement. On subsequent days (not all data shown) all animals had reverted to two main grazing bouts with smaller inter bout grazing periods and the diurnal pattern of behaviour of previously housed animals was comparable to their grazing counterparts. The interaction between the proximity of the previously housed animals and the behaviour of the long term grazing animals may relect “social facilitation” or “allelomimicry” (Stoye et al. 2012). Thus the different behaviour of the previously housed animals may have been adopted by the long term grazing animals during their first day of exposure. Subsequently, the more established behavioural pattern of the grazing animals resumed. This phenomenon may also have contributed to the lack of behavioural differences between both treatment groups on day 2 post turnout and subsequently i.e. the previously housed animals adopted the behaviour of the long term grazing animals. Turn out of cattle to pasture out of view of the longterm grazing animals would be required to separate allelomimicry from any other influence on behavior. Therefore housing prior to grazing did not greatly affect the ability of animals to quickly adapt their daily behavioural profiles nor did it influence the amount of time animals dedicated to eating or lying, or on the number of lying bouts displayed. In this regard, Charmley et al. (2003) observed that on the first day post turnout steers had “little discipline in their grazing pattern” but a more consistent pattern developed after several days.

An increase in the frequency of abnormal lying behaviours has been suggested to be an indicator of animal discomfort on slatted accommodation which does not appear to affect lying time or production (Ruis-Heutinck et al. 2000). It was suggested that this behaviour reflects a level of nervousness on behalf of the animals, which is adopted to reduce the risk of slipping and hurt when lying. In the present study, the behaviour was individualistic in nature, as only 3 animals out of 15 displayed it and it was temporary. However it must be acknowledged that where animals are housed for extended periods (i.e. feedlot systems) carpal joint lesions can develop from this behaviour which may adversely influence animal well being.

Conclusion

Housing altered the behaviour of animals compared with their grazing counterparts. However when the housing duration was short the alteration in behaviour was non-permanent in nature. This would suggest that behaviour alterations during housing are temporarily adopted to sustain animal well being.

Acknowledgements

The authors would like to acknowledge the contribution of the late Mr. M. Greally, Mr. P Collins, Mr P. Whelan, Ms. V Grangiens and Ms. K. Cullen to this project.

References

Aharoni, Y., Dolev, A., Henkin, Z., Yehuda, Y., Ezra, A., Ungar, E.D., Shabtay, A. & Brosh, A. 2013. Foraging behaviour of two cattle breeds, a whole-year study: 1. Heat production, activity, and energy costs. *Journal of Animal Science* 91: 1381−1390.

Cazcarra, R. F. & Petit, M. 1995. The influence of animal age and sward height on the herbage intake and grazing behaviour of Charolais cattle. *Animal Science* 61**:** 497−506.

Charmley, E.,Jannasch, R.W. & Boyd, J. 2003. Grazing behaviour and weight change of cattle turned out to pasture in spring. *Canadian Journal of Animal Science* 83: 801−808.

Fisher, A.D., Crowe, M.A., O'Kiely, P. & Enright, W.J. 1997. Growth, behavior, adrenal and immune responses of finishing beef steers housed on slatted floors at 1.5, 2.0, 2.5 or 3.0m^2 space allowance. *Livestock Production Science* 51: 245-254.

Hickey, M.C., French, P. & Grant, J. 2002. Out-wintering pads for finishing beef cattle: Animal production and welfare. *Animal Science* 75: 447−458.

Hoffman, R. R. 1989. Evolutionary steps of ecophysiology adaptation and diversification of ruminants: a comparative view of their digestive system. *Oecologica* 78: 443−457.

Linnane, M. I., Bereton, A. J. & Giller, P. S. 2001. Seasonal changes in circadian grazing patterns of Kerry cows (*Bos Taurus*) in semi-feral conditions in Killarney National Park, Co. Kerry, Ireland. *Applied Animal Behaviour Science* 71: 277–292.

Noci, F., Monahan, F.J., French, P. & Moloney, A.P. 2005. The fatty acid composition of muscle fat and subcutaneous adipose tissue of pasture-fed beef heifers: Influence of the duration of grazing. *Journal of Animal Science* 83: 1167−1178.

O'Connell, J., Giller, P. S. & Meaney, W. 1989. A comparison of dairy cattle behavioural patterns at pasture and during confinement. *Irish Journal of Agricultural and Food Research* 28**:** 65−72.

Ruis-Heutinck, M., Smits, C. J., Smits, A. C. & Heeres, J.J. 2000. Effects of floor type and floor area on the behaviour and carpal joint lesions in beef bulls. In: Blokhuis, H.J., Ekkel, E.D. & and Wechsler, B. (eds). *Proceedings of sessions of the European Association for Animal Production Commission on Animal Management and Health* Publication Number 102. p. 29−36.

SAS. 1988**.** SAS/STAT Users guide (Release 6.03). SAS Inst. Inc., Cary, NC, USA.

Stoye, S., Porter, M.A. & Dawkins, M. S. 2012. Synchronized lying in cattle in relation to time of day. *Livestock Science* 149: 70−73.