Cattle behaviour: methods for improving the movement of cattle into a stunning pen and the implications for the use of electrical goads

MSc Project

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AUTHOR'S DECLARATION

I declare that the work in this dissertation was carried out in accordance with the regulations of the University of Bristol. The work is original except where indicated by special reference in the text and no part of the dissertation has been submitted for any other degree.

Any views expressed in the dissertation are those of the author and in no way represent those of the University of Bristol.

The dissertation has not been presented to any other University for examination either in the United Kingdom or overseas.

Signed Date

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Cattle behaviour: methods for improving the movement of cattle in to a stunning pen.

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Abstract.

There is currently a problem in slaughterhouses with the movement of cattle through a raceway and into the stunning pen resulting in the use of coercion and electric goads. The major problem of the design of the stun box is that it involves movement of the animal in to a 'blind box' and thus a dead end. A knowledge of, and the use of, an animals' flight zone is important when coercing cattle in raceways; however the design of the environment is also important. Excessive use of electric goads can adversely affect the animal's welfare and perhaps more importantly to the industry, carcass and meat quality. The overall lighting in the race approaching the stun box and within the stun box was improved and three treatment groups were investigated (the use of: 1. A mirror, 2. A picture of a cow's rear and 3. A picture of a horizon) for the effect on cattle movement in to the stun box. Animals were scored using a scoring system including the ease of movement, number of times an animal baulks and the time taken to enter in to the stun box. The results show that the most effective treatment to improve cattle movement was the incorporation of a picture of the horizon. This study suggests that improving the design of the stun box in combination with the practice of good animal handling can reduce the number of times an electric goad is used on an animal and ultimately reduce the amount of coercion required to move animals into the stunning pen.

Keywords- animal welfare, behaviour, cattle, electric goad, meat quality, stunning pen

Contents

Introduction

The range of cattle behaviours seen within the lairage environment has been shown by various researchers, to result in a ‘hesitancy to move forward’ at specific points in the system (Cockram & Corley, 1991, Bourguet et al., 2011). In addition to the handling systems employed, deficiencies in the design and lighting of the lairage and race ways leading up to stunning areas and the stun box itself have resulted in animals refusing to continue to move forward resulting in the overuse of the electric goad or the application of inappropriate force by other means of coercion (Farm Animal Welfare Council, 2003). Pre-slaughter stress induced by repeated goading or poor handling systems is detrimental not only to the animal’s welfare but also to carcass and meat quality, which is essential to the meat industry (Warriss, 2010). The use of electric prods/goads has been known to increase stress in animals with adverse effects on the quality of the meat producing increased toughness in beef (Warner et al., 2007). Pre-slaughter handling has been described as one of the most stressful events encountered by livestock animals destined for food production and it can adversely affect the welfare of the individual animal as well as the efficiency of the slaughter line and meat quality (Cockram & Corley, 1991).

The level of lighting within the race, prior to the stunning pen and within the stunning pen itself, is also an important factor to consider when assessing cattle movement through the race and in to the stun box. Shadows and contrasts in colour in the race can cause animals to baulk and stop to investigate the area, slowing movement through the race (Grandin, 1990). Cattle are hesitant to move into a dark area from a light area and are best moved through diffuse light (Blackshaw, 1986). Lighting can be used to illuminate the floor however it must not shine or reflect back into the eyes of approaching animals which would cause the animal to baulk (Grandin, 1990). Lighting under the base of the swing doors (ejection) separating the stunning pen from the slaughter hall, provides a distraction for cattle causing them to lower their heads (grazing position). This is counterproductive to the accurate placement of the captive bolt gun and may result in ineffective stunning (Wotton, personal communication).

The lairage and race way layout can be designed and adapted to facilitate natural behaviours expressed by cattle in order to aid movement, reduce distractions and stressors and reduce or remove the need for an electric goad or other means of forceful coercion (Blackshaw, 1986, Grandin, 1993). For example cattle have a tendency to constantly monitor each other, maintaining visual contact and they naturally tend to follow each other (herding instinct) (Blackshaw, 1986). When cattle can maintain visual contact with the animal in front of them they will move more easily through a narrow passage. Due to their tendency to follow each other, the transition between the crowding pen and the single file race must be smooth to prevent bunching of the animals (Grandin, 1980). A curved race facilitates this natural following behaviour and prevents animals from seeing the stunning pen or a closed, dead-end to the race in the abattoir; a catwalk along the inner radius of the race enables the cattle to maintain visual contact with the handler and facilitates the animal's natural tendency to circle the handler (Grandin, 1980). Thus good handling practices and calm approaches are important during the last few minutes before slaughter. Anecdotal evidence (Wotton, personal communication) has reported the variation in animal behaviour witnessed when different systems at different abattoirs are studied. In order to improve an animal's welfare, in terms of animal handling pre-slaughter, it is important to first understand the normal repertoire of behaviours of a bovine animal and how the animal interprets its environment.

The aim of this study is to:

- Improve the movement of cattle into the stunning pen in aiding animal handling, such as reduced electric goad use, by the manipulation of design of the stunning pen as a continuation of the race

This will contribute to improved animal welfare and thus reduce or prevent the unwanted effects of poor welfare on meat quality. The interactions between the environment, the animal and the stockmen are the variants that require investigation in order to make recommendations for the improvement of cattle movement in to the stunning pen. This study can ultimately be used to improve the understanding of the behavioural aspect of stress in cattle at slaughter.

Materials and methods

Experimental protocol.

Two experiments were conducted at the commercial abattoir Southern Counties, Langport, part of the RWM food group. The company currently processes 120, 000 cattle per year (approximately 370 per day) consisting of clean (under 72 months of age) cattle, including dairy breeds, and cattle over 72 months of age. In the first experiment four experimental treatments, including a control, (see figure 1) were tested based on the movement of 20 cattle per treatment from the end of the lairage race in-to the stunning box using the original lighting levels (shown in figure 2);

- No experimental input (control)
- Modification of the stunning box using a mirror
- Modification of the stunning box using a picture of the rear end of a cow
- Modification of the stunning box using a picture of a field with a horizon

The original lighting levels in the race leading up to the stun box and the stun box itself were considerably low (see figure 2); 5-35 lux in the race just before the stun box, 10-70 lux in the stun box (the range in readings were obtained dependant on the orientation of the probe of the light meter- Megatron DL3/Lc).

The interaction between the environment, the animal and the stockmen was observed and recorded using a scoring system (see figure 3) and video recorded for later analysis.

In the second experiment the lighting levels were increased from the original low levels to 50 lux in the race just before the stun box and 60-150 lux in the stun box itself. The treatment groups were increased to 80 animals per treatment to investigate which treatment group resulted in less coercion for the movement of animals through the race and up to the point of stun. Animal movement was recorded by video camera for analysis of cattle behaviour, with and without the experimental treatments. The treatments under investigation were assessed using animals that were both clean cattle (under 72 months) and cattle over 72 months.

Figure 1. Images of treatment groups in place in the stun box: 1. Control (top left), 2. Mirror (top right, 3. Cow rear (bottom left) and Horizon (bottom right).

Figure 2. Original race and stun box conditions; light levels 5-35 lux in the race and 10-70 lux in the stun box.

Animal behaviour, ease of movement, the type of coercion applied as well as the effect of the experimental treatment on the orientation of the animal's head to aid accurate placement of the captive bolt gun were recorded using a scoring system.

The type of coercion was discussed with the slaughterman in order to achieve standardised handling as follows;

Type of persuasion/coercion- 1 - 4

1. No persuasion required - animal enters easily without coercion
2. Use of the point of balance (POB) - animal responds and enters the stun box
3. Touch/patting of the rump of the animal - if POB fails
4. Use of the electric goad - if patting the animal fails (number of goad applications)

The overall ease of movement of the animals into the stunning pen was scored in conjunction with the type of coercion, the number of times the animal baulked or backed up in the race and the number of applications of the electric goad;

Ease of movement 1 - 4

1. Animal moves easily into stun box with no coercion
2. Animal moves easily with little coercion - use of the point of balance/touching or patting the animal
3. Animal baulks and backs up in the race
4. Animal refuses to move - a lot of coercion required (use of goad)

Normal procedure at Southern Counties (RWM Food Group)

Animals arrive at the lairage at Southern Counties. Cattle are penned in batches based on their transport groups to reduce stress from the mixing of animals. Each lairage pen contained:

- A maximum of 8-10 animals or, in smaller groups, if the animals were laired overnight
- Bedding was added to every pen to encourage normal behaviour and thus reduce stress - more bedding was added for animals staying overnight

Trained animal welfare officers (AWO) were present in the lairage to maintain welfare standards and to reduce animals stress. When batches were moved forward, each animal was free to walk into the crowding pen and into the race leading to the stun box. The single-animal race was comprised of smooth curves with no sharp corners. The part of the race leading to the stun box was separated by a non-return gate, which closed off the entrance to the animal next in line. Several procedures are enacted to reduce stress and produce a calming environment:

- Animals are encouraged forward by the use of hands and a calm tone of voice
- If animals refuse to move into the stunning pen, an electric goad is used
- Only one person (slaughterman) is permitted to be present when the animal is restrained in the stun box, who then performs the stunning procedure

Figure 3 shows the dimensions of the stun box and the distance from the front of the box to the wall; experimental treatments were fixed securely to the wall during the initial trial and brought forward to the vertical bars at the front of the stun box during the main experiment as shown in figure 2.

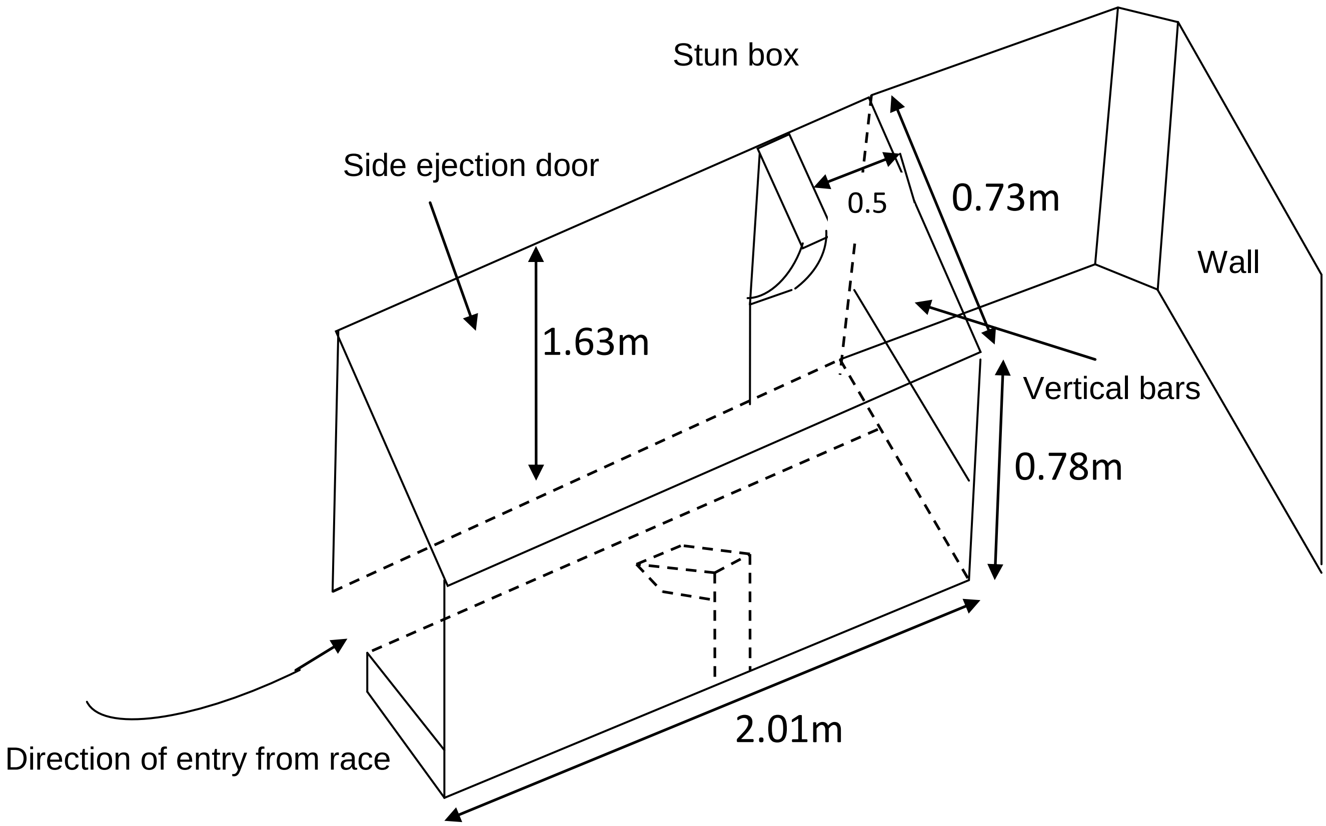

Figure 3. Stun box measurements.

Statistical analysis

Data collected was presented in *Excel (Office 2007)* and analysed using *SPSS18* with univariate analysis of variance, Kruskal-Wallis (Monte Carlo) and Pearson Chi-Square (Monte Carlo two-sided) tests.

Results

Each animal was scored by two observers using a pre-defined scoring system. Animals were also video recorded to allow further analysis to be carried out retrospectively. The first experimental trial (n = 20 per treatment) was conducted under the original lighting conditions (5-35 lux in the race leading up to the stun box and 10-70 lux in the stun box). The second experiment (n = 80 per treatment) was conducted under increased lighting levels (50 lux in the race leading up to the stun box and 60-150 lux in the stun box). The control group was conducted under normal conditions with no improvement to the design of the stunning box.

Figure 4 shows the results for the amount of time taken for cattle to enter the stunning box (timed from the time the guillotine door was opened to the time the guillotine door was closed behind the animal). The results suggest that treatment 3, the picture of a horizon, had a slight effect in reducing the amount of time taken for the animal to enter the stun box with a greater proportion of animals entering the stunning box under 40 seconds compared to the control. However, no significance was found by statistical analysis with a Kruskal-Wallis (Monte Carlo) test. The results were converted into log time (LnTime) shown in figure 5 and analysed comparing the first experiment with the second experiment to identify any effect of the difference in lighting levels. Analysis using a Kruskal-Wallis (Monte Carlo) test did not show any significant differences between the control and treatment groups.

The presence of tail swishing was recorded and scored as 0 and 1 (0 = no tail swishing, 1 = tail swishing). The results are shown in figure 6 and demonstrate that the control had a higher amount of tail swishing compared to the treatment groups. Analysis using a Chi-Square test showed a significant difference ($P = 0.00001663$) between the control and treatments.

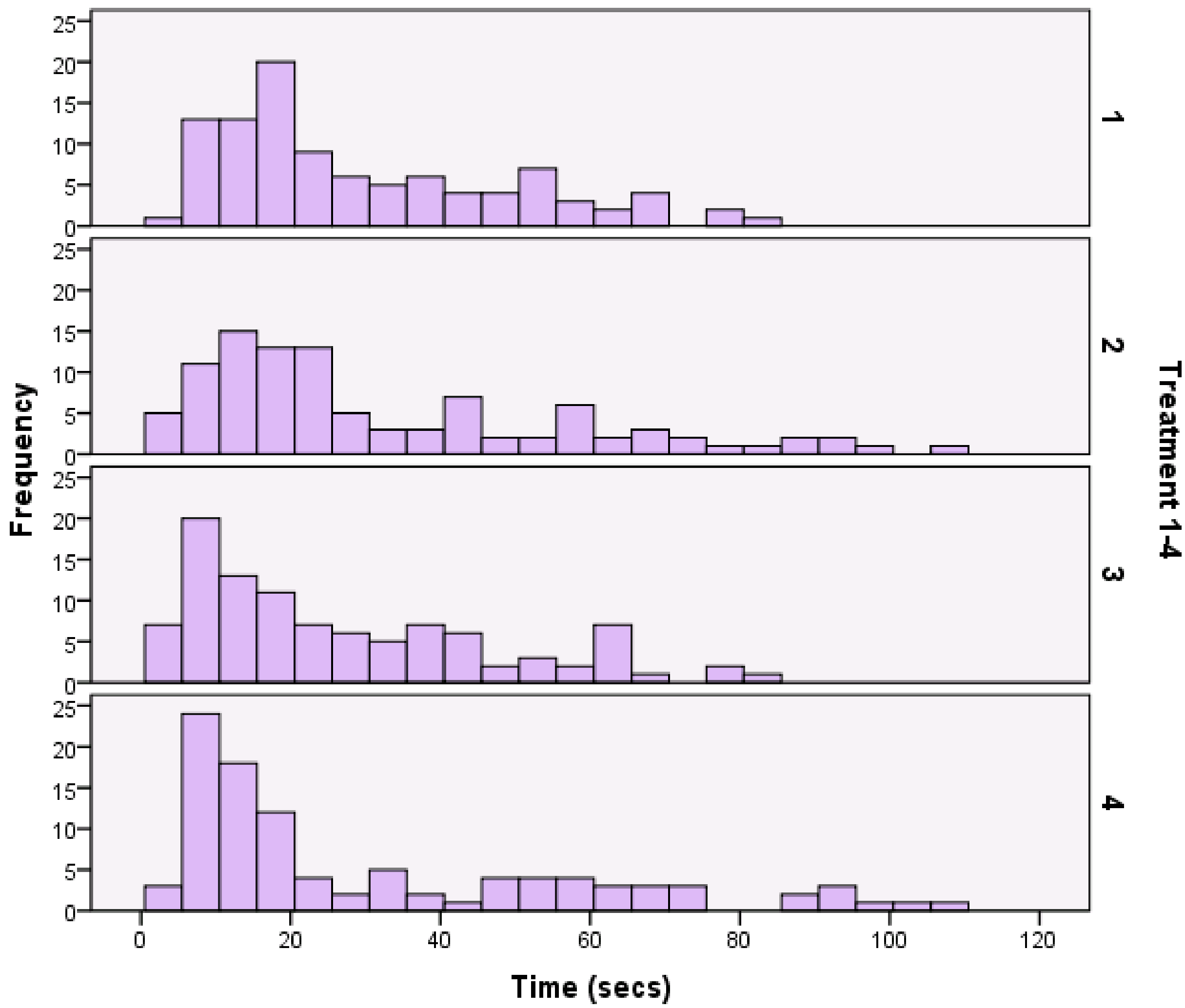

Figure 4. The effect of treatment groups (experiments 1&2 combined) on entry time (secs); treatment 1 (mirror) (n = 100), treatment 2 (picture of a cow rear) (n = 100), treatment 3 (picture of a horizon) (n = 100) and treatment 4 (control) (n = 100). No statistical significance was found on analysis with a univariate analysis of variance test.

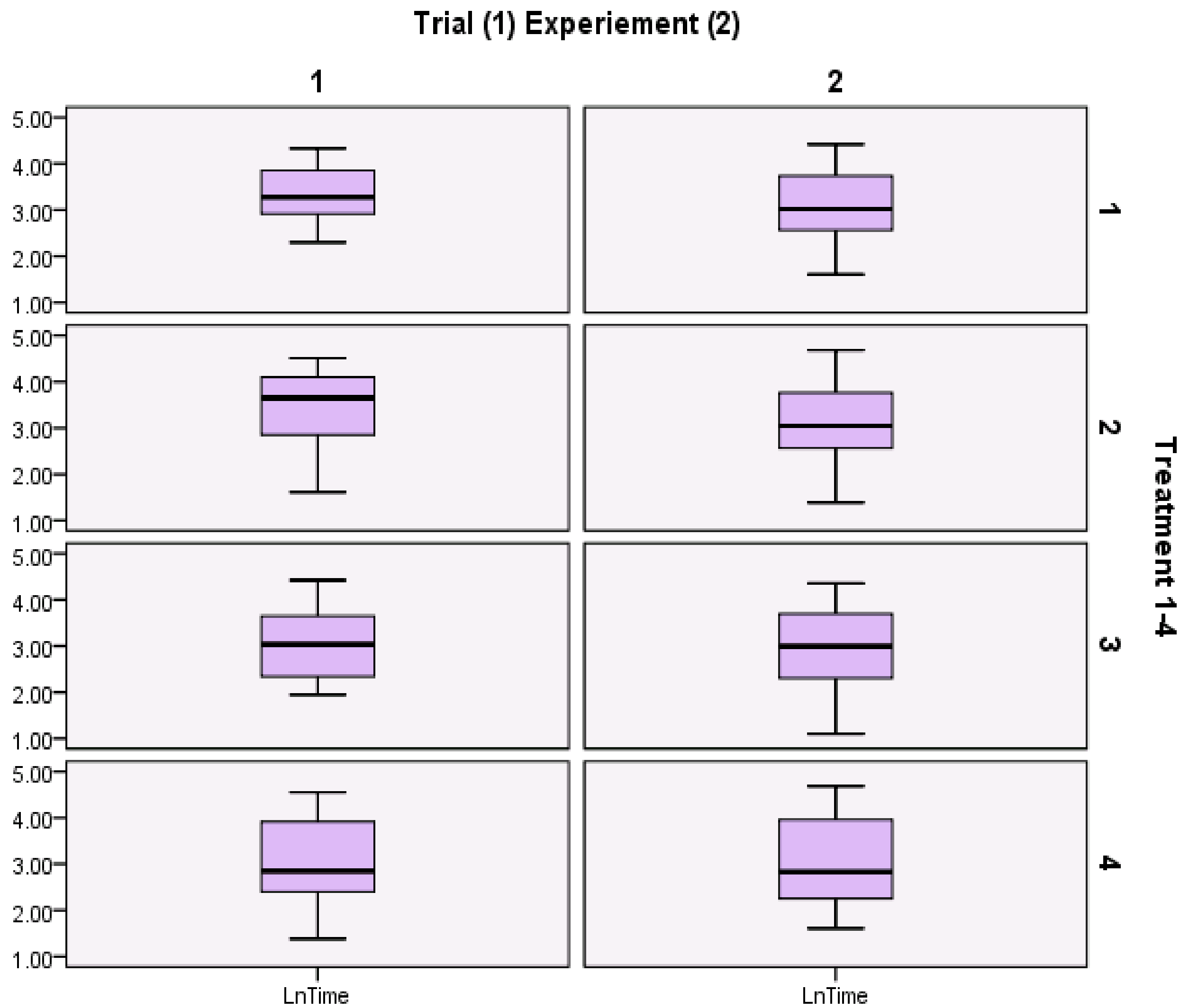

Figure 5. The effect of experiment 1 (constant light levels of 5-35 lux in the race and 10-70 lux in the stun box) and experiment 2 (constant light levels of 50 lux in the race and 60-150 lux in the stun box) on log time. No statistical significance was found on analysis with a univariate analysis of variance test.

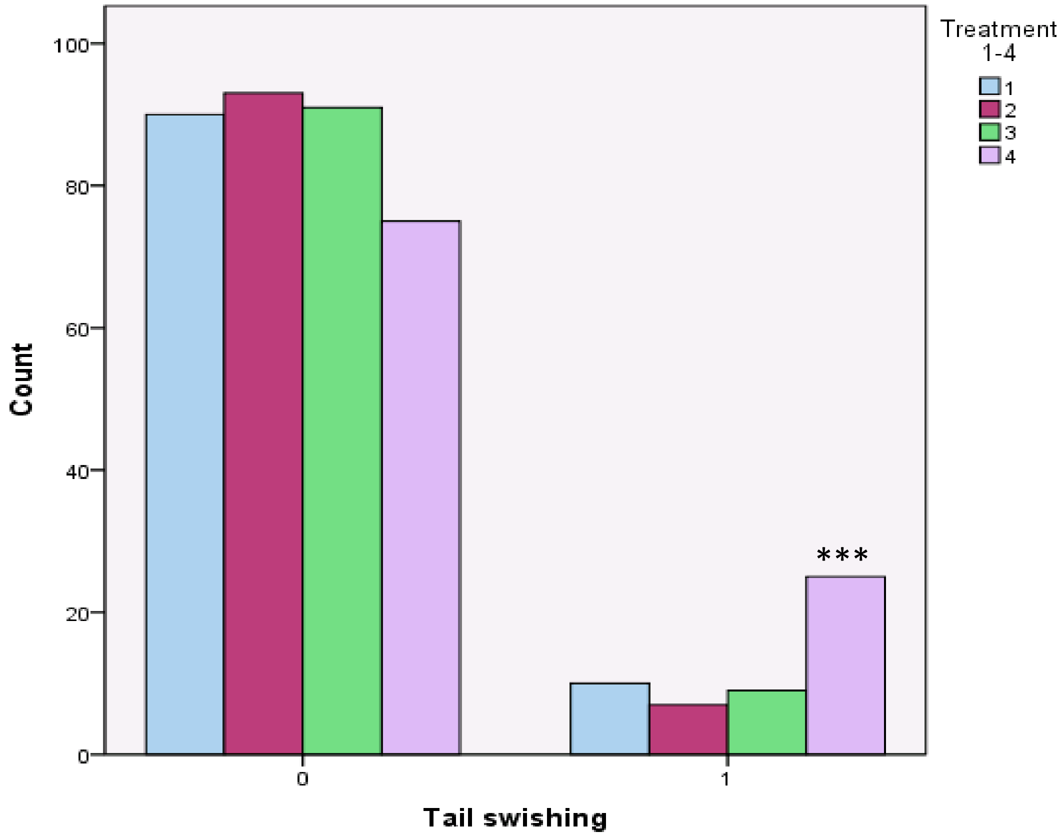

Figure 6. The effect of treatments 1 - 4 (experiments 1&2 combined) on tail swishing (0 = no tail swishing, 1 = tail swishing); treatment 1 (Mirror) (n = 100), treatment 2 (Picture of a cow rear) (n = 100), treatment 3 (Picture of a horizon) (n = 100) and treatment 4 (control) (n = 100). Significance of P < 0.001 on analysis using a Pearson Chi-Square Test (exact 2-sided).

In order to assess the effect of the treatment group on the behaviour of the animal, the orientation of the animal's head was scored on a basis of 1-3; where 1 the animal does not lift its head at all presenting the grazing position, 2 the animal stretches its head forwards and 3 the animal lifts its head up. The results are shown in table 1 which demonstrates that each treatment group improved the animal's head position, achieving larger numbers of score 2 and 3 compared to the control. However there does not seem to be any one treatment which had a greater effect on the animal's head position than the others. Analysis using a Pearson Chi-square (Monte Carlo) test showed a significant difference (*P* = 1.39E-29) between the control and treatments.

Orientation of head 1-3 * Treatment 1-4 Cross tabulation

			Treatment 1 - 4				Total
			1	2	3	4	
Orientation of head 1 - 3	1	Count	16	11	11	74	112
		% within Treatment 1 - 4	.2	.1	.1	.7	.3
	2	Count	58	60	55	7	180
		% within Treatment 1 - 4	.6	.6	.6	.1	.5
	3	Count	26	29	34	19	108
		% within Treatment 1 - 4	.3	.3	.3	.2 ***	.3
Total		Count	100	100	100	100	400
		% within Treatment 1 - 4	1.0	1.0	1.0	1.0	1.0

Table 1. The effect of treatments 1 - 4 (experiments 1&2 combined) on the orientation of the animal's head at the point of stun 1-3; 1. The animal does not lift its head (grazing position), 2. The animal stretches its head forward and 3. The animal lifts its head up. Treatment 1 (Mirror) (n = 100), treatment 2 (Picture of a cow rear) (n = 100), treatment 3 (Picture of a horizon) (n = 100) and treatment 4 (control) (n = 100). Significance of P < 0.001 on analysis using a Pearson Chi-Square Test (Monte Carlo 2-sided).

The type of coercion was recorded and scored 1 - 4 as described in the experimental protocol. The results shown in table 2 show that the control scored higher in the scale (score 4) than treatments 2 and 3 (Picture of the cow rear and picture of the horizon, respectively). Analysis using a Pearson Chi-Square (Monte Carlo) test showed a significant difference between the control and treatments (P = 0.028). However, the results do not suggest a difference between treatments.

Coercion type (1 - 4) * Treatment 1 - 4 Cross tabulation

			Treatment 1 - 4				Total
			1	2	3	4	
coercion type (1 - 4)	1	Count	9	9	7	5	30
		% within Treatment 1 - 4	.1	.1	.1	.1	.1
	2	Count	9	6	10	21	46
		% within Treatment 1 - 4	.1	.1	.1	.2	.1
	3	Count	50	59	57	40	206
		% within Treatment 1 - 4	.5	.6	.6	.4	.5
	4	Count	32	26	26	34	118
		% within Treatment 1 - 4	.3	.3 *	.3 *	.3	.3
Total		Count	100	100	100	100	400
		% within Treatment 1 - 4	1.0	1.0	1.0	1.0	1.0

Table 2. The effect treatments (experiments 1&2 combined) on the type of coercion used 1 - 4; 1. No persuasion required- animal enters easily on its own accord, 2. Use of the point of balance (POB) - animal then enters, 3. Touch/patting of the rump of the animal- if POB fails and 4. Use of the electrical goad - if patting the animal fails (number of times used). Treatment 1 (Mirror) (n = 100), treatment 2 (Picture of a cow rear) (n = 100), treatment 3 (Picture of a horizon) (n = 100) and treatment 4 (control) (n = 100). Significance of P < 0.05 using a Pearson Chi-Square Test (Monte Carlo 2-sided).

The presence of non - social vocalisation was recorded and scored as 0 and 1 (0 = no vocalisation, 1 = vocalisation). The results are shown in figure 7 showing that the control had a higher amount of vocalisation compared to the treatments. Analysis using a Chi-Square test showed treatment 3, the picture of the horizon, to have significantly lower amount of vocalisations ($P = 0.0002$) compared to the control.

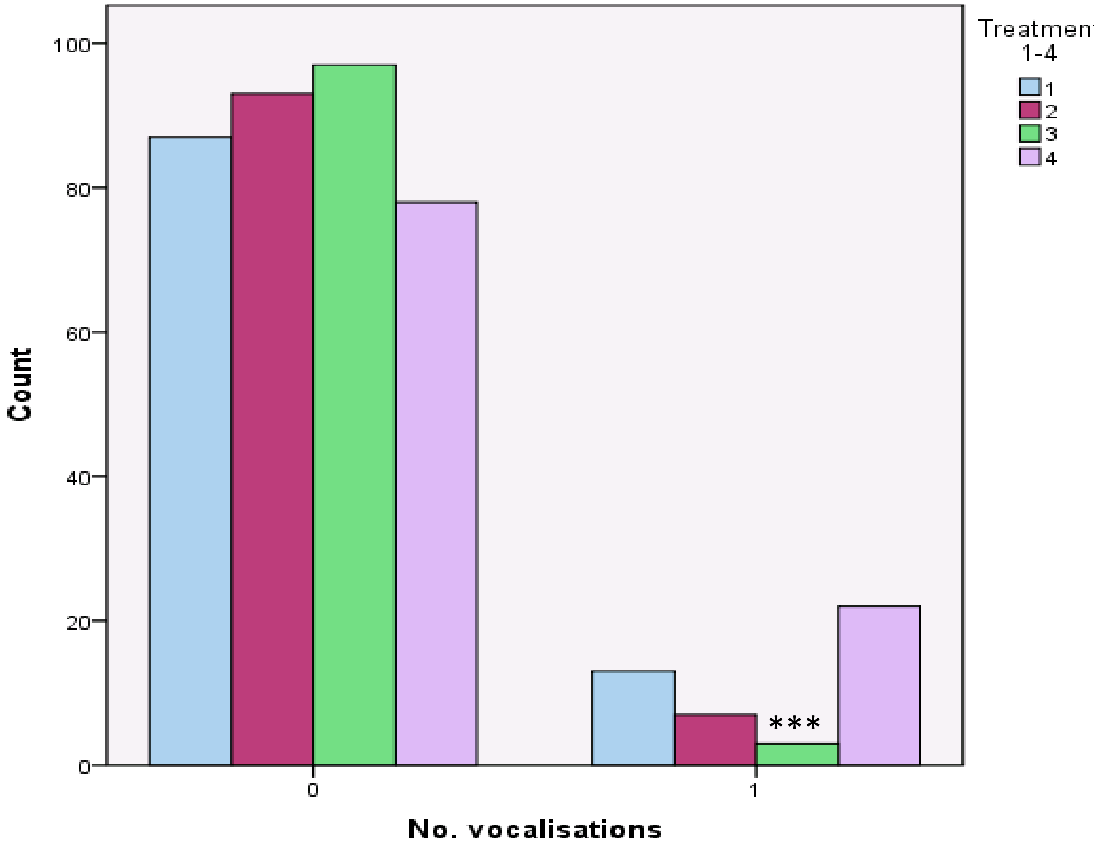

Figure 7. The effect of treatments (experiments 1&2 combined) on non-social vocalization (0 = no vocalization, 1 = vocalization). Treatment 1 (Mirror) (n = 100), treatment 2 (Picture of a cow rear) (n = 100), treatment 3 (Picture of a horizon) (n = 100) and treatment 4 (control) (n = 100). Significance of P < 0.001 using a Pearson Chi-Square Test (Monte Carlo 2-sided).

The number of goad applications applied to each animal was recorded in conjunction with the overall ease of movement and number of times the animal baulked. The results are shown in figure 8, where it suggests that treatment 3, the picture of the horizon, produced a greater effect that the other treatment groups on achieving a lower overall number of applications compared to the control. Analysis using a Kruskal-Wallis (Monte Carlo) test did not show any significant differences between treatments and the control.

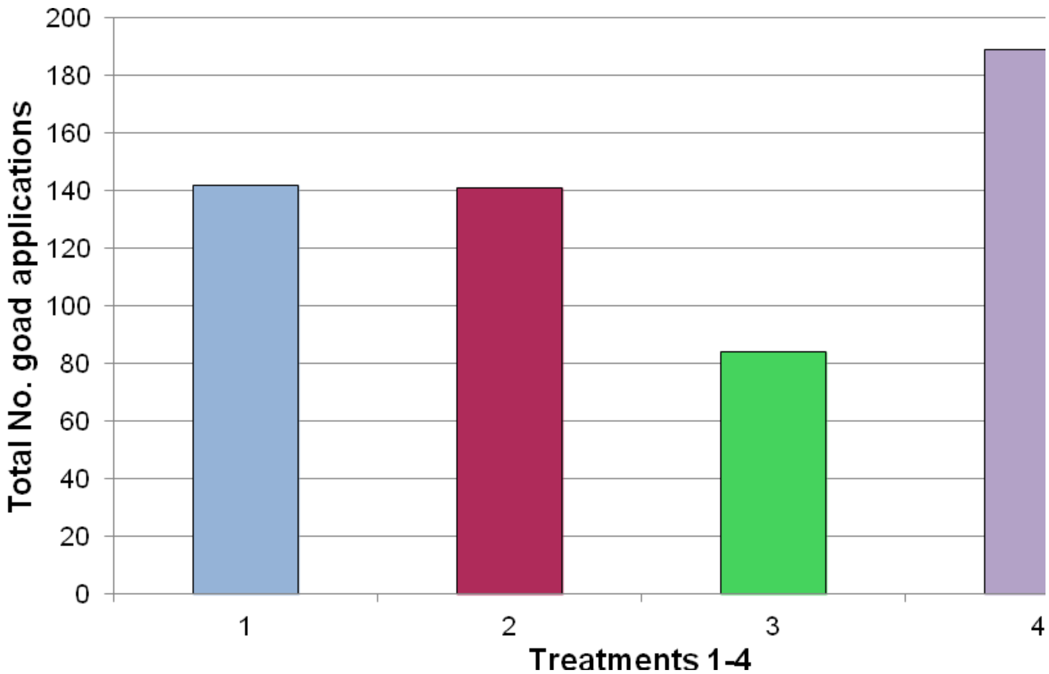

Figure 8. The effect of treatments (experiments 1&2 combined) on the total number of electric goad applications. Treatment 1 (Mirror) (n = 100), treatment 2 (Picture of a cow rear) (n = 100), treatment 3 (Picture of a horizon) (n = 100) and treatment 4 (control) (n = 100). No significance found on analysis using a Kruskal-Wallis Test (Monte Carlo).

In order to assess the ease of the animal's movement, with each treatment group, in-to the stun box, the number of times animals baulked and backed-up in the race when coerced was recorded and the results are shown in figure 9. The results suggest that there was a slight difference between the control and treatments in the total number of times the animals baulked, with the control group animals being slightly higher. However, analysis with a Kruskal-Wallis (Monte Carlo) text did not show any significant differences between treatments and the control with the total number of times the animals baulked and backed-up in the race.

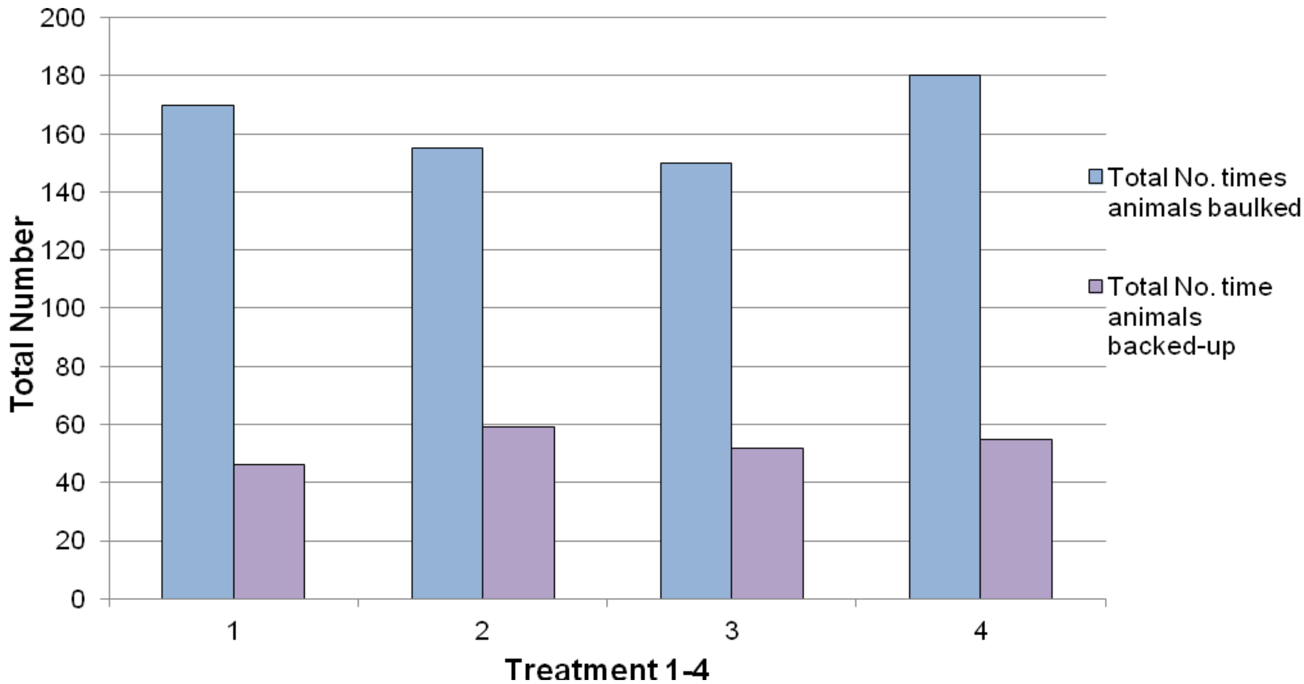

Figure 9. The effect of treatments (experiments 1&2 combined) on the total number of times animals baulked and back-up in the race. Treatment 1 (Mirror) (n = 100), treatment 2 (Picture of a cow rear) (n = 100), treatment 3 (Picture of a horizon) (n = 100) and treatment 4 (control) (n = 100). No significance found on analysis using a Kruskal-Wallis Test (Monte Carlo).

The overall ease of movement was recorded and scored 1 - 4 as described in the experimental protocol. The results are shown in figure 10, showing that there were slight differences between treatment groups. Treatments 2 and 3 had a slightly reduced number of animals scored 4 compared to the control; however on analysis using a Kruskal-Wallis (Monte Carlo) test no significance was found.

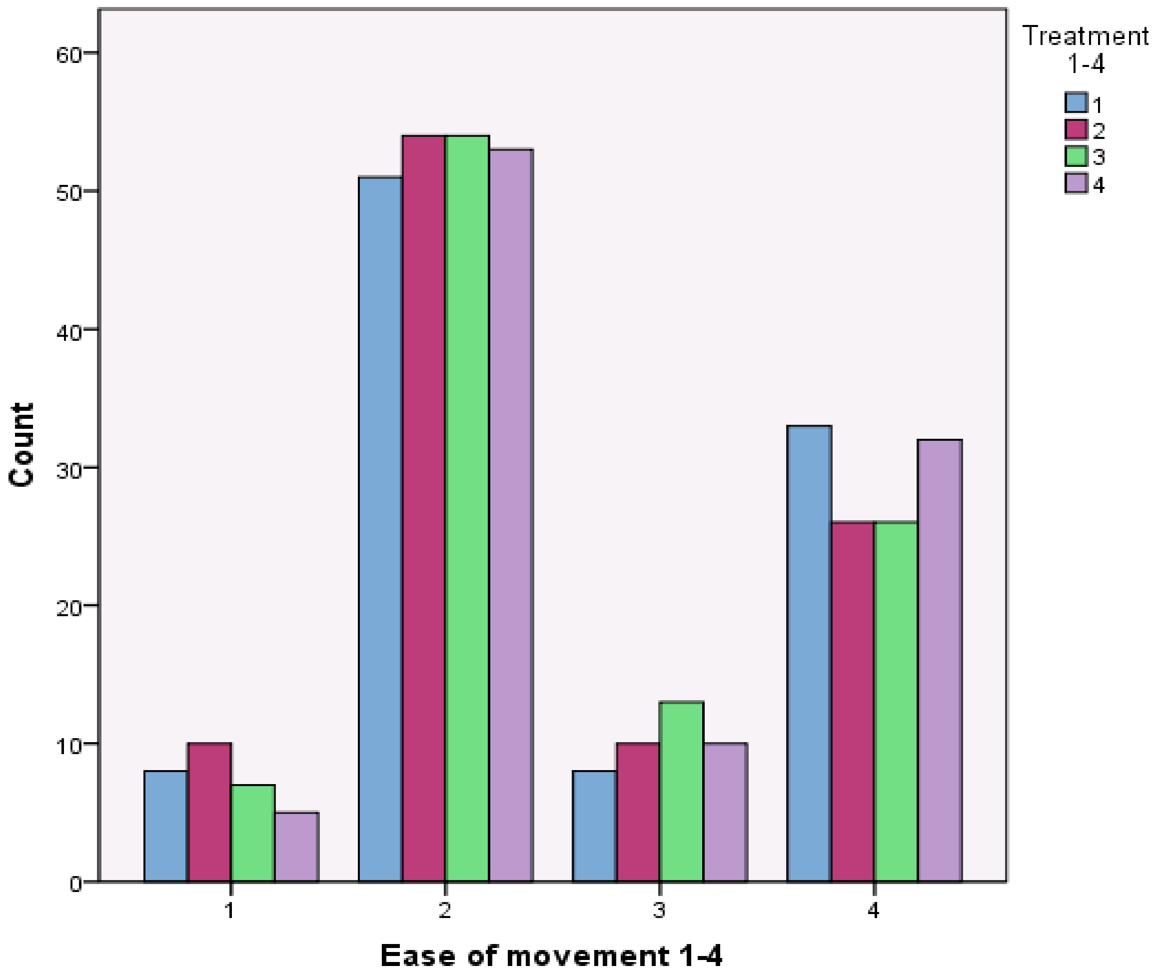

Figure 10. The effect of treatments 1 - 4 (experiments 1&2 combined) on the overall ease of movement of the animal in-to the stun box 1 - 4; 1. Animal moves easily into the stun box with no coercion, 2. Animal moves easily with little coercion - use of the point of balance/touching or patting the animal, 3. Animal baulks and backs up in race and 4. Animal refuses to move - a lot of coercion required (use of goad). Treatment 1 (Mirror) (n = 100), treatment 2 (Picture of a cow rear) (n = 100), treatment 3 (Picture of a horizon) (n = 100) and treatment 4 (control) (n = 100). No significance found on analysis using a Kruskal-Wallis Test (Monte Carlo).

Discussion

Different abattoirs have different race and stun box designs, with different lighting regimes and slaughter procedures. This results in different abattoirs presenting different problems for animal handling, through the race and into stunning boxes. Bourguet et al. (2011) showed that there is a significant problem with moving cattle through a race and in to a stun box. They demonstrated that in a commercial abattoir, the most use of coercion using electric prods or goads was within the slaughter corridor; however the number of prods applied per unit time was shown to be the highest at the entrance to the stun box. The major problem with the design of the stun box is that it involves the movement of an animal in-to a 'blind box' and thus it appears as a dead-end, with no way of escape. In order to aid and encourage movement in-to the stun box the use of animal behaviour and handling principles i.e. the point of balance can be used; it is well known that cattle will baulk if the slaughterman is in front of their field of view i.e. in front of the point of balance (Wotton, personal communication). Cattle have a herding instinct with a tendency to constantly monitor other members of the herd, maintaining visual contact so that they naturally tend to follow each other therefore, if they can maintain visual contact with the animal in front of them they will move more easily through a narrow passage or race (Blackshaw, 1986). To make use of their tendency to follow each other, the transition between the crowd pen and the single file race must be smooth to prevent bunching of animals (Grandin, 1980). A curved race facilitates this natural following behaviour and prevents animals from seeing the stunning pen or a closed end to the race (Grandin, 1980). In addition, a catwalk along the inner radius of the race enables the cattle to maintain visual contact with the handler and facilitates the animal's natural tendency to circle the handler (Grandin, 1980).

Franklin and Hutson (1982a) showed that mirrors can be used to encourage sheep movement. Placing a mirror at the end of a race, reflecting approaching sheep, could help to overcome problems such as when sheep are required to move towards the noise of a shearing pen, approaching a dead-end and possibly to pass stationary sheep in the catching pen (Hutson, 1980, Franklin & Hutson, 1982a). However, the results obtained from this experiment with cattle, did not concur with those found by Fanklin and Hutson, with sheep. There were no any significant differences in the time taken to enter the stun box or any improvement in the ease of movement when the mirror treatment was compared to the control or the other treatments. This may be due to the presence of light reflections from the mirror, which could shine back into the animal's eyes causing them to baulk, although great care was taken to prevent and reduce this effect. The mirror may also have had an effect of causing an animal to become wary due to the mirror's reflection showing an animal approaching and/or animal movement. This 'mirror effect' may have resulted in the higher number of goad applications than was seen with the other treatment groups, however the mirror treatment group achieved a lower total number of goad applications compared to the control group.

Franklin and Hutson (1982a) also showed that sheep can recognise a two-dimensional image of a sheep as another animal and react to it as if it were a live animal. The study conducted by Franklin and Hutson (1982a) suggested that the most attractive visual stimulus to sheep in a race is the sight of other sheep and that the attractive effect of live decoy sheep can be reproduced using images in the form of mirrors, pictures and films. Franklin and Hutson (1982a) demonstrated that the rear view of the sheep was found to be more attractive than pictures of the front view of sheep. This may be due to the fact that naturally facing or approaching sheep may indicate aggression, whilst the rump view represents a 'follow-me' gesture and a sign of submission (Guthrie, 1971). However, the picture of the cow rear did not appear to improve movement significantly, when compared to the control. This may be due to the clarity of the picture which may not have been defined sufficiently to produce a significant response, also the picture was secured to the end of the stun box on the outside of vertical bars which may have prevented cattle from distinguishing the picture as that of a cow.

There are many factors which may have contributed to the hesitancy of some animals to move easily into the stun box with little coercion. One factor which may have impeded entry is the presence of blood on the floor of the stun box when moving some animals in-to the stun box, which may have contributed to a hesitancy to move forward. It has been shown that cattle are much better at distinguishing longer wavelengths (yellow, orange and red), which may be due to a survival adaptation against predators, allowing the herd to escape when blood is spilt (Phillips, 1993, Dabrowska et al., 1981). Cattle can also distinguish different odours, and will baulk at the smell of blood and offal, which is an important fact for the stockmen to know when moving cattle through the race in to the stunning pen (Blackshaw, 1986, Grandin, 1980). Therefore, any blood which is spilled in the stunning pen should be washed away before moving the following animal in-to the pen. Another factor may be that animals are able to communicate through scent marking which has the advantage of allowing one individual to leave a signal for another individual without having to be present (Franklin & Hutson, 1982b); it has been shown that sheep are able to distinguish between individuals using a range of secretory and excretory products (Baldwin & Meese, 1977).

Lighting levels play an important factor in the ease of movement of animals. Cattle are hesitant to move into a dark area from a light area and are best moved through diffuse light to prevent the creation of shadows and areas of contrast (Blackshaw, 1986).

Lighting can be used to illuminate the floor however it must not shine or reflect back into the eyes of approaching animals, which would cause the animal to baulk (Grandin, 1990). During experiment 2, the light levels were increased and great care was taken to angle the lighting in order to prevent or reduce shadows and reflections. The addition of artificial light in the stunning area greatly improved the amount of light within the race leading to the stun box and within the stun box. However, as previously discussed, this may have caused some shadowing and reflections within treatment 1, the mirror. There was also light shining beneath the base of the side ejection door of the stun box from the slaughter-hall, which may have caused animal’s to baulk to investigate the light source. This is not only counterproductive to the ease of cattle movement into the stun box but also to the accurate placement of the captive bolt gun and may result in ineffective stunning (Wotton, personal communication).

Another factor is the noise levels within the slaughter hall, which is adjacent to the stun box to permit quick and straightforward access for shackling and slaughter. There are several noise sources, which are a cause for concern such as the high frequency sound produced by the venting of pneumatic machinery, e.g. from the pneumatic ram used to control the side ejection door of the stunning box and from within the slaughter hall itself. The clanging of metal gates within the lairage and race ways, and also the high volume of a radio from the slaughter hall can all contribute to stress in cattle. Noise can be a stressor to all animals and can be significantly greater with cattle than with humans, due to the increased hearing range of cattle at higher frequencies (Dalton & Kilgour, 1984). Sudden and unexpected sounds or impulse sounds, such as banging gates, machinery and people shouting, are thought to elicit a fear response in cattle (Waynert et al., 1998). Pearson et al. (1977) showed that animals that were slaughtered under a quiet environment in an abattoir produced lower levels of blood cortisol compared to those slaughtered in a noisy commercial abattoir. Similar results were also found in cattle showing that animals were more vocal and stressed in noisy environments and in response to poor handling (Weeks et al., 2009). It may therefore be beneficial to reduce the noise emitting from within the slaughter hall through the use of baffles such as curtains. Rubber padding can be implemented to reduce the level of noise produced from the clanging of metal gates (Waynert et al., 1998) and piping the air outside the building as a solution to the problem of pneumatic vents (Wotton, personal communication).

During the initial experiment a ventilation fan was mounted towards the front-end of the stun box attached to the ceiling for the benefit of the slaughterman. This may have impeded cattle entry as its is known that cattle will baulk at the entrance to the race and stunning box if there is air blowing towards them such as from ventilation vents or openings between the slaughter hall and the lairage (Grandin, 1996a). There was also a step at the entrance to the stun box as shown in figure 2, which prevented the majority of animals from taking the final step in-to the stun box and thus resulted in many animals which may have originally been scored as a 2 (for the ease of movement into the stun box), receiving an application of the electric goad and therefore producing a score of 4.

Conclusion

The results concluded from these experiments suggest that treatment 3, the picture of a horizon, may have improved the movement of cattle into the stun box. The results suggest a reduced number of electric goad applications and an improved overall ease of movement with this treatment. The picture of the horizon significantly improved the orientation of the animals head to aid accurate captive bolt position and significantly reduced non-social vocalization and tail swishing. Tail swishing in horses and cattle when no flies are present is a recognisable behavioural sign in grazing animals which can relate to the amount of stress or fear the animal is experiencing; the speed of tail swishing increases as the animal becomes increasingly agitated (Grandin, 2010b). Non-social vocalisation can be a measure of stress as an indicator of poor welfare (Grandin, 1997). However, there was not a large difference in the time taken to enter into the stun box between treatments and between the treatments and the control.

This study suggests that the raceway leading to stunning pens can potentially be designed based on the behavioural principles of animals to improve their individual welfare, which should remove of the need for excessive coercion. However, it is still vitally important for the stockmen to have a full understanding of the natural behaviour and tendencies of the species entering the lairage in order for animals to be calm, as calm animals are easier to handle and move (Grandin, 2010a). The training and education of personnel and stockmen can be enforced to improve the awareness of animal welfare, behaviour and handling as well as the link between improving welfare and meat quality, which has significance to the meat industry (Broom, 2005). The factors which will impede animal movement can cause increased stress and excitement in cattle and can result in bruising of the carcass; these are major failures in the design of the handling facilities, race and the animal handling of the stockmen (Grandin,1996b).

Further improvements

The study was conducted over a period of two days, with the trial being conducted on one day and the experiment on the other. It may have been beneficial to spread the experiment over a few days to obtain a balanced number of clean (under 72 months old) and over 72 month old cattle to compare the animal's response to the treatments as well as comparing ex-dairy cattle with beef breeds. There may have also been an effect of the time of day due to the fatigue of the lairage personnel and slaughterman, which may have affected cattle behaviour and movement. It may therefore be beneficial to conduct the experiment over a number of days at set times to compare the effect of the time of day on the movement and responses to treatment groups.

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