Acta Scientific Veterinary Sciences (ISSN: 2582-3183)

Volume 2 Issue 7 July 2020

Research Article

Assessing the Effectiveness of Acoustic Enrichment for 'Settling' Sanctuary Hens

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Received: April 17, 2020

Published: June 17, 2020

Abstract

The aim of this study was to establish whether certain forms of acoustic enrichment improve settling behaviour in laying hens to a greater extent than others. Based on acoustic enrichments previously applied to captive animals, three acoustics were involved: classical music, white noise and radio. Due on previous findings, it was hypothesised that hens would display more settled (inactive) behaviour when exposed to classical music than when exposed to white noise or radio. It was also hypothesised that hens would display more settled (inactive) behaviour when exposed to white noise than to radio, due to its unpredictable nature. Testing involved one group of 15 laying hens in a Northern Ireland hen rescue centre. Hens were exposed to randomised acoustics (including a control) for 30 minutes, during four consecutive per week, for four consecutive weeks. Video observations were used to assess the level of active and inactive behaviour during exposure as well as overall settling time. No statistically significant results were found in three of four observed behaviours; perching, preening on the perch, lying/sitting on the perch. However, findings appeared to indicate less activity in hens during exposure to white noise, compared to classical music and radio. Therefore, the first hypothesis was rejected. In contrast to expectations, this study appeared to provide support for previous theories of species-specificity regarding classical music. A statistically significant result was found for standing behaviour on the perch which provided support for the second hypothesis. Post-hoc analysis indicated that a higher proportion of observed hens displayed standing behaviour during radio exposure, compared to the control ($p = .012$). This allowed the second hypothesis to be accepted as hens generally appeared to display less active behaviour overall during exposure to white noise, and statistically more active behaviour during radio exposure. Somewhat conflicting findings emerged in regards to overall setting. 80% of hens settled in a shorter time during radio exposure, than during exposure to white noise. This was also the case when measured at 90%. Although this finding was insignificant it highlights a need for further, more precise research.

Keywords: Feather Pecking (FP); Acoustic Enrichment; Sanctuary Hens

Introduction

In non-cage commercial laying hen systems, unsettled social and behavioural issues such as aggression and feather pecking (FP) are common. Contributed to by modern issues such as confinement and overcrowding, normal behaviours such as pecking are often redirected and this can cause welfare issues for the hen itself as well as others in a flock. Issues such as thwarted feeding can also transpire into negative behaviours such as displacement preening, pacing and gakel-calling [1]. The European Commission council directive (1999) currently in use allows for 9 hens per m^2 which can be considered in relation to why confinement issues may give rise to unsettled behaviours. Given that the amount of space used for common behaviours such as turning, stretching, wing flapping, preening and ground scratching range from around 540 cm^2 to 1980 cm^2 [2] 9 hens per m^2 is restrictive to the extent that hens are unable to express common behaviours. Therefore, stocking density alone could be assumed to give rise to FP and other issues. Scientific evidence, however, is conflicting in relation to the extent to which stocking density alone contributes to such issues.

High stocking density has been repeatedly linked to an increase in FP [3,4] over time. Outdoor range use has also been linked to a reduced risk of FP [3,5] which could be said to contribute to lower stocking density levels within housing areas. However, in some cases higher instances of FP and aggression have been reported in low density flocks (7 birds per m^2) compared to more densely housed groups (12 birds per m^2) as well as more preening and allopreening

[6]. Further evidence supports this, with various studies suggesting that larger flocks generally have lower aggression than small flocks [3,7]. This suggests that it is not only group size which effects hen welfare but other elements of confinement.

Various methods of enrichment for improving the welfare of captive laying hens have been applied over time in line with the behavioural needs of the hen. Corresponding directly to their common behaviours, enrichments aim to provide a similar environment to that of nature. For example, laying hens express a desire to work for food rather than being fed freely by an owner [8] therefore feed may be scattered. Perches are also a common form of enrichment given the natural desire of a hen to find higher ground to avoid predators. Hens express a willingness to work to gain access to a perch at night [9] and have been found to spend up to 100% of their time perching during the night [10]. This represents a psychological need for enrichment alongside basic needs such as comfort and food. Arguably, there are many psychological influences which may have an effect on how successful such forms of enrichment may be.

In both a commercial and sanctuary setting, noise issues may affect the level of effectiveness of enrichments. In commercial farming, hens are likely to be exposed to high levels of chicken related noise due to higher stocking density, whilst sanctuary hens may be exposed to both familiar and unfamiliar noise caused by humans or other animals. This has been considered in modern research. Hens exposed to background noise (chickens vocalisations and fan noises) as well as noises which may be more unsettling (truck, train and airplane noises) have been found to have significantly higher heterophilia than those exposed only to background noise [11]. This represents a stress response using the heterophil/lymphocyte ratio as a measure. Hens in the truck noise group also displayed longer tonic immobility, which is an indicator of vigilance, or unsettled behaviour. From this it can be assumed that exposure to noise can affect multiple aspects of welfare in laying hens, particularly in a sanctuary setting. As animal sanctuaries are often in the countryside and hold a variety of animals, such as dogs, it is extremely likely that noises such as tractors or dog barking will arise. The use of acoustics in combating this has recently received attention. It is unclear at this time, however, whether the provision of acoustics acts as an enrichment in itself or provides a form of distraction from other stressors. Nonetheless, the use of acoustics may be a necessary and helpful step in support of laying hen welfare moving forward.

Classical music

Whilst noise stimulation has been historically linked to increases in activity [12], modern evidence suggests that certain acoustic enrichments can have the potential to improve welfare. Classical music in particular has been repeatedly examined and linked to a reduction in stereotypical behaviours which are considered harmful to welfare. Zoo gorillas, for example, express more behaviour typically associated with relaxation and fewer behaviours typically associated with stress when exposed to classical music than gorillas who are not [13]. This is the case even in comparison to exposure to more naturalistic sounds. Asian elephants also present less stereotypical behaviours (weaving, pacing) when exposed to commercially available classical music such as Mozart compared to those who are not [14]. Mozart in particular has also been found to improve maze learning in rats compared to white noise and silence [15]. Captive animals (particularly laboratory and zoo) however, are undeniably pre-disposed to negative welfare due to circumstances, therefore it is important to consider how successfully acoustic enrichment can be applied in differing settings. Sanctuary animals, such as dogs, respond well to classical music. It has been found that within two days of exposure rescue centre dogs appear more relaxed when exposed to classical music compared to silence [16]. Similarly, dogs exposed to classical music have been found to sleep more and vocalise less compared to those who are exposed to other acoustics such as heavy metal [17], with pop music and human conversation having no effect [18]. Laying hens, in contrast, have previously been found to shake their heads more and preen less when exposed to classical music compared to those who are not [19]. This represents conflicting findings regarding the use of classical music.

White or background noise

Higher tonic immobility has been recorded in hens exposed to classical music combined with background noise (chicken vocalisations and fans, control) than background noise alone [11]. Various conflicting arguments can be made with regards to this study, however most studies agree that responses to classical music may be species-dependant [20,21] or that loudness or intensity of the acoustic may have an effect [22]. Background style noise has however been linked to increased calmness. For example, macaques exposed to white noise have been found to be calmer during blood collection than those who were not [23]. From this it has been suggested that controlled sound such as white noise may be less likely to cause stress than uncontrolled sound [24] such as music. However, conflicting theories contrast this theory entirely and suggest that exposure to acoustics of a complex nature can give rise to welfare benefits.

Radio

Listening to the radio provides an element of complexity and unpredictability that music or white noise alone may not. Variation between human voices, sounds and music genres could contribute to improved learning and awareness. Furthermore, hearing human voices on a radio could lessen stress during handling and improve human-interaction. In this sense, radio listening could act as a form of conditioning. Stereo music has indeed been found to have significant positive effects, including a reduction in agitation and aggressive behaviour in biomedical research chimpanzees [25] and lower heart rate in singly caged baboons [26]. It is therefore fair to suggest that radio listening may harbour welfare benefits for animals in captivity, however these benefits will likely be capped in environments such as biomedical research and single cage systems. Due to other welfare issues in this environment, such as a lack of socialisation or experiences of pain and suffering it is difficult to assess how successfully acoustic enrichment can be applied in this type of setting. In a sanctuary setting, human conversation and pop music, typical of radio listening, have also been said to have no effect on canine behaviour [18]. Therefore, in laboratory settings it is possible that any sound may be a break from monotony, and the effect may not necessarily be dependant on the type of acoustic. Evidence does however suggest a potential for better handling and human-interaction which could indicate an overall positive effect on welfare.

Current study

This aim of this experiment was to apply the three aforementioned acoustic enrichments: classical music, white noise and radio, in a sanctuary setting. This was carried out with one small group of laying hens in a Northern Ireland battery hen rescue and re-homing centre. In comparison to commercial systems, where laying hens are more likely to experience productivity pressures and associated health issues, the hens in this study were exposed to a relatively positive environment prior to and during data collection, including various positive enrichments within the sanctuary. This included freedom to roam during the day within outer areas, freedom to use perches, straw, and other enrichments. As the level of volume needed to acoustically enrich a larger flock would likely be too high and become a disturbance in itself a small sanctuary flock was chosen to assess the effectiveness of acoustic enrichment as an additional form of enrichment.

As previous research has repeatedly supported the use of classical music it was hypothesised that the hens would display more settled (inactive) behaviour when exposed to classical music than when exposed to white noise or radio. It was also hypothesised that hens would display more settled (inactive) behaviour when exposed to white noise than to radio, due to its unpredictable nature.

Materials and Methods

Animals and housing

The behavioural effects of acoustic enrichment in the form of classical music (cl), radio (r), and white noise (w) were assessed in laying hens. 15 hens within a Northern Ireland battery hen rescue and re-homing centre were observed via 30 minute video recordings during the month of July 2018. Individual differences including age and size were taken into account during observations where necessary. One housing area (10 ft 6 x 16 ft) was used throughout data collection during which existing forms of enrichment remained the same. This included: perch availability, bedding type, ventilation, available floor space, stocking density, and lighting. Sunlight entered housing via one window (2 ft x 2 ft). One centralised light bulb fixture inside provided further lighting, which was turned on during data collection. Hens were closed inside housing at 18:30 each evening. Camera placement and acoustic enrichment commenced at this time to minimise disturbance.

Design

16 video recordings were taken via a Toshiba Camileo X-sports camera on four consecutive days (Tuesday-Friday) during each week of July 2018 between 18:30 and 19:00. The camera was mounted on the light switch fixture beside the housing entrance door using a flexible tripod (See appendix A). A pilot study presented this as the camera position with the most suitable lighting. This view enabled observation of the entire housing area including perches and ground space below. Acoustics were supplied using an IPhone 6 set to the European Union recommended volume maximum (85db). The IPhone will be placed upon an inner window ledge, speaker side up.

Materials

Acoustic materials used:

- Classical music - Piano Concerto No. 21 in C, K. 467: 2. Andante By Wolfgang Amadeus Mozart (Stephen Kovacevich, London Symphony Orchestra and Sir Colin Davis)
- White noise - White noise For Deep Sleep by White noise (ITunes download)
- Radio - BBC Radio 1
- Control - No acoustic.

Treatments

Treatments were applied randomly for counterbalancing purposes as follows:

Week 1

- Day 1 white noise
- Day 2 control
- Day 3 classical
- Day 4 radio.

Week 2

- Day 1 control
- Day 2 classical
- Day 3 radio
- Day 4 white noise.

Week 3

- Day 1 radio
- Day 2 classical
- Day 3 white noise
- Day 4 control.

Week 4

- Day 1 classical
- Day 2 white noise
- Day 3 control
- Day 4 radio.

Measurements

Behaviour was assessed via observation of video footage. Four scan observations were taken of each 30-minute recording (at 0, 10, 20, 30 minutes). Each recording was used to establish a fixed observation of the number of hens present and the proportion of hens visible or not visible on camera. Visible hens were then scanned using a behavioural ethogram adapted from previous studies (See table 1). This included active and inactive behaviours such as the number of visible hens who are perching or not perching. The time taken for the majority of hens to settle (become inactive) was also separately collected for each video recording. Two times were noted; the times at which 80% and also 90% of the hens displayed settled (inactive) behaviour.

Data collection

At the planning stage, the intention of this study was to compare a larger number of hens by way of independent groups in separate houses. Due to time constraints and a lack suitability in groups, the use of independent replicates was not physically possible. Therefore, data from differing weeks served as replicates to enable statistical analysis. Scan observations were primarily noted using excel then transferred and analysed using IBM SPSS statistics 25. Upon completion of data entry, five ethogram items (eating (G), drinking (G), dustbathing (G), socialising (G/P) and other (G/P)) were removed from further analysis as no observations were made of these activities. Small data entries were collected for three behaviours (vigilant (G/P), ground pecking/foraging (G), and preening (G) therefore these were discussed manually within results. Of the remaining observable behaviours collected, four yielded data suitable for analysis, all of which were on the perch (P). These were: perching, lying/sitting (P), standing (P) and

Behavioural state	Behavioural activity	Definition (referenced where applicable)	Ground(G)/Perch (P)
Inactive	Perching	Hen in upright perching position with no other behaviour evident.	P
Inactive	Lying/sitting	Hen in resting position with no other behaviour evident.	G/P
Active	Standing	Bird appears alert [27].	G/P
Active	Drinking	Drinking of water from the water dispenser [27].	G
Active	Eating	Beak touching feed in the trough [27].	G
Active	Preening	Grooming, the beak is run through the feathers [27].	G/P
Active	Vigilant	Head is above the back and the beak is horizontal or angled upwards (not engaged in other active behaviours [28].	G/P
Active	Dustbathing	Pecks and scratches at the dust bath area, then squats down and follows an organized sequence of behaviour patterns such as head rubbing and vertical wing shaking [29,30].	G
Active	Ground pecking/ foraging	Pecking of floor or other areas (not feather/social)	G
Active	Socialising	i.e. 'feather pecking/forceful pecks [31], aggressive/submissive acts or sexual related activities [32]	G/P
Other		Any behaviour not listed.	G/P

Table 1: Ethogram of observed behaviours [33].

preening (P). Settling behaviour was analysed separately based on the time, in minutes and seconds, at which 80% of hens were settled (inactive) and also 90% of hens were settled (inactive).

Data assumptions

The assumptions of the chosen statistical test (1 Way between groups ANOVA) were as follows; the independent variable should be categorical, the dependent variable should be interval/ratio, residual scores should follow an approximately normal distribution, groups should have approximately equal variances. The independent variable (acoustic) was categorical and the dependent variable was ratio. Normality of data was assessed through inspection of histograms which showed that residual scores followed an approximately normal distribution. For preening, all assumptions were met. However, homogeneity of variance testing (Levene's test) showed that data did not have approximately equal variances for three of the four dependant variables: lying/sitting (p = .020), perching (p = .001), standing (p = 0.48). Therefore, Krustal-Wallis tests were carried out for these three items. All ANOVA assumptions were met in settling data at 80% (Levene's test = .849) and 90% (Levene's test = .678). A significance level of p = .05 was used for all tests.

Results

Observed behaviour

The proportion of visible hens who were perching whilst exposed to white noise (M = 10.62, SD = 2.66) and radio (M = 10.56, SD = 1.86) was numerically higher than the number of hens who were perching during exposure to classical (M = 9.75, SD = 3.04) and the control (M = 9.00, SD = 2.33) (See figure 1). However, no statistical difference was found between the four types of acoustic in perching behaviour, H (3) = 6.81, p = .078.

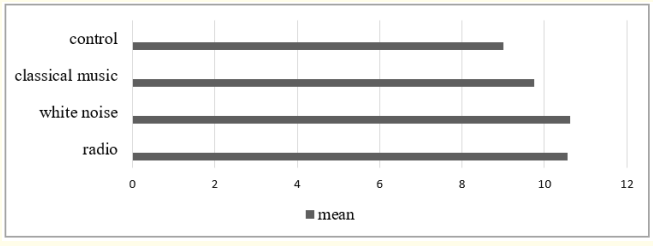

Figure 1: Mean proportion of visible hens that were perching, grouped by acoustic

A statistically significant difference was found between the four types of acoustic for standing (P) behaviour, H (3) = 10.90, p = .012. Of visible hens that were perching, the proportion that were standing in the radio (M = 6.12, SD = 2.50), classical music (M = 5.63, SD = 2.10) and white noise (M = 5.56, SD = 3.28) category, was much higher than the control (M = 3.31, SD = 1.82) category (See figure 2). However, post hoc analysis (Tukey's) indicated that the only significant difference lay between the radio and control category at the adjusted level of significance (p = .012).

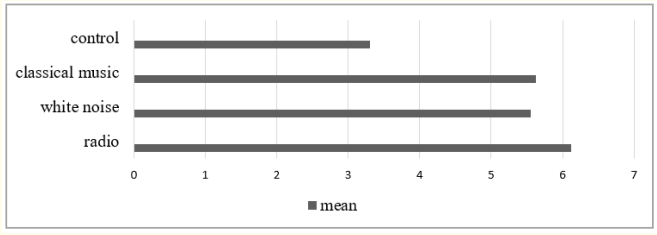

Figure 2: Mean proportion of visible hens that were perching, grouped by acoustic.

No statistical difference was found between the four types of acoustic in lying/sitting (P) behaviour, H (3) = 6.65, p = .084. However, of visible hens that were perching, the proportion which were lying/sitting in the control (M = 5.81, SD = 1.97) and white noise category (M = 5.06, SD = 2.62) was notably higher than the radio (M = 4.38, SD = 2.40) and classical (M = 4.13, SD = 1.75) category (See figure 3).

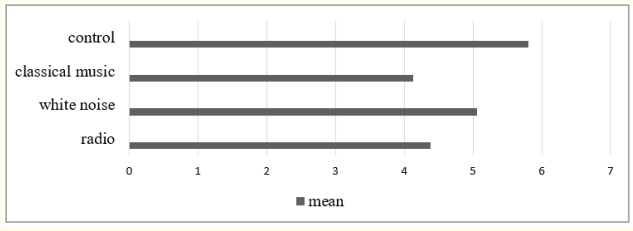

Figure 3: Mean proportion of visible hens lying/sitting on the perch, grouped by acoustic.

No significant difference was found between the four types of acoustic in preening (P) behaviour, F (3, 60) = .158, p = .924. Of visible hens who were perching, the proportion of hens who were preening varied very little between acoustic categories with preening occurring only slightly more in the radio (M = 1.86, SD = 1.03)

and white noise (M = 1.50, SD = 1.32) categories than in the classical music (M = 1.37, SD = 1.08) and control (M = 1.38, SD = 1.13) category (See figure 4).

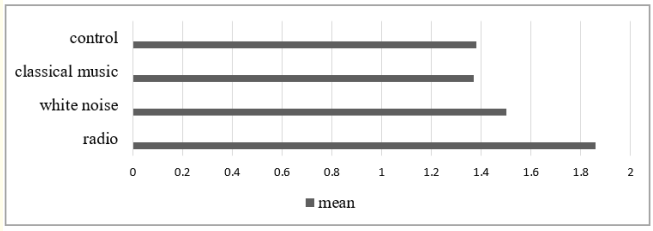

Figure 4: Mean proportion of visible hens preening on the perch, by acoustic group.

Settling behaviour

No significant differences were found between the four acoustic categories in settling behaviour. 80% of visible hens appeared to display settled behaviour in a shorter time (mm.ss) in the radio category (M = 12.49, SD = 6.84) compared to all other categories (See table 2). However, an ANOVA indicated that this result was not significant, F (3, 12) = .340, p = .797. This was also the case when observing the time it took for 90% of the hens to display settled behaviour, F (2, 13) = .872, p = .483. Here, the radio (M = 15.55, SD = 10.34) and white noise (M = 16.27, SD = 4.72) categories displayed noticeably shorter times than the classical music (M = 20.44, SD = 6.78) and control (M = 23.28, SD = 8.23) categories, although insignificant.

Acoustic	Mean time (minutes)		Standard Deviation	
	80%	90%	80%	90%
Control	16.50	23.28	7.36	8.23
Classic	15.67	20.44	4.44	6.78
White noise	14.50	16.27	4.67	4.72
Radio	12.49	15.55	6.84	10.34

Table 2: Acoustic means and standard deviations for settling behaviour (80% and 90%).

Other behaviour

The data collected for the ethogram items deemed unsuitable for analysis; vigilant (G/P), ground pecking/foraging (G), preening (G), did not appear to provide any further enlightenment in addition to the main analysis. Incidences of visible vigilance on the perch were higher in the classical music (7) category than in the radio (3) or white noise (1) categories. There was only one display of vigilance on the ground and this was in the radio category. Ground pecking/foraging occurred most in the white noise category (8), followed by the classical musical and control category (4). 3 incidences of ground pecking/foraging occurred in the radio category. Preening (G) occurred once in the white noise category, and three times in the control category.

Discussion and Conclusion

Although the use of classical music has previously been shown to increase relaxation and reduce stereotypical behaviours in captive animals [13,14,16] this study did not support this. This study presented findings fitting to previous hen-specific studies which link exposure to classical music to increased movement and less preening [19]. In the current study, preening occurred less in hens exposed to classical music, compared to all other types of acoustic, including a control. This suggests not only that classical music exposure does not have a positive effect on behaviour but that it may have a negative effect. Lying/sitting also occurred less when hens were exposed to classical music compared to other acoustics which provided further support, however findings for overall settling time conflicted with this result slightly. Of the three types of acoustic, hens exposed to classical music settled slowest, however this was faster than in control settings. Therefore, there can still be debate regarding the use of classical music for settling or relaxation purposes. Taking the limitations of this study into account, such as sample size, provides room for discussion. The small sample size used on this occasion is unlikely to provide a true representation of laying hens on a wider scale, thus explain the insignificance of the majority of the findings. Furthermore, although this study may lend support to theories that responses to classical music may be species-specific [20,21] it does not provide and understanding of how or why. Therefore, further research is necessary in this area. Nonetheless, the first hypothesis (that hens would display more settled behaviour when exposed to classical music than when exposed to white noise or radio) was overall rejected.

The second hypothesis (that hens would display more settled (inactive) behaviour when exposed to white noise than to radio, due to its unpredictable nature) could be accepted. Hens exposed to white noise displayed various behaviours associated with settling. During exposure, hens displayed the most perching overall as well as the most sitting/lying behaviour (significantly least standing) compared to other acoustics, as well as during the control. Given that lying/sitting is the most inactive state possible, this is the most compelling finding and provides support for previous research [23,24] which considers white noise to have a calming effect. As radio and classical music are more commonly used in practice,

likely due to availability and familiarity in human use, increasing evidence of successful use of white noise may influence an increase in its use in practice. This was ultimately the goal of this study, to aid the development of welfare supporting enrichments. However, as there were various limitations regarding the current data, such as sample size, findings may only be relevant to small sanctuary flocks. Larger group studies, with independent samples, would be preferred for future research.

Although the use of white noise appeared to positively influence inactive behaviour, radio listening still appeared to have an effect on settling behaviour. Overall, the analysis performed solely for settling showed that hens settled in less time when exposed to radio, followed by white noise. Again, conflicting findings are likely due to sample limitations, however, this provides a window for further debate. In this case, this result may have occurred as the sanctuary hens are more accustomed to human voices due to the hands-on nature of the sanctuary owner. However, it is possible that the complexity of radio listening provides more elements of cognitive stimulation than other acoustics which could then give rise to quicker resting. For example, a human who reads a book before bed may feel tired faster as they have focused more on a book than perhaps they would a television. The same could arguably be applied to radio versus white noise. Given that the most standing and preening occurred during radio exposure, followed by the fastest settling, arguably, this could be the case. Future research could perhaps investigate this further using music followed by forms of cognitive testing.

Future research could also apply this type of study on a much larger scale using acoustic tracking during video recordings to pin-point which elements of sound elicit different behaviours. This would allow for more precise results. However, there may be drawbacks involved in using a larger group. In a small sanctuary setting, human voices are, arguably, more likely to be perceived in a positive way than in a larger or commercial setting. Human interaction is likely to be less common and less positive in such settings, therefore it would be difficult to apply radio acoustics without accounting for this. As discussed previously, stocking density may also have an impact on all behaviour and influence behaviour beyond enrichments. Whereas, in this study, there were various other factors which may have significantly impacted the result. During data collection, there were numerous occasions when other animals (dogs, ducks, geese, pigs) close to the hen house caused noise which may have disturbed the hens, thus effecting findings. For the duration of two of the sixteen recording sessions, nearby fields were being harvested, which resulted in extremely high levels of tractor noise. Therefore, neither sanctuary nor commercial housing can offer an ideal research base. This study did, however, provide a helpful insight in moving forward and bettering the behaviour and therefore welfare of laying hens [34].

Acknowledgements

With thanks to Niamh O'Connell (project supervisor) of Queen's University, Belfast for her support and guidance throughout the planning, execution and reporting stages of this study, and to Barbara Mladek, of the Northern Ireland battery hen rescue and rehoming centre, for her hospitality, knowledge and support throughout the data collection process.

Appendices

Appendix A: Housing representation.

Figure

X represents camera placement.

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