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Project identification

1. Defra Project code: AW1402a
2. Project title: Studies to assess the effect of pet training aids, specifically remote static pulse systems, on the welfare of domestic dogs; field study of dogs in training
3. Contractor organisation(s): University of Lincoln
4. Total Defra project costs (agreed fixed price): £ 69,925
5. Project: start date .... October 2010
   end date .... June 2011

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Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

The project had a single aim, namely to assess the impact of use of remote static pulse electric training aids (e-collars) during the training of dogs in comparison to dogs referred for similar behavioural problems but without e-collar training. The specific objective was to use appropriate behavioural and physiological measures to make inferences about the welfare of subjects including their aversion and anxiety during and following training. A secondary objective was to evaluate the efficacy of treatment and possible explanations for any differences between treatment groups. These included owner assessment of severity of problem, population characteristics, trainer factors and temperament of dogs. The study design was developed following consultation with trainers to ensure a protocol that was representative of advised best practice in use of e-collars. Adult dogs (n=63) undergoing training by professional trainers were recruited to investigate the welfare consequences of behavioural modification incorporating e-collars, in comparison to positive reward based training. Dogs had been referred for problems commonly addressed using e-collars (recall problems and livestock/wildlife worrying) and were divided into three populations; one using e-collars and two control populations where dogs were not exposed to e-collars. Treatment groups were defined as follows

Group A: E-collar group (N = 21) ECMA recommended trainers with experience of use of e-collars, using e-collars as part of their training programme.
Group B: Control 1 (N = 21) ECMA recommended trainers with experience of use of e-collars, **not** using e-collars as part of their training programme.
Group C: Control 2 (N = 21) APDT affiliated trainers who do not normally use e-collars in training, **not** using e-collars as part of their training programme.

Methods Behavioural and physiological data that can be related to a dog's emotional state were collected to assess immediate impact of exposure to e-collar stimulus in comparison to the control groups, as well as adaptation during training procedures. This included field observations of behaviour, cortisol samples from saliva and urine, judgement bias tests and questionnaires relating to impulsivity and temperament. Pre-training data were collected to assess if there were significant differences in treatment groups prior to training and follow up assessments were conducted 3 months post training to assess longer term welfare consequences of training methods and their efficacy. Dogs were allocated to treatment groups to control for the nature of referred problem and owner assessment of severity.

During training, data were collected over a period of up to 5 days covering the period of initial behaviour modification. For Group A, dogs' training regimes followed recommended practice for resolving the problem under referral as advised by e-collar manufacturers. Trainers used e-collars with a variable intensity setting and a pre-warning cue which, with time, would allow dogs to modify their behaviour to avoid exposure to the e-collar stimulus. Dogs in this group had the working level of e-stimulus determined on day 1 of training. On subsequent days non-compliance with tasks was associated with exposure to e-stimulus. The pre-warning stimulus was used to predict potential application of e-stimulus if the dog did not respond appropriately. Dogs in this group also received positive reinforcement such as food, play or praise for compliance. Dogs in control groups B and C followed training regimes without exposure to e-collar stimulation. Dogs in these groups wore a dummy collar (de-activated e-collar) to control for collar wearing and ensure observers of video tapes were blind to treatment. On the final training day, dog owners conducted the training under instruction from the trainers.

Following completion of training, owners were surveyed for their assessment of the ease and efficacy of the training programme. At three months post-training, owners returned to the training centres and took dogs through a series of training commands including the recall command that they had been trained to follow. Dogs' behaviour was video recorded and saliva samples taken on first arrival and following training with and without a deactivated collar.

Results There were no differences in the reasons for referral between dogs in the three groups or their owner's assessment of the severity of the referred problem. Data collected prior to training days found no differences between the treatment groups in dog's performance in cognitive bias tasks or in their temperament and impulsivity scores. There were no day effects on behaviour except more owner directed behaviour on final day of training.

Dogs in groups A and B spent roughly half of their time walking during training, whilst dogs in group C spent more time standing and spent less time sitting during the training sessions than dogs from groups A and B. Group C dogs also showed more food related lip licking than the other treatment groups. Dogs in group C engaged in more environmental interaction such as sniffing, than dogs from Groups A and B and were less often observed yawning than Group A dogs. These treatment effects were found to be significant following Holm-Bonferroni correction for multiple comparisons. Dogs in group C may have spent less time tense during training sessions (4% of scans) than dogs in groups A (25%). Dogs from group C may have had their tail in a low position

less often (0.8% of scans) than dogs from groups A (9%) and B (6%) and may have moved away from the trainer less often. Dogs in Group A may also have yelped more (0.5 per training session) than dogs in groups B and C (0.1 per session) and panted more (20% of scans compared with 10%), however these latter measures were not found to have a significant treatment effect at the sample sizes of this study.

Dogs in group C had higher salivary cortisol levels throughout the training period compared to group B, whilst group A dogs' salivary cortisol was no different to groups B or C. There was a decline in salivary cortisol in all groups over the 5 training days, but no difference in the size of this decline between the three groups. There was no significant difference in urinary cortisol:creatinine ratios between treatments and no changes in this ratio over the five days of training for any treatment.

Owners were generally satisfied with the training advice they received, and no differences were found between the treatment groups in owner satisfaction at one week or 3 months post-training. It would appear from owner feedback that spending an extended period of time with experienced trainers handling their dogs was generally beneficial in terms of improving owner's understanding of dog behaviour and training. These measures were however solely based on owner assessment, and an independent assessment of the severity of the referred behaviours by for example a behavioural consultant may have been useful.

During observations on return to the training centre after 3 months, dogs tended to spend more time running (15.7% of scans) and more time excited (25.9% of scans) than in the training days and less time relaxed (24.1% of scans). Activities that might be associated with aversion or anxiety were rare and there were no significant behavioural differences between treatment groups. There were no differences between treatment groups in cognitive bias scores, nor in measures of temperament. None of these measures had changed from the pre-treatment assessments.

There was no effect of treatment on the ratio of urinary cortisol to creatinine at 3 month follow up. Group A dogs showed higher levels of salivary cortisol on arrival at training centre and there was also a decline in salivary cortisol from first arrival at training centre to end of training in all three groups.

Discussion and Conclusions. In previous defra funded work (AW1402) there was evidence that experience of e-collars had long term negative welfare consequences in some dogs from the pet community. However, the retrospective nature of this previous work meant it was not possible to establish a causal relationship. In this study we sought to overcome this limitation and also examine industry recommended practice concerning the use of e-collars in the field. Reason for referral, and severity of referred behaviour were also successfully controlled in this study. It was already known that training dogs with e-collars can have severe welfare consequences (E.g. Beerda et al 1998, Schilder and van der Borg 2004), however, advocates of e-collar training have argued that such studies are not representative of the appropriate use of modern e-collars for correcting behavioural problems, and for this reason this study focussed on the welfare consequences of use of e-collars within industry recommended training protocols compared with reward based training.

Dogs in the three treatment groups were found to be comparable in all measures prior to training with the exception that group C dogs had a higher salivary cortisol measure than group B before experiencing their training programme, which persisted throughout the five training days. There were, however, a number of behavioural differences between the groups observed during training. Some of these appeared to relate to trainer related factors, rather than the use of e-collars. For example, trainers for groups A and B tended to use more commands than those in group C and encourage sitting rather than standing. Dogs in groups A and B engaged in less environmental interaction than Group C dogs and there was some evidence that group A and B dogs also, showed lower tail carriage and moved away more often from trainers than group C dogs. There were, however, differences between behaviour of group A and C dogs of welfare relevance, for example group A dogs performed more yawns during training than Group C dogs and they were more tense, whilst group C dogs engaged in more environmental interaction. The incidence of yelping and panting noted in group A dogs related to high frequencies of these activities in a small number of dogs in this group. Overall these differences in behaviour suggest that some dogs in group A exhibited more negative emotional responses than dogs in Group C, though there were few behavioural differences between group A and group B

At follow up, the only treatment group difference was the higher salivary cortisol level of group A dogs on first arrival at the training centre, which may be related to anticipation of events based on previous experiences. However, this level declined with time and signs of aversion or anxiety were rare on return to the training centres, and not significantly related to treatment group. Dog owners were generally satisfied with the training advice they received, and although numerically a greater proportion of group C owners thought their dogs' behaviour had improved, this was not a significant effect.

The results of this study show that that both the trainers' general approach and the tools they use in training affect the dog's emotional responses to training. It would therefore be of value to further investigate the welfare consequences of the skill levels of e-collar operator as well as the tools they use. Nevertheless the study did find behavioural evidence that use of e-collars negatively impacted on the welfare of some dogs during training even when training was conducted by professional trainers using relatively benign training programmes advised by e-collar advocates.

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:
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   - details of methods used and the results obtained, including statistical analysis (if appropriate);
   - a discussion of the results and their reliability;
   - the main implications of the findings;
   - possible future work; and
   - any action resulting from the research (e.g. IP, Knowledge Transfer).

STUDIES TO ASSESS THE EFFECT OF PET TRAINING AIDS,
SPECIFICALLY REMOTE STATIC PULSE SYSTEMS,
ON THE WELFARE OF DOMESTIC DOGS

FINAL REPORT ON DEFRA PROJECT AW1402A

PREPARED BY:

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Overview

This study aimed to assess the welfare of dogs trained with pet training aids, specifically manually operated remote static pulse collar systems (defined as “e-collars” in this report). Studies of dogs in training have tended to focus on sub-populations of dogs such as those trained for police work (Schilder and van der Borg 2004) or model populations of laboratory dogs (e.g. Schalke et al 2007). These populations may not represent the companion or pet dog population and no large scale studies of pet dogs exposed to e-collars during training appears to have been conducted previously. This project builds on the findings of previous work funded by defra (AW1402) which investigated the physical properties of electronic training devices and conducted a retrospective study of the welfare consequence of having been trained with e-collars.

The previous project concluded that: -

“*for a subset of dogs tested, the previous use of e-collars in training are associated with behavioural and physiological responses that are consistent with significant negative emotional states; this was not seen to the same extent within the control population. It is therefore suggested that the use of e-collars in training pet dogs can lead to a negative impact on welfare, at least in a proportion of animals trained using this technique*.”

Due to the retrospective nature of the study, it was not possible to determine if the treatment effects were solely due to exposure to e-collars or related to other treatment related predispositions, such as the severity of the problems that had been the subject of training approaches, or differences in the dog-owner interaction other than these specific training approaches. For these reasons, a longitudinal study of dogs before, during and after training with e-collars and with alternative approaches was conducted. This project is the subject of this report which addresses the single objective:

Investigate the behavioural and physiological effects of using training devices in dogs undergoing training with remote, static pulse training collars

It can be argued that inappropriate use of such devices, for example, failure to link delivery of the e-collar stimulus with clear conditioning stimuli, or poor timing of response and reinforcement, could lead to welfare problems (Klein 2000, Lindsey 2001, 2005) and such practice has been investigated experimentally (e.g. Schalke et al., 2007), to show that they can cause distress if used in this way. However, the use of the electronic training device on pet dogs in accordance with best practice by experienced trainers, has received less attention. By investigating the use of these devices in this context, we aimed to address the question of whether, in the hands of skilled professionals, these devices necessarily result in welfare concerns. Whilst the consequences of poor training techniques and intentional abuse using e-collars or other training tools is also of interest, for ethical considerations the project team did not include the intentional misuse or poor application of e-collar stimuli.

The project sampled adult dogs (over 6 months of age) from dog populations undergoing training by professional trainers. Dogs had been referred for problems commonly addressed using e-collars (for example recall problems and livestock worrying) and were trained in one of three ways; one using e-collars and two control populations where dogs were not exposed to e-collars. Behavioural and physiological data that related to dog's emotional state (e.g. Beerda et al 1997, 1998) were collected during training to assess the immediate impact of exposure to e-collar stimulus in comparison to control groups, as well as adaptation to training protocols. There was also pre-training data collected to assess if there were significant differences in treatment groups prior to training and a follow up assessments of dogs one week and three months post training, to assess longer term welfare consequences of training methods and their efficacy, using methods derived from project AW1402 (Appendix 3).

In addition a pilot study had been conducted during AW1402 to assess the robustness of techniques in the field and to road-test data collection techniques. This involved 8 dogs undergoing training to deter sheep chasing behaviour and one dog undergoing training for recall using e-collars. Data from this study was used in the design of this project and a summary of findings are presented in Appendix 5.

Research Plan - Recruitment of Trainers and Dogs
The study investigated the immediate effects of exposure to training collars in a pet dog training context, using experienced e-collar trainers and compared their responses with dogs presenting with similar behaviour problems for training that does not involve use of e-collars. Data collection focused on behavioural and physiological measures of emotional state before, during and after training. Two experienced dog trainers were recruited with help from The Electronic Collar Manufacturers Association (ECMA) to train dogs in treatment groups A and B. Equal numbers of dogs were allocated to treatment group A and treatment group B, with each trainer then working with half the dogs in each treatment group. For treatment group C, two trainers who did not use e-collars were recruited from a professional training organisation (Association of Pet Dog Trainers; APDT) with similar experience and competence in dog training to trainers used in treatment group A and B. Dogs used in this study had been referred to the trainers for problems related to recall and chasing and data were collected from dogs over a five day training period. Recruited dogs therefore belonged to three groups:

A. E-collar Group. Dogs referred to trainers with problems that might be treated with remote electronic training aids, for whom this option was exercised.

B. Control Group 1. Dogs referred to the same trainers with problems that might be treated with electronic training aids, but were treated using only other training methods.

C. Control Group 2. Dogs referred to trainers who do not use electronic collars with problems that might be treated with electronic training aids.

Prior to allocation to treatment groups a questionnaire was used to collect data on the general characteristics of dogs, their past training history and information on why owners were referring dogs for training. Recruited dogs were primarily selected on the basis of attention and recall related problems (including livestock worrying and wildlife chasing) and were trained for a recall task at distance. The majority of dogs with experience of e-collars in project AW1402 had been trained for recall and/or chasing problems, and the trainers used in treatments A and B commonly used e-collars to address these problems. Dogs with prior experience of electronic training devices were excluded from recruitment in this study. Following assessment for suitability for the study, 63 dogs were recruited with 21 dogs in each treatment group.

The main selection criterion was the reason for referral as it was essential that the control dogs presented similar behavioural problems and similar levels of severity as those dogs exposed to e-collars. In project AW1402, owners who had used e-collars reported their dog's obedience problems to be more severe than the control dogs with no experience of e-collar training. Where possible dogs were to be matched by age, sex and breed. Dogs recruited for treatments A and B were initially randomly allocated to treatment group, but if following interview by research team, owners expressed a preference for or a concern against training with e-collars, they were swapped between groups with a dog with equivalent training problem and severity. This represented a small number of owners (2 pairs representing 4 dogs). For treatment group C, dogs were selected to match dogs studied in treatment group A.

Prior to training, dogs underwent a cognitive bias test (Harding et al 2004, Paul et al 2005) based on that developed by Burman et al (2008) for rats and Mendl et al (2010) for dogs. This test had also been used in project AW1402. Positive and Negative Activation Scores (PANAS) (Sheppard and Mills 2002) and Impulsivity scores (Wright et al. 2011) were also determined via owner survey prior to training.

Dog Training protocols During training data were collected over a period of up to 5 days covering introduction to e-collar and other training stimuli and the period of modification of behaviour. For Group A the choice of collars and precise training regime were determined by trainers using e-collars with a variable setting to allow the operator to determine the level at which the e-collar stimulus is delivered, and a pre-warning cue to allow dogs over time to modify behaviour prior to exposure to e-collar stimulus. Trainers only worked with their preferred make and model of device, which were Sportdog SD-1825E (n = 11) and Dogtra 1210 NCP (n = 10). E-collars were chosen that had both tone and vibration pre-warning cues, however, only vibration cues were used during training to ensure video analysis was blind to treatment.

Dogs' individual training regime was determined by trainer and followed typical practice for resolving the problem under referral (see appendix 1) as advised by e-collar manufacturers (e.g. Petsafe, Dogtra, Sportdog). Dogs in Group A were to have the working level of e-stimulus determined on day 1 of training, whilst on subsequent days non-compliance with tasks would be associated with potential exposure to the e-stimulus, with the pre-warning stimulus used to predict the application of e-stimulus and allow dogs to modify their behaviour accordingly. Dogs in this group also experienced other forms of training including use of positive reinforcement such as food, play and/or praise. Dogs in control groups B and C followed a training programme without exposure to e-collar stimulation and principally used positive reinforcement to shape the behaviour of dogs. Dogs in this group wore a dummy collar (de-activated e-collar) to control for collar wearing and ensure observers of video tapes were blind to treatment (see appendix 2). On the final training day (day 5), the dog owners conducted the training under instruction from the trainers. For a small number of dogs, where trainers felt training had progressed sufficiently, this final owner training day was day 4, and the dogs did not return for a 5th day of training.

Dogs were trained at one of two training centres. Dogs in treatment groups A and B were trained at a farm location near to Edinburgh during Autumn 2010. Dog training initially occurred in a field setting with a small flock of sheep and small flock of poultry were penned in the training field. Following severe weather the training location was relocated to a yard on the same farm with similarly penned animals. Treatment C was conducted at a training centre near Lincoln in Spring 2011, with a field set up to replicate conditions originally used in the Edinburgh training centre.

Data collection included collection of saliva for analysis of short term changes in circulating cortisol (Ligout et al 2008), collection of urine to assess daily changes in cortisol/creatinine ratios and video recording of behaviour. Monitoring of heart rate had been planned using telemetric equipment. During piloting, it was found that equipment could reliably record heart rate on stationary resting dogs, but once dogs became highly active as occurred during recall training, the recording became unreliable. As it would require repeated interruption to the training bouts to maintain contact, it was decided to discontinue heart rate recording.

Each training sessions lasted approximately 15 minutes and each dog received two training sessions per day, one in the morning and one in the afternoon. On day 1, prior to start of training, early morning/first passage urine sample was collected for assay of creatinine and cortisol. (See appendix 3 for techniques). On arrival at the training centre on the first day of training a saliva sample was taken. Behavioural data was collected by video recording for the full duration of each training session. Ten to fifteen minutes following the second training session of the day a post-training saliva sample was taken on each day. Data was collected in this manner on days 1, 2, 3, 4 and 5 as applicable, with first passage urine samples collected on each day prior to training and saliva samples collected at the end of the day's training sessions. On the final training day there was also a pre-training saliva sample taken on arrival at the training centre. Saliva and urine was stored and analysed using methods described in Appendix 3.

Behavioural Data - Video Analysis Video analysis was conducted by four observers with experience of behavioural recording who were blind to treatments and the objectives of the study. Each observer received training to become familiar with the ethogram developed for this project (Appendix 4) and the data collection protocols, and to allow assessment of inter-observer reliability. Inter-observer reliability was tested by allocating the same videos to different observers at an early stage of analysis. Consistency in scoring was assessed by calculating the correlation co-efficient r for the behavioural categories. Where $r > 0.8$, it was assumed there was good agreement between observer's scores and they were reliably and consistently following the sampling method. Where there were poor agreement ($r<0.8$), observers received further training to address the inconsistencies. This was only necessary for one observer, who following retraining and re-analysis of early tapes was in good agreement with all other observers for rest of data collection. Training videos were allocated so that each observer had similar numbers of dogs from each treatment, although they were also blind to this partition.

Data from training videos was extracted from video tapes using a Microsoft Excel based check-sheet with each video observed twice. The first sampling was an instantaneous scan sample technique where videos were sampled once per minute (up to 15 scans per video). At each sampling point the dog's posture (sit, stand, walk, run), overall state behaviour (relaxed, tense, excited, neutral), proximity to owner, proximity to trainer, tail carriage (high, low), tail movement and panting were recorded. If dogs were out of sight or behaviour could not be determined at the sampling point then each category of behaviour was recorded as unknown.

The second sampling was a continuous sampling of the frequencies of key behavioural events. These included oral activities (yawn, lip licks (with or without food)) and vocalisations. In addition, any time out of view was recorded. This allowed calculation of the frequency of events per minute of time in view for analysis. (See Appendix 4 for Ethograms). Categories used in these ethograms were derived from previous studies investigating anxiety and arousal in dogs (e.g. Beerda et al 1998, Hiby et al 2006, Mills et al 2006, Rooney et al 2007) as well experience of data collection during pilot study and project AW1402 (Casey et al sub).

Follow up Studies In the week following completion of training a second cognitive bias test was undertaken and owners were surveyed for their initial impression of the ease and efficacy of the training programme. A further visit was conducted at 3 months post training. This involved collection of first passage urine, cognitive bias test, PANAS, and observation of dogs during standard training tasks as used in AW1402 (Casey et al sub). This follow up again assessed owner satisfaction and effectiveness of training in the longer term. For the training tasks owners returned to the training centres and took dogs through a series of training commands including the recall command that they had been trained to follow. Dogs were videoed whilst completing the task with no e-collar, with the fitting of the e-collar that had been used in training, and whilst completing the tasks wearing this (de-activated) e-collar. Saliva samples were also taken on first arrival and following training with and without wearing the e-collar (see appendix 3 for methods derived from AW1402). Data from follow-up videos were analysed by a single trained observer, using Observer 9 XT, using the same ethogram to that used in the training videos.

Statistical Analysis Data analysis was completed in SPSS (PASW 17.0) using parametric approaches where appropriate on raw data or following transformation. Rare behaviours seen in less than 10% of dogs were removed from analysis, as were distance to owner and distance to trainer as these could not be reliably assessed for many videos as they were out of frame for long periods. Where data was collected on a single occasion then treatment effects were analysed using one way ANOVA and where data was collected over several phases of study, then a repeated measure design was conducted with dogs nested within treatment used as the between subject variable. However, this was not possible for behavioural data because many measures did not fit the requirements of parametric statistics so it would not be appropriate to investigate within and between subject effects in the same model for all measures. Changes in measures over time (e.g. day of training) were therefore assessed using a repeated measure ANOVA for data that met parametric requirements and Friedman ANOVA for data that did not. In order to assess between treatment effects we calculated total counts of each activity for each dog and analysed this with a one way ANOVA for parametric data or Kruskall-Wallis test for non-parametric data. A post-hoc Tukey test was employed to test for differences between treatments where treatment effects were identified from ANOVAs (or pair wise Mann-Whitney for non-parametric data). Finally for dogs in Group A, although it was not possible to determine the number of applications of electronic stimulus during training, data was available for the device setting at the start of each training session, which allowed analysis of co-variance between behavioural responses and collar settings (controlling for trainer/collar brand) for parametric data and Spearman rank correlation for non-parametric data.

As data analysis included multiple comparisons of related data, correction factors were used to control for Type I errors. For this the sequential correction approach advocated by Holm (1979) was used to take into account the analysis of a large number of behavioural measures. Variables that met this criteria are presented in bold in tables 1 and 2, and described in text as there being a significant effect. As a guard against Type II errors, power analysis was used after data collection to assess the confidence in accepting null hypotheses at the sample sizes used. For this, rather than overlook all variables which did not meet the Holm-Bonferroni correction criteria, those variables that would have met the criteria if the same distributions had been found in a sample of approximately double the size (n = 120, or 40 in each group) are presented in italics in Tables 1 and 2, and are described in the results and discussion as non-significant potential effects.

Results: Sample Population. The average age of dogs used in the study was 46 months (just under 4 years) and there was no difference in age of dogs between the three groups ($F_{2,60}$=0.04, ns). Thirty four out of the sixty three dogs were female (54% of sample), with similar numbers of female dogs in groups A (n=13) and C (n=12), but slightly less in group B (n=9). There was a similar distribution of dogs in terms of sex and neuter status across all three groups and in particular between Groups A and C. Gundogs and cross breeds were the most commonly referred breed types, represented by 16 dogs each or 25% of the sample. The remaining dogs represented pastoral breeds (n=11, 17%), terriers (N=8, 13%), hounds and working breeds (both n=6, 10%). There were no representatives of toy or utility breeds as defined by Kennel Club in the UK. The majority of dogs referred had chasing or worrying as their owner's primary concern (51 dogs or 81% of sample), including chasing sheep/lambs, horses, rabbits, joggers and cars, or a combination of these. These were similarly represented in the three treatment groups. Nine dogs (14%) were referred for general recall problems without the owners reporting any issues with chasing or worrying, whilst three dogs (5%) had owners whose primary concern was aggressive encounters with other dogs whilst off lead. The owners were asked to broadly rate the intensity of the main referred problem as; 1 "Always displayed", 2 "Frequently displayed", 3 "Occasionally displayed", 4 "Rarely displayed" and 5 "Never displayed". The majority of owners rated the problems as either 1 (31 dogs or 49% of sample) or 2 (24 dogs; 38%). Six dogs were rated as occasional, one as rare, and one dog (in Group B) as never showing the referred problem, as the problem had been resolved between referral and recruitment, but the owner had wanted further advice on addressing off-lead problems. An apparently higher proportion of dogs in Group C were described as *always* showing the referred problem (67% of group) compared with 48% of Group A and 33% of Group B, but this did not represent a statistically significant difference in owner rating (X^2 = 4.79, df = 2, p = 0.091).

Data collected prior to training days found no differences between groups in dog's performance in cognitive bias tasks. For example dogs approached the near positive probe at an average speed of 1.59 ± 0.09 ms^{-1} and the near negative probe at 1.22 ± 0.08 ms^{-1}, but there was no treatment effect on either ($F_{2,46}$ = 0.47 ns and $F_{2,46}$ = 0.65 ns respectively). No differences were found between the three treatment groups in scores derived from PANAS and Impulsivity questionnaires.

Behavioural Measures During Training. There were no day effects on dog activity, panting or behavioural state. Dogs in treatments A and B spent roughly half of their time walking during training (Figure 1), whilst dogs in treatment C more commonly stood during the training sessions (Table 1, Appendix 5). As a consequence walking was more common in treatments A and B than treatment C, whilst standing was more common in treatment C than treatments A and B. There were also treatment differences in sitting which was most common in group A and least common in group C (Table 1, Figure 1). There was no difference in tail carriage except there may have been a treatment effect on low tail carriage (K-W = 6.38, p = 0.041) where dogs from group C may have been less likely to have a low tail carriage than dogs in both groups A (M-W W= 507, p = 0.018) and B (M-W W= 479, p = 0.013; Figure 2). No difference were found in high or medium tail carriage between treatments nor in tendency to wag tail (Table 1). Within Group A there may have been a relationship between collar settings and proportion of training session spent sitting, with dogs that sat less receiving higher intensity stimuli (F1,17 = 7.55, p = 0.014).

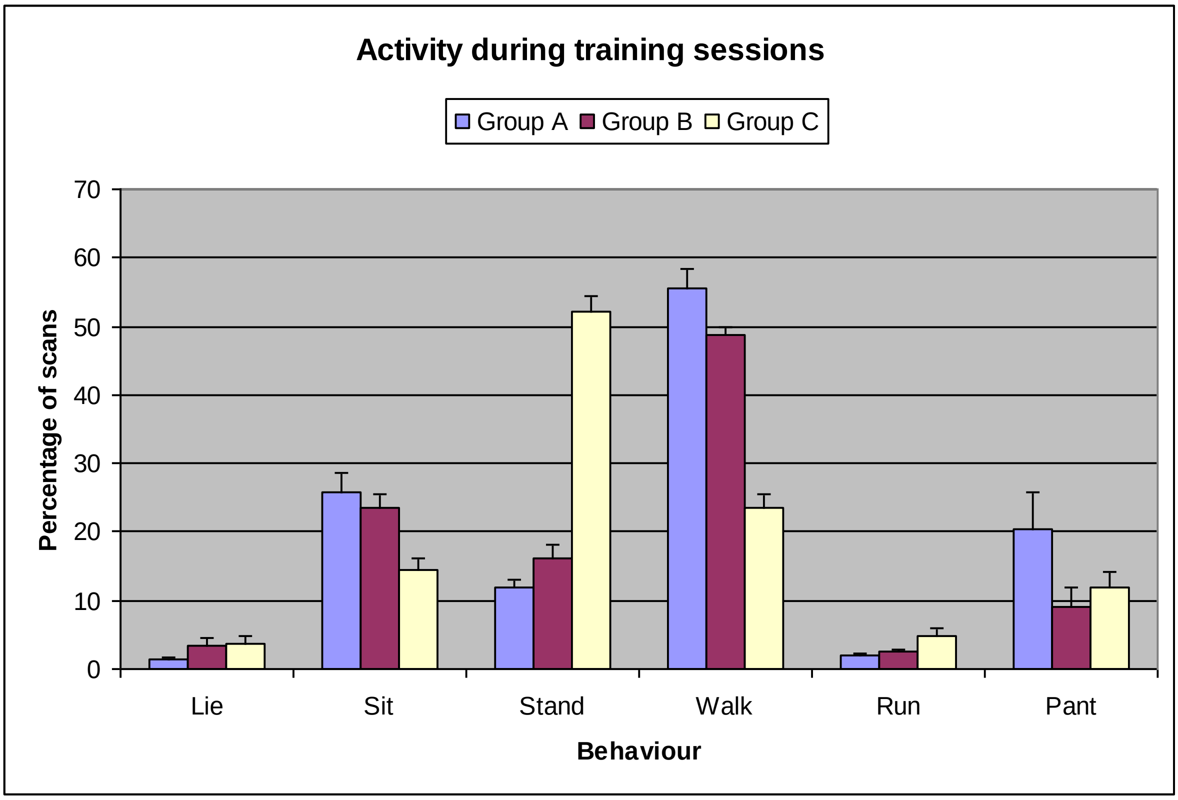

Figure 1 Percentage of scans (mean ± SE) in postures and panting during training for treatment groups A (e-collar) and Control Groups B and C.

Panting appeared to be twice as common in group A dogs (20% of scans) as groups B and C (both about 10%: Figure 1), however, this was not a significant effect. Close examination of the data indicated that that a small number of dogs in group A showed elevated rates of panting (4 dogs were panting in over 50% of scans, compared with none in groups a B and C), but the majority were no different to dogs in group B and C. Exploratory analysis of these outliers found no relationship between panting and other individual traits. There was no evidence of a difference in percentage of scans in the behavioural states relaxed, ambiguous or excited (Figure 2) between the three groups. Potential effects were seen in the tense state ($F_{2,60}$ = 4.99, p = 0.01), as dogs in treatment C spent less time tense than dogs in treatment A (Tukey, t = 3.14, p = 0.007), with the difference between groups B and C non-significant (t = 1.87, p = 0.16). Dogs in group C may also have spent more time in an anticipatory state than dogs in groups A and B Table 1).

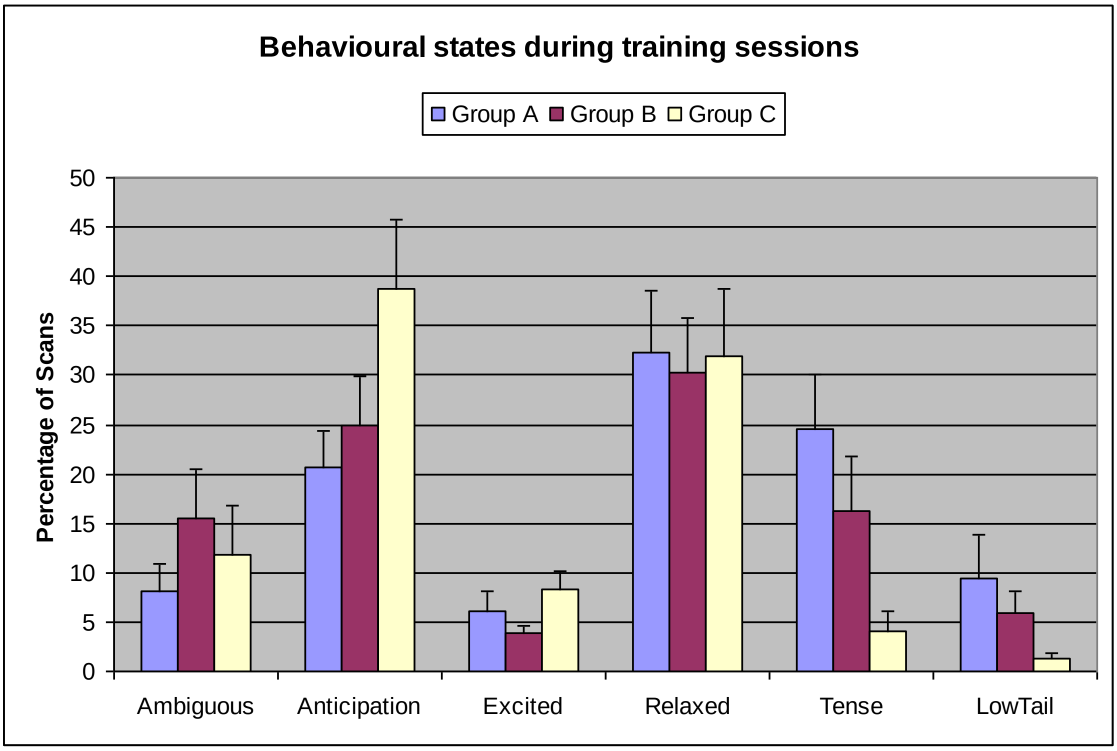

Figure 2. Percentage of scans (mean ± SE) in behavioural states during training for treatment Groups A (e-collar) and Control Groups B and C.

There were no day effects on continuous recorded activities except owner directed behaviour which was more common on the final day of training. There were treatment effects on the rates of a number of activities (Table 2). Overall lip licking was similar between the three training approaches, however, when this was separated between lip licking in association with food, then treatment C dogs showed more food related lip licking than dogs in treatments A and B (Figure 3). In contrast, lip licking when food was not present appeared to be more common in group A and B dogs than those in group C, but was not significant at the sample sizes in this study (Table 2).

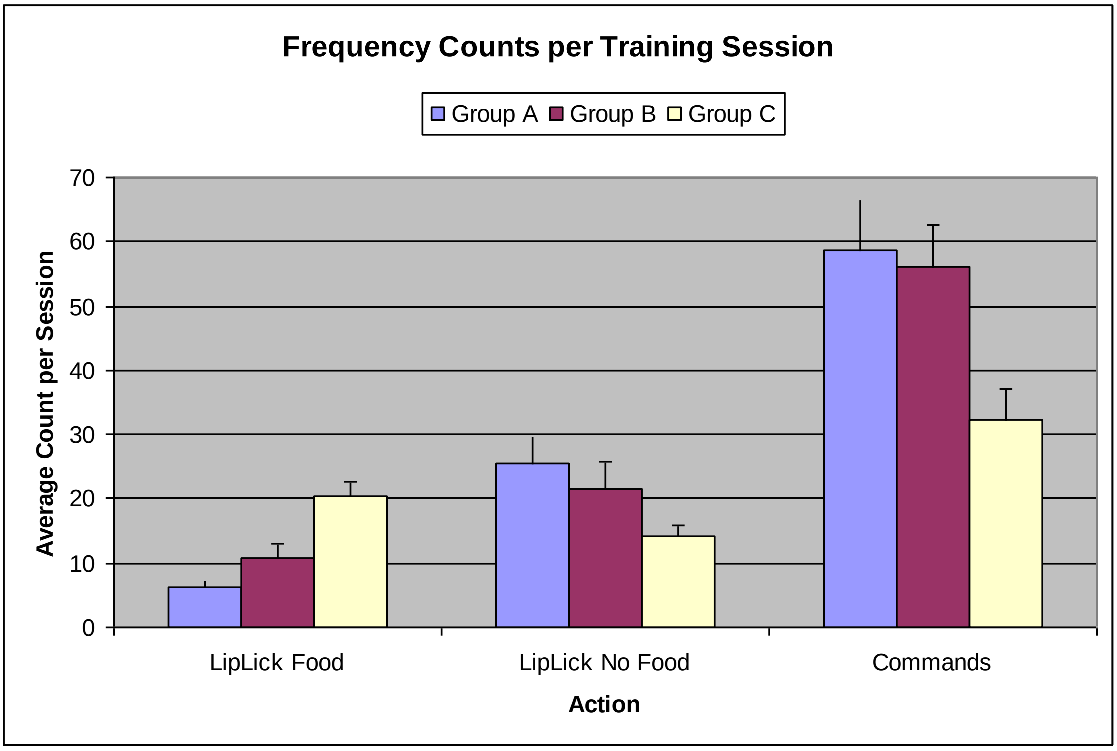

Figure 3. Mean (±SE) number of lip licks and commands per training session treatment for Groups A (e-collar) and Control Groups B and C

Dogs from group A showed more yawning than dogs in group C (Figure 4; Table 2). There may have been treatment effects on sudden movements away from trainer, including rapid turning away of head or body movements, which appeared to be least common in group C, though again this was not significant at the sample size of the study. Treatment A appeared to elicit most yelping, though yelping was rare in all groups and most dogs were not recorded yelping in any training session. Where yelping was noted, it appeared to be about 5 times more common in group A than groups B and C (Figure 4), but this apparent difference was not significant. As with panting, yelps appeared to be primarily observed in a small number of dogs in treatment A with the majority of dogs in that group showing no yelping. There was, however, evidence of a relationship between vocalisations and collar settings for group A dogs, with yelping (F1,17 = 7.58, p = 0.014) and all vocalisations (F1,17 = 10.7, p = 0.004) increasing with collar setting.

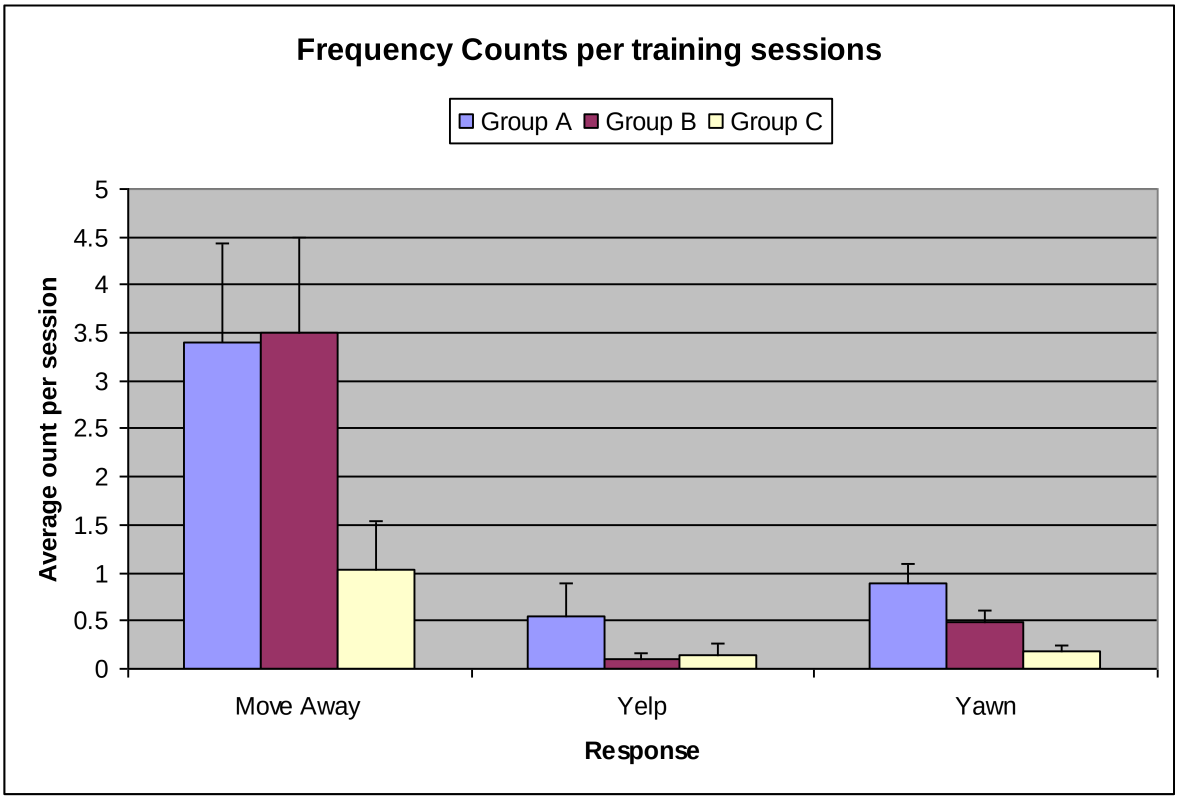

Figure 4. Mean (±SE) number of sharp movements away from trainer, yelps and yawns per training session treatment for Groups A (e-collar) and Control Groups B and C

Physiological Measures During Training Overall there was a treatment effect on salivary cortisol ($F_{2,46}$= 6.52, p = 0.003), with dogs in group C (logCort = 3.10 ± 0.016) having higher levels during study than group B (logCort = 2.92 ± 0.022; LSD, p=0.001). Measures from group A (logCort=3.02±0.023) did not differ from those of group B (LSD, p=0.08) or group C (LSD, p=0.066). There was a decine in salivary cortisol over the study period (F1,46=4.28, p=0.044) particularly from day 2 to day 5 (Figure 5).

Overall there was no significant difference in urinary cortisol to creatinine ratios between groups, ($F_{2,34}$ = 0.02, p = 0.98) with levels of 1.61 ± 0.06 for group A, 1.69 ± 0.12 for Group B, and 1.62 ± 0.07 for group C. There were also no changes in concentration ratios over the five days of training for any group (Figure 6). There was no effect of collar setting on either physiological measure in Group A.

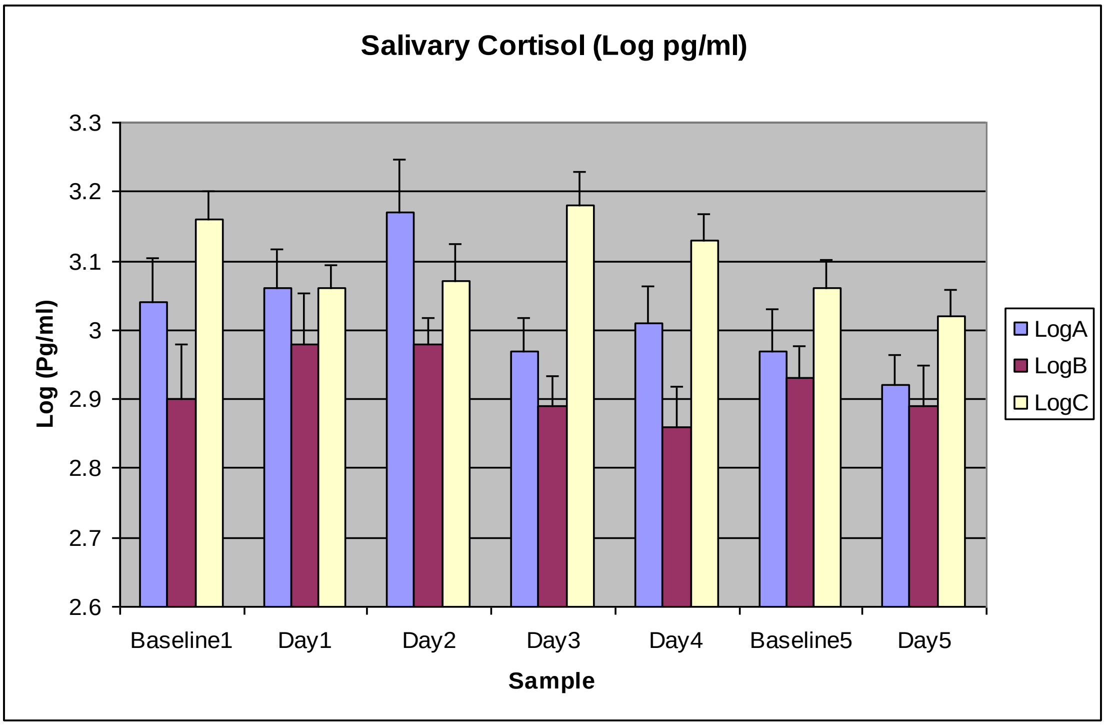

Figure 5. Log_{10} salivary cortisol (mean ± SE) for dogs during training.

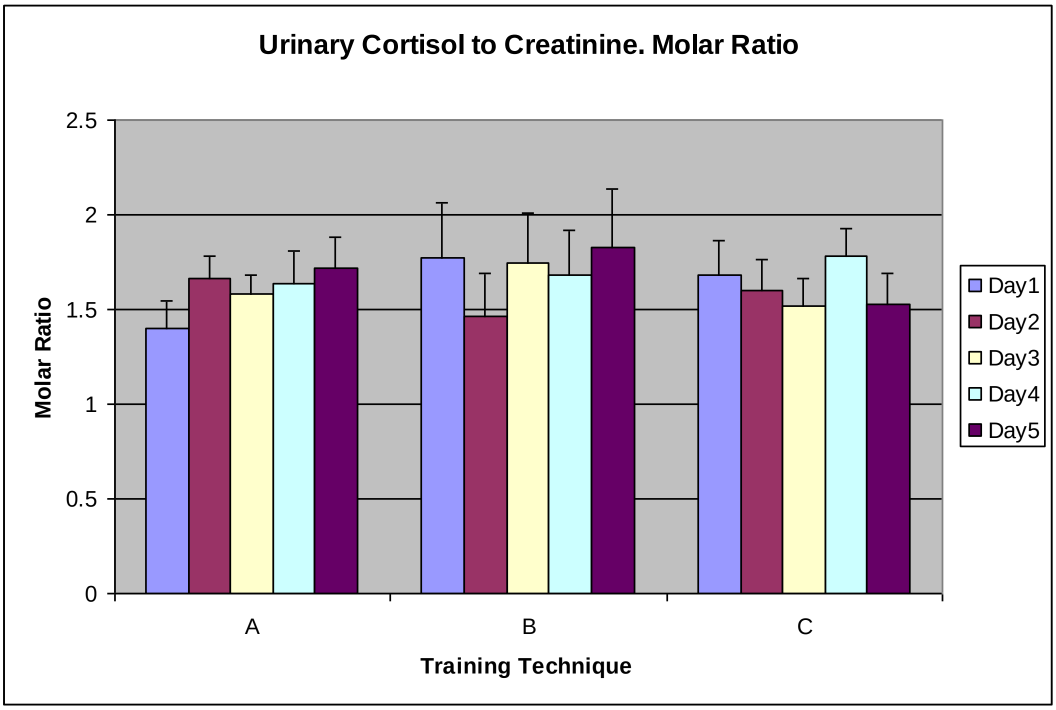

Figure 6. Urinary cortisol to creatinine molar ratios (mean ± SE) for dogs during training.

Follow Up data

Post training questionnaires were designed to assess if the efficacy of training, in terms of whether owners perceived the behavioural problem under referral (or behaviour in general) had been improved as a consequence of the training programme, and their perception of how useful and easy to apply the training programmes were. Behavioural and physiological data collected three months after training were also used to assess longer term welfare consequences of having experienced the training treatments. A total of 50 dogs were presented for follow up studies after one week representing 16 out of 21 dogs from group A, 15 out of 21 dogs from group B and 19 out of 21 dogs for group C. At three months, a total of 57 dogs were presented for follow up studies representing 19 out of 21 dogs from group A, 17 out of 21 dogs from group B and 21 out of 21 dogs for group C.

Cognitive Bias, Impulsivity and PANAS. No treatment effects on cognitive bias scores were found before, immediately after and at three month follow up between treatment groups. There were effects of time of treatment on measures such as speed to probes but no significant changes in cognitive bias scores. There were no differences in PANAS or Impulsivity scores between treatment groups prior to testing, and no differences following testing. There were no consistent changes over time, except owner's scores suggested dogs were less persistent in follow up studies. This may represent a change in the owner's perception of dog's behaviour following training or be a consequence of an improvement in the dogs' general behaviour as a result of experience of training.

Owner Perception of Efficacy. Owners were generally satisfied with the training programmes in which they had participated. For example at one week post training, 92% of owners reported they were satisfied with the training advice they received and would continue to use this advice for general training and in relation to the referred behaviour, with 94% being confident of being able to continue to apply the training programmes. There was no evidence of differences between the three training groups in these measures of satisfaction, which remained high at three months post training.

Behavioural Data at Follow Up During observations on return to the training centre, dogs tended to spend more time running (15.7% of scans) and more time excited (25.9% of scans) than in the training days. Rates of most activities that might be associated with aversion or anxiety were low and did not vary between treatments. Lip-licking (without food) was seen relatively frequently (1.88 ± 0.29 per minute) and whilst there was some evidence of a higher frequency for dogs from group A (2.77 ± 0.66) compared with groups B (1.94 ± 0.56) and particularly group C (1.16 ± 0.24), this was not statistically significant (F = 3.07, p = 0.057). No other behaviours were seen to approach significant treatment effects except time spent down, which appeared to be more common in dogs from group C (F = 3.65, p = 0.035) and time spent in an ambiguous behavioural state which was apparently more common in dogs from treatment group A (F = 3.24, p = 0.049), though neither were significant once Bonferroni correction was applied.

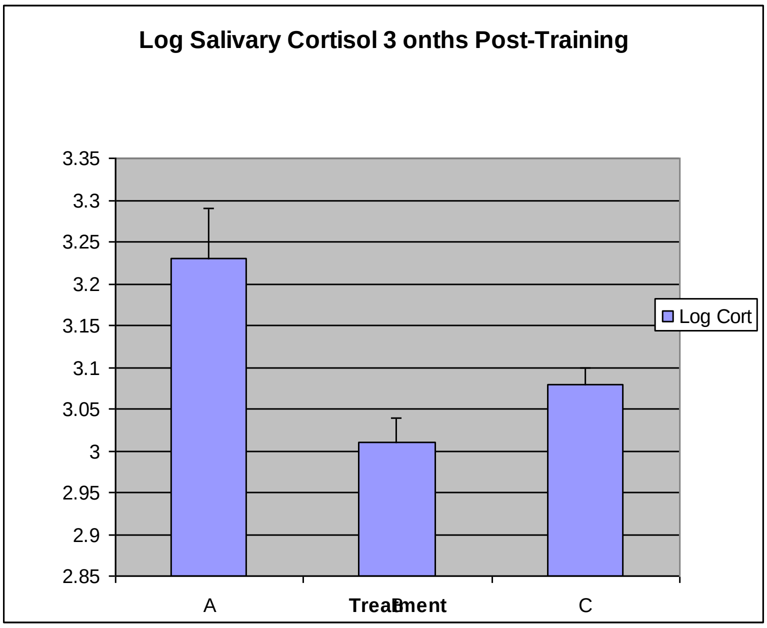

Figure 7. Log_{10} salivary cortisol (mean ± SE) on return visits to training centres 3 months post training, showing overall effects and changes over the three sampling periods.

Physiological Data There was no effect of treatment on ratio of urinary cortisol to creatinine (One way ANOVA, $F_{2,48}$= 0.27. p=0.76) with ratios of 1.55 ± 0.26 for group A, 1.59 ± 0.18 for group B and 1.40 ± 0.13 for group C. Saliva was sampled from 56 dogs of which one dog did not provide a sample at second and third sampling point so was not included in analysis. The remaining 55 dogs represented 19 out of 21 dogs from group A, 15 out of 21 dogs from group B, and all 21 dogs from group C. Data was log transformed to conform with requirements for parametric analysis. There were treatment ($F_{2,52}$ = 3.41, p=0.041) and sampling period ($F_{1,52}$=8.02, p=0.007) effects on log. salivary cortisol. Post-ANOVA pair-wise comparisons indicated that the sampling effect was due to a lower measure of log salivary cortisol in the final sampling period (Figure 8) than at the previous two samples (p=0.020 and p=0.015 respectively), whilst the treatment effect was related to lower log salivary cortisol in treatment group B than treatment group A (LSD, p=0.015), whereas the apparent difference between treatment groups A and C (Figure 7) was not significant (LSD, p=0.071). Measures of salivary cortisol were generally higher on the follow up visit particularly on the first sample (3.15 ± 0.04) compared with average over the training period (3.03 ± 0.03, Paired t-test, t_{56} =2.43, p = 0.018), and although this increase appeared to be largest in dogs from group A, (average rise of 0.23±0.17 for group A compared with 0.01±0.05 for group C) there was no treatment difference in elevation (One way ANOVA, F 2, 53=2.01, p = 0.11).

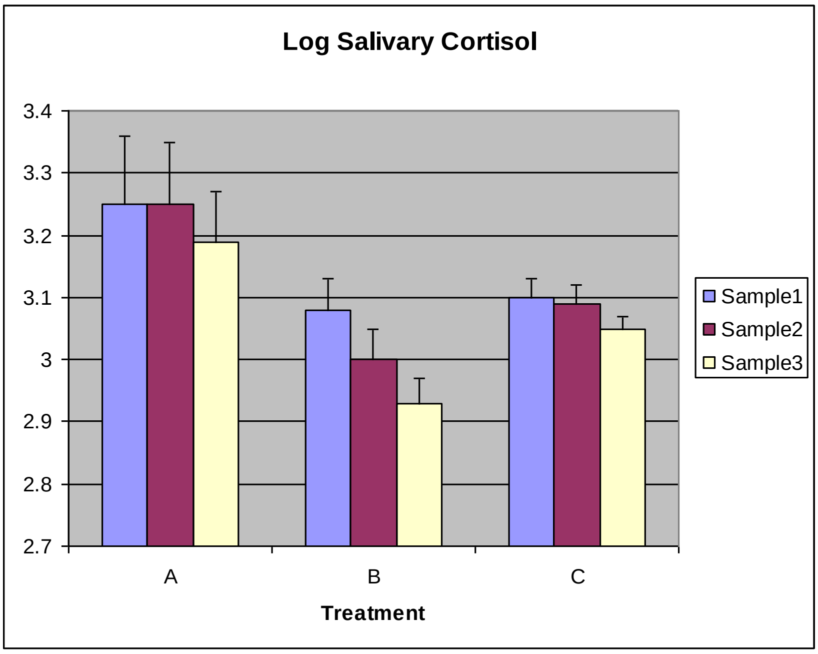

Figure 8. Log_{10} salivary cortisol (mean ± SE) on return visits to training centres 3 months post training, showing overall effects on arrival (Sample 1), after training without collar (Sample 2) and following training with deactivated collar (Sample 3).

Discussion and Conclusions In previous work funded by defra (AW1402) there was evidence that some dogs that had received e-collar training experienced long term negative welfare consequences. In particular dogs with previous experience of e-collars showed an increase in salivary cortisol and in tense behaviours and a reduction in relaxed behaviours in the training context compared to dogs who had not been exposed to e-collar training. However, as these dogs were studied retrospectively it was not possible to determine if this related solely to experience of e-collars or other cohort effects. In particular dogs from the control population were described as having less severe behaviour problems than those from the e-collar experienced population.

In this study we sought to investigate the welfare consequences of dogs in training, controlling for reason for referral, and severity of referred behaviour. A training programme was chosen that was consistent with the best practice advocated by collar manufacturers (e.g. Petsafe no date) and delivered by trainers with experience of training with and without e-collars. Data from these dogs were compared with data from dogs trained by the same trainers but without e-collars and by trainers who did not advocate use of e-collars.

The training programme used by e-collar trainers was devised in consultation with the Electronic Collar Manufacturers Association (ECMA) and was intended to represent best practice with respect to use of e-collars. In particular trainers included a period assessing the dog’s sensitivity to e-collar stimuli, to ensure that the intensity setting was sufficiently high to cause the desired response but that dogs need not be exposed to excessively high intensities. Furthermore, a pre-warning cue was paired with exposure to e-stimulus as a conditioned stimulus with the aim of allowing dog’s to learn over repeated pairings to respond appropriately before receiving the e-stimulus. Finally, selected trainers were experienced with using e-collars to modify the behavioural problems under referral, and normally combined use of e-collars with a range of other training tools including the use of positive reinforcement protocols.

It should be noted at this stage, that whilst this “idealised” use of e-collars may represent the way some dogs are trained with e-collars, it does not represent the methods used for all dogs. Owners recruited to AW1402 reported considerable variation in their use of e-collars, including use of high settings during training, and poor understanding of functions such as the warning cue. Most had used devices without formal training and instruction manuals varied considerably in guidance during training (Blackwell et al sub). Even where trainers used e-collars, there was evidence of variation from this best practice with only one trainer out of three recruited for the pilot study (Appendix 5) following a training programme that approximated to that used in this study, and the remaining two using high settings without pre-warning cues to discourage sheep chasing. As already stated in the introduction the research team were not able to intentionally replicate poor practice or inappropriate use of e-collars, such as unjustifiably high settings, the absence of pre-warning stimuli or poor timing between cues used in training, as the intentional imposition of these treatments would not have been compliant with the project's ethical approval. Nevertheless, if use of e-collars under these idealised conditions, was effective at resolving the dog's obedience problems, without negative welfare consequences, then this would support those who argue that e-collars can be used as an effective tool for behaviour modification. Alternatively, if e-collar training under idealised conditions carried significant risks for dog welfare in comparison to equally effective alternative training approaches, then this would support the arguments of those opposed to use of remote static e-training devices in dogs.

To control for behaviour problem and owner assessment of severity, dogs from group C were selected so as to match for dogs in group A for these criteria. Sufficient dogs were available for this group to allow good matching and there was consequently no difference in nature of problem or its severity between these two groups. Dogs presented to groups A and B, were randomly allocated to treatment by the research team, and the only intervention following interview was where owners had expressed a preference for or against e-collar training for their dog and its obedience problem. In these cases the dog could be re-allocated to the other group, but swapped with a dog that was equivalent in problem and severity. Only two dogs were affected by this, with one owner specifying their wish to be involved in the e-collar group and one owner who wished not to be in this group, so numbers affected were small and unlikely to have introduced any bias given they were swapped with dogs with equivalent behavioural problems. There was consequently no difference between dogs in group A and dogs in control groups B and C in reason for referral and no statistical difference between treatment groups in owner's assessment of severity, although numerically more dogs were assessed as having more severe problems in group C. Although age, sex and breed were not specifically included as matching criteria, there was no difference in age profile, sex ratios or breed prevalence between the three treatment groups, so these factors were unlikely to have an influence on any treatment differences found during training. Finally there were no differences in PANAS or Impulsivity or in Cognitive Bias scores were found between the three treatment groups prior to training, suggesting no differences in predispositions between the three groups and that the need for similar populations in the three treatment groups had been met.

The one measure that was found to differ between the three groups prior to training was salivary cortisol, which was higher in group C dogs when sampled on arrival at the training centre before experiencing their training programme, and continued to be consistently higher than treatment group B for the duration of the 5 day training period. The reasons for this elevation were not clear, it may have been that dogs from the East Midlands generally have elevated cortisol levels compared with dogs from Scotland, or it may have been a time of year effect, as dogs were studied at Lincoln during settled weather in late winter/early spring, whereas dogs were studied in Edinburgh in late autumn, which included a period of prolonged cold temperatures and snow cover. The effect may also relate to journey times to the training centres, or the ease of the journey, although none of these potential confounds resulted in no other difference between groups A, B and C dogs in measures taken prior to exposure to treatment. In all three treatment groups, salivary cortisol declined over the 5 days of training, suggesting a decline in arousal with repeated exposure to the training situation. No treatment effects or day effects were found with urinary corticosteroids.

There were a number of behavioural differences between the groups during training. Some of these, where group C differed from groups A and B, could be attributed to the trainer's overall style or differences between the training centres, as opposed to a consequence of use of e-collars. For example trainers for groups A and B tended to use more commands than those in group C and encourage sitting rather than standing. Dogs in groups A and B tended to show more sudden movements away from trainers, a lower tail carriage and were less likely to sniff environment than dogs in Group C, which may be associated with a higher level of anxiety or aversion to these trainers' approaches. Although no two training locations will be identical, considerable effort was made to replicate the Edinburgh training centre at Lincoln, with for example similar field location and the penning of potential prey, however it was not possible to replicate the severe weather encountered in Edinburgh in late 2010. Nevertheless, it is not clear how these location differences could directly and consistently alter dogs' behaviour between the two locations. Differences between trainers would seem to be a more likely explanation for these behavioural changes. These trainer based differences would be worth further investigation, as whilst the trainers for groups A and B were recommended by ECMA, and the trainers for group C were accredited by APDT, they are only 4 trainers out of a much larger population who may vary considerably in their interpretation and application of different training approaches. A post-hoc analysis of data using trainer as a factor indicated that some of the training related factors discussed above (e.g. time sitting and time walking during training sessions) did differ between trainers in the same treatment group, however none of the measures that may be interpreted as measures of aversion or anxiety were found to differ between trainers in the same treatment groups.

A number of behaviours differed between dogs in group A dogs and those in the control populations. These included yawning which was more common in group A than in group C as were the tense behavioural states, which approached a significant effect post Holm-Bonferroni correction. Yawning has been identified as a behavioural sign of anxiety or conflict in response to mild stressors (Voith and Borchelt 1996, Beerda et al 1998), whereas an increase in time spent tense was seen in dogs with prior experience of e-collar training, when the e-collar was worn in their training context. A reduction in environmental interaction can be seen as a consequence of greater obedience or attention to trainer, or a form of behavioural inhibition or passive avoidance of potentially aversive stimuli. In this study we did not quantify the dog's perception of the aversiveness of cues encountered during training, as this would have involved interruption of the training programmes delivered by the trainers. It would be of interest (subject to ethical approval) to have made an assessment of the aversion to e-collar stimulation (for example using passive avoidance techniques, Cooper et al 1998) during this study. In project AW1402 (Lines et al sub), a stimulus strength perception index was developed based on human volunteers' perception of e-collar cues, and this may give some indication of the potential impact of different forms of e-collar stimuli in dogs, but not an absolute quantification of aversiveness.

High levels of yelping and panting were observed in a small number of dogs in group A, but this did not represent a significant difference from the control groups. Yelping may be interpreted as a response to pain and was reported in Schilder and van der Borg's (2004) study as well as the pilot study presented in Appendix 5, where dogs were exposed to higher intensity e-collar stimuli. However most dogs in treatment group A yelped at a much lower rate than reported in the other studies, equivalent to roughly half a yelp per fifteen minute training session, in which dogs could have received several e-stimuli. In Group A, vocalisations were associated with higher settings, with dogs who sat less being exposed to higher settings. Panting has also been associated with acute stress in dogs (e.g. Voith and Borchelt 1996) and whilst not significantly affected by treatment, there was again some evidence that some in Group A engaged in more panting. It seems unlikely that temperature or exercise would account for these differences as dogs in group A were trained at similar temperatures and showed similar levels of activity as group B dogs. In contrast, dogs in group C experienced higher ambient temperatures and higher levels of activity (more running) in than dogs in group A and B which would have been expected to lead to increased panting. As we did not have baseline data on panting rates in these dogs it is not possible to further determine if this was a treatment effect.

Following training there were no treatment differences except for higher salivary cortisol level of group A dogs on arrival at the training centre, which may be related to anticipation of events based on past experiences. However, this level declined with time and signs of aversion or anxiety were rare on return to the training centres, and not significantly affected by treatment group.

Owners were generally satisfied with the training advice they received, and no differences were found between the treatment groups in owner satisfaction or assessment of efficacy at one week or 3 months post-training. It would appear from owner feedback that spending an extended period of time with experienced trainers handling their dogs was generally beneficial in terms of improving owner's understanding of dog behaviour and training. These measures were however solely based on owner assessment, and an assessment of the severity of the referred behaviours by for example a behavioural consultant before and after treatment may have been useful to provide an independent measure of efficacy.

In conclusion, this study shows that even with best practice as advocated by collar manufacturers and trainers, there were differences in the behaviour of dogs that are consistent with more negative emotional states (including anxiety and aversion) in some dogs trained with e-collars, that these differences persist for the duration of the initial training periods, and that there is some evidence of elevated arousal upon the later return to the training situations by these dogs. Further, the results indicate that there is no statistical significant nor clinically relevant differences in the efficacy of an e-collar training protocol combined with rewards and a reward based programme that does not use an e-collar for the management of dogs presented with comparable levels of livestock chasing, which is one of the most commonly advocated justifications for the necessity of e-collar training. The findings of this study are however confined to the specific application of the training protocols investigated, namely the use of positive reward based training of a recall task, compared with additional use of e-collar training, as advocated by industry representative bodies.

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9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

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Appendix 1.

Lincoln Study for Objective 4

1. Training Protocol

It is anticipated that the trials will last at least four weeks with each of the weeks starting on Monday and ending on Friday.

Day 1.
a) Dogs are assessed so suitable pairings can be achieved. This will also familiarise the dogs with the surroundings and the people who will be present.
b) Dogs from each pair are then assigned to treatment groups E-Collar and Control; E-collar dogs will wear the active e-collar and control dog will wear the dummy e-collar. Training the e-collar group will involve praise, reward & conventional training, with e-collar use as appropriate, whilst control dogs will follow same procedures without use of e-collars.
c) The first introduction to the e-collar should be to establish the dog's working level. This is the minimum stimulus that the dog in question can feel and should not evoke adverse reactions from the dog.
d) Teaching dog to pay attention to the minimum stimulus will involve application at minimum level and giving treat, praise, game with toy, when dog pays attention.

Day 2.
a) Dogs in E-collar group may be worked on leads/long lines through various commands such as recall and "follow me" whilst wearing the e-collar in switched off mode for approx 15 minutes followed by a 5 minute break for play
b E-collar dogs taught recall or "follow me" using long line to gently guide dog to handler using lowest possible level of stimulation.
c) This is then repeated once more. Fifteen minute sessions are usually enough, any longer and dogs may get bored and more easily distracted.
d) Dogs in control group are worked on leads/long lines using the chosen reward based method proceeding as above.

Days 3, 4 & 5.
Dogs in E-collar group work again, either on lines or not and may be given a static activation at low level.

Dogs in control group are worked as above without static stimulation.

Over the course of the trial, all three groups of dogs will be taught in the following sequence:
1. Teach the exercise with no distractions.
2. Move to different locations and repeat training without intentionally added distractions.
3. Train in different locations with mild distractions or distractions in distance.
4. Continue training amongst stronger distractions.
5. Increase difficulty/duration/distance over the days.

This training protocol is a guideline but may need small adjustments to accommodate variation in dogs' responses.

Appendix 2

Data Collection Protocol.

Up to 60 dogs will be investigated. These will be:

E-collar Group. Up to 20 dogs referred to trainers with problems that can be treated with remote electronic training aids.
Control Group 1. Up to 20 dogs referred to the same trainers with problems that could be treated with electronic training aids, but that will be treated using other training tools.
Control Group 2. Up to 20 dogs referred to trainers who do not use electronic collars with problems that may be treated with electronic training aids. Dogs in Control Group 2 will be matched for presenting problem and severity of problem with Dogs in E-Collar Group and Control Group 1.

Dogs in all three groups will be studied during training with follow up visits at between 3 and 6 months post-training to assess short and long term effectiveness of training in terms of training problem for which referred and for long term consequences on dogs' behaviour and welfare.

During training data will be collected over a 5 day period covering introduction to e-collar (or other training) stimuli and the period of modification of behaviour.

On day 1, prior to start of training early morning/first passage urine sample will be collected for assay of creatinine/cortisol. Dogs will also undergo a cognitive bias test. PANAS and Impulsivity Scores will also be assessed via owner interview prior to training on day 1, where owners are willing to comply. A pre-training survey will also be conducted to collect demographic data, determine reasons for referral and assess whether dogs conform to inclusion criteria. These will provide background data on dogs under investigation as well as baseline data on dogs' physiological and psychological status.

Dogs' individual training regime will be determined by trainer and will follow typical practise for resolving the problems under referral. Trainers will not change practise for benefit of research team and research team will gather data without disturbing training regime. Prior to training on first day dog will be fitted with heart rate monitor and a baseline saliva sample will be taken. Behavioural data will be collected by direct observation supported by video recording during training. At end of training programme a second saliva sample will be taken and a final sample taken 2 hours after end of training.

Heart rate and behavioural data will be collected in this manner on days 1, 2, 3, 4 and 5, with first passage urine samples collected for each dog on days 1, 2, 3, 4 and 5 and saliva samples taken at end of training on days 1, 2, 3, 4 and 5.

At the end of training a second cognitive bias test will be undertaken.

Follow ups will be conducted at 3-6 months post training

These will involve collection of first passage urine, cognitive bias test, PANAS, and video observation of dogs being taken through standard training tasks. A survey will be conducted at the 3-6 month visits to assess owner satisfaction and effectiveness of training.

Appendix 3. Follow Up Protocol (from AW1402)

Urine cortisol; creatinine

Dog owners were sent instructions and containers for first passage urine to be collected on day of visit. Owners were asked to collect 10ml of urine using a disposable cardboard urine tray, transfer contents to a sealable 100ml tube and store tube in their domestic refrigerator. On arrival researchers pipetted urine in 0.5ml aliquots into up to three 5ml vacutainers, one of which contained 0.05ml hydrochloric acid (HCl) (32%) to stabilise neurotransmitter metabolites. Where less that 1ml of urine had been collected analysis of urinary cortisol was prioritised. and as a consequence sample sizes for assays of neuro-transmitters were lower than those for urinary cortisol. These were stored on ice (or on dry ice if not returning to lab on the same day) and transferred to -80 centigrade freezer prior to analysis of neuro-transmitter metabolites by HPLC. The remaining urine was transferred into 2x 30ml plastic tubes. Both samples were frozen at -18 centigrade on return. One sample analysed at University of Lincoln for cortisol/creatinine analysis using ELISA and the other retained as a back-up.

Salivary Cortisol

Saliva samples were collected by encouraging salivation with food treats, and inserting a cotton epaulet mounted on a long handle into the space between dogs' cheeks and teeth (Beerda et al 1998, Ligout et al 2009). Saliva samples were collected from dogs at three time points during visits:

1. Sample 1: as soon as possible on arrival at training centre
2. Sample 2: 20 minutes after completing all sub-tests of the first set of standardised tests (with no collar)
3. Sample 3: 20 minutes after completing all sub-tests of the second set of standardised tests (with dummy collar)

Standard training tasks and collar fitting

Dogs were observed whilst undertaking 3 standard training tasks ('stay', 'recall' and 'leave', selected as commonly trained behaviours) plus one task for which the focal training device or method had been specifically used by the owner. . Each dog tested four times in total: initially without wearing a collar and trained separately by owner and researcher, and then when wearing a collar with both owner and researcher. Owners were asked to use the e-collar (turned off) that they had used in training, but if this was no longer available, a dummy collar which could not deliver a stimulus was provided by the researchers. The dummy collar was used for the control population. To investigate the occurrence of behavioural signs on fitting the collar, the behaviour of each dog was recorded as the owner fitted the collar and for a period of one minute afterwards. Behavioural data was collected on video and analysed using Observer software.

Judgement bias task

The project used a spatial discrimination task as developed by Burman et al (2008) in rats and subsequently used to investigate judgement bias in dogs by Mendl et al (2010). During training, dogs discriminated between two locations in which a plastic bowl could be located: in one location the bowl was baited with food, in the other there was no reward. Placement and baiting of bowls was unseen to dogs and auditory/olfactory cues controlled. Once the training criterion was reached (where the speed to the positive location was consistently faster than to the negative on six consecutive presentations), dogs moved to the test phase. Here dogs were presented pseudo-randomly with ambiguous 'probe' trials, where an empty bowl was positioned in one of three positions – central between positive and negative locations ('middle probe'), between the centre and positive location ('near positive probe') and between the centre and negative location ('near negative probe'). The rationale behind using this test was that the extent to which an individual animal perceives the intermediate probes as likely to be 'positive' (i.e. baited) or not (known as 'judgement bias') reflects their internal emotional state. Hence, animals in a more negative emotional state may be more pessimistic about achieving a reward and less likely to run to an intermediate probe than one that is in a positive state. The recorded running speeds to the positive and negative locations and three intermediate probes was scaled to account for potential differences in running speed between matched pairs of dogs. Scaling the data was done using the following formula:

$$\frac{\text{Mean speed to reach ambiguous probe} - \text{Mean time to reach positive}}{\text{Mean time to reach negative} - \text{Mean time to reach positive}}$$

As in previous studies (e.g. Mendl et al. 2010) a standard test area size with negative and positive training bowls 4m apart and all bowls placed 3m from the dog's starting position.

Appendix 4. Ethogram for Scan Sampled Behaviour

Behaviour	Description
Down	Body is touching the ground
Run	Fast movement
Sit	Dogs bottom is on the floor in a sit position
Stand	All four feet are on the ground and fully extended, bottom is in the air
Walk	Slow movement
Posture Unknown	Dog is not visible or too far away for behaviour to be interpreted.
Panting	Mouth open wide, breathing vigorously
Tense	Dogs shows a combination of: tense facial posture (muzzle tight), ears back or down, tail held stiffly or between legs, lip licking, rapid jerky head movement
Relaxed	Dog shows slow, relaxed movement with no tension in face or muzzle
Excited	Dogs shows a combination of: rapid or jerky movement, jumping, panting, ears forward, tail high or wagging, play signals
Anticipatory	Dog shows intense focus on a person or task, for example waiting for a command, with ears forward and direct gaze
Ambiguous	Dog clearly displays a mixture of ‘tense’ and ‘relaxed’ or ‘excited’ behavioural signs
Unknown	Dog is not visible, video recording is unclear, or the behaviours of the dog cannot be clearly interpreted
Next to owner:	Dog is positioned adjacent to the owner
Close to owner:	Dog is within arms distance (less than 1m) from owner
Inter to owner:	Dog is within 1-5 metres from owner
Far from owner:	Dog is over 5 metres from owner
Unknown to owner:	Dog is not visible or too far away for behaviour to be interpreted.
Next to trainer:	Dog is positioned adjacent to the trainer
Close to trainer:	Dog is within arms distance (less than 1m) from trainer
Inter to trainer:	Dog is within 1-5 metres from trainer
Far from trainer:	Dog is over 5 metres from trainer
Unknown to trainer:	Dog is not visible or too far away for behaviour to be interpreted.
Tail Still:	Tail is held stationary
Tail Wag:	Tail moving from side to side
Tail Unknown	Dog is not visible or too far away for behaviour to be interpreted.
Tail High	Tail is held stiffly and upright, either curled over the back or straight
Tail Neutral	Tail is held in the normal carriage position for dog
Tail Low	Tail is held down either straight or slightly curled under the dogs legs

Ethogram for Continuous Sampling

Body Shake: Vigorous movement of whole body side to side

Elimination: Expelling of faeces or urine

Flinch or back away: Generally a quick action where dog lowers body towards floor, (bottom is usually higher than head and dog's head can generally be turned away), or where dog briefly backs away from owner or collar. Muzzle is often tense and ear position is backwards. Tail can be positioned between legs or downwards.

Move or Turn away: Dog turns away from owner or researcher involving either head movement alone or whole body movement.

Attention Seek: or initiate physical contact: Any attempt to elicit attention from owner or researcher physically, e.g. jumping up at, pawing, touching with nose.

Sniff or Manipulate environment: Dog places nose in close proximity to the ground, air inhalation (sniffing) or snorting can sometimes be heard, and/or uses mouth or a paw to engage with immediate environment e.g. tugging lead, digging ground, picking up sticks or stones

Paw lift: One fore limb only is lifted off the ground. It is not directed at any person or object and all other limbs remain on the ground.

Groom or Scratch: Dog places mouth on its body or brings part of its body (usually front limb) to mouth and proceeds to lick or nibble at coat or skin.

Lip lick: Tongue leaves and re-enters mouth, either following the ingestion of food or when no food has been given.

Vocalisation:
Bark: Short duration, medium pitch, often repeated vocalisation
Whine: Long duration, high pitch vocalisation
Yelp: Short duration, load, high pitched vocalisation
Growl: Medium duration low pitched vocalisation

Yawn: Mouth opened wide briefly then shut.

Command Given: Owner gives dog a command such as Sit, Down, Stay, No

Table 1. Mean (SE) percentage of scans in posture/activity, panting, behavioural state and tail movement and position. F-statistic and probability from one way ANOVA. Treatment differences identified by post-hoc Tukey t-test; a and b indicate that there are significant differences between treatments. Where data did not conform to requirements of parametric analysis, a Kruskall-Wallis test was applied followed by Mann-Whitney test to identify treatment differences. These measures are marked with an asterisk*. To correct for Type I errors due to multiple comparisons, a sequential Holm-Bonferroni (Holm 1979) correction was imposed. Variables in **bold** met this adjusted criteria. To take into account Type II errors, power tests were applied to the sampled data. Variables in *italics* did not meet the Holm-Bonferroni criteria but application of power analysis suggest that if the pattern of treatment variation had been found in a sample size approximately twice that of this study (n=120), then the data would also have met this criteria.

Activity	Treat A	Treat B	Treat C	$F_{2,60}$
Posture/Activity				
Down	1.45 (0.33)	3.55 (1.09)	3.97 (1.02)	2.61* ns
Sit	**25.9 (2.64)a**	**23.6 (1.80)a**	**14.4 (1.84)b**	**8.21 p = 0.001**
Stand	**11.7 (1.20)a**	**16.2 (1.62)a**	**52.1 (2.32)b**	**144 p < 0.001**
Walk	**55.0 (2.92)a**	**48.1 (1.28)a**	**23.4 (2.06)b**	**57.7 p < 0.001**
Run	1.87 (0.39)	2.49 (0.52)	4.64 (1.34)	0.93* ns
State				
Ambiguous	8.30 (2.93)	15.7 (5.31)	11.9 (5.05)	1.05* ns
Anticipatory	*20.8 (3.63)*	*25.5 (4.97)*	*39.5 (7.31)*	*3.16 p = 0.050*
Excited	6.05 (2.13)	3.78 (0.84)	7.69 (1.77)	1.57* ns
Relaxed	32.2 (6.37)	29.6 (5.83)	33.0 (7.15)	0.09 ns
Tense	*24.6 (5.43)a*	*16.3 (5.25)*	*3.96 (2.06)b*	*4.99 p = 0.010*
Tail Movement and Position				
Still	65.6 (5.29)	63.6 (6.02)	58.3 (6.73)	0.68 ns
Wag	34.1 (5.28)	36.3 (6.07)	41.7 (6.73)	
High	13.5 (4.53)	15.9 (5.26)	16.9 (6.54)	0.11 ns
Neutral	72.2 (6.49)	78.6 (5.57)	82.3 (6.47)	0.69 ns
Low	*9.42 (4.42)a*	*5.87 (2.24)a*	*1.12 (0.58)b*	*6.38* p = 0.041*
Panting				
Panting	*20.3 (5.60)*	*9.42 (3.04)*	*12.5 (2.34)*	*3.77* p = 0.15*

Table 2. Frequencies of activities presented as mean counts (SE) events per training session. Treatment differences identified by post-hoc Tukey t-test; a, b and c indicate that there are significant differences between treatments. Where data did not conform to requirements of parametric analysis, a Kruskall-Wallis test was applied followed by Mann-Whitney test to identify treatment differences. These measures are marked with an asterisk*. To correct for Type I errors due to multiple comparisons, a sequential Holm-Bonferroni (Holm 1979) correction was imposed. Variables in **bold** met this adjusted criteria. To take into account Type II errors, power tests were applied to the sampled data. Variables in *italics* did not meet the Holm-Bonferroni criteria but application of power tests, suggest that if the pattern of treatment variation had been found in a sample size approximately twice that of this study (n=120), then the data would also have met this criteria.

Activity	Treat A	Treat B	Treat C	$F_{2,60}$
Attention-Seeking				
Owner	**0.45 (0.16)**	**0.16 (0.06)a**	**0.81 (0.21)b**	**9.94* p = 0.007**
Trainer	1.53 (0.83)	3.78 (1.21)	2.38 (0.60)	1.56 ns
Lip Lick				
Food	**6.13 (1.26)a**	**10.7 (2.24)b**	**20.4 (2.38)c**	**12.9 p < 0.001**
No Food	*25.5 (4.19)*	*21.6 (4.15)*	*14.1 (1.74)*	*2.67 p = 0.078*
Vocalisation				
Bark	0.22 (0.10)	0.36 (0.22)	1.00 (0.42)	1.91* ns
Whine	0.42 (0.26)	0.75 (0.44)	1.92 (0.82)	4.27* ns
Yelp	*0.55 (0.35)*	*0.10 (0.06)*	*0.14 (0.13)*	*5.27* p = 0.072*
Other Events				
Move Away	*3.38 (1.04)a*	*3.53 (1.01)a*	*1.03 (0.49)b*	*6.61* p = 0.037*
Paw Lift	7.43 (2.51)	13.3 (4.26)	7.04 (2.29)	1.24 ns
Yawn	**0.90 (0.21)a**	**0.49 (0.13)**	**0.19 (0.06)b**	**11.1* p = 0.004**
Scratch	0.15 (0.07)	0.18 (0.10)	0.68 (0.49)	0.97* ns
Shake	1.10 (0.22)	1.33 (0.42)	1.49 (0.36)	0.35 ns
Sniff	**12.1 (2.00)a**	**14.3 (1.99)a**	**22.1 (2.52)b**	**5.84 p = 0.005**
Eliminate	0.27 (0.13)	0.15 (0.05)	0.48 (0.17)	4.95* ns
Command	**58.8 (7.82)a**	**56.3 (6.32)a**	**32.2 (4.85)b**	**5.19 p = 0.008**

Appendix 5.
Prior to the commencement of this project (AW1402a) as part of the previously funded project (AW1402), data was sampled from dogs in training with e-collars, however this study was not completed due to problems with recruiting suitable dogs, and issues with the degree to which the study represented dogs overall response to e-collar training. In particular the study was only conducted on dogs on first exposure to e-collars, so did not look at changes in behaviour with repeated exposure when dogs may learn to associate changes in their behaviour with avoidance of e-collar stimulation. In addition the study did not include a follow-up (see Schilder and Van der Borg 2004, Schalke et al 2007) to assess long term consequences for these dogs in terms of their quality of life and the efficacy of training techniques. Nevertheless, the data from this study has been extracted here, as it illustrates potentially useful behavioural and physiological responses to short term exposure to e-collar stimuli, as well as proving a useful pilot of approaches used in the main study funded by AW1402a. For this reason an account of the study is provided in full in this report.

In the original study design, there was an objective covering the behavioural and physiological responses of dogs in training. This was to involve studying 20 dogs that had been referred to dog trainers for e-collar training and 20 dogs that were referred with similar behavioural problems to trainers who would not be using e-collars in their training, but instead used a reward based training programme. Data collection was to be focussed around the first exposure to e-collar stimuli including the trainer's assessment of the sensitivity of the dogs to collar setting and the context in which e-collar was used to resolve the behavioural problem that was the basis of referral. Ethical approval was given by all three participating contractors' institutions, and discussed with a Home Office inspector who specialised in dogs. As the use of e-collars was not illegal in participating countries at the time of the study, and researchers were not modifying trainers' normal use of e-collars the Home Office inspector advised that a project licence was not required.

Trainer contact details were obtained from publically available marketing (e.g. websites, magazine small ads) or through collar manufacturers. Trainers were initially contacted by phone and provided with information regarding the project and the planned data collection. Visits were then arranged if trainers had sessions already booked, or once new bookings were made. Discussions were generally open and positive, but a subset of trainers expressed concerns with participating in a study focussing on first presentation of e-collar stimuli. Negotiations were therefore begun involving ECMA representatives and Defra regarding a longer term study of responses to e-collar training aids in comparison to other training methods. These became the basis for the main study involving data collection over several days of training and a follow up assessment of medium to long term consequences of e-collar training on these dogs.

Nevertheless, a total of nine visits were conducted with three trainers (1 dog, 2 dogs and 5 dogs respectively), who were willing to allow recording of first exposure only. Of the 9 dogs sampled, 8 were referred for sheep chasing and 1 for problems with off-lead recall. Owners were present during training and all training was conducted over short periods of a single day. Training occurred in rural locations (i.e. farm yards and fields).

Data collection was to include recording behaviour on video, heart rate recording and collection of saliva samples for assay of salivary cortisol. Data was collected prior to training, during training and post training. Saliva samples were taken at the beginning of the day (baseline, sample 0), approximately 15 minutes after a pre-training behaviour observation (sample 1), 15 minutes after first exposure to e-collar stimuli (sample 2), approximately 15 minutes after a post-training behaviour observation (sample 4). Video records were taken for a period of 5-10 minutes prior to training involving dog-owner interaction, a similar period after training sessions had finished and during the training session itself. Heart rate monitors proved impractical in the training context due to losing traces during period of high activity.

Full analysis of data is not presented in this report, as the sample size is small, the contexts relatively specific and no matched controls were sampled. Nevertheless it would be useful to provide some qualitative and descriptive data.

For the 8 sheep chasers, the collar was fitted prior to exposure to sheep and trainers selected a setting which they anticipated would be the correct intensity. Dogs were then allowed to roam off-lead in a field, where sheep were present. If dogs engaged in chasing behaviour, then the trainer would apply an e-collar stimulus using settings and timings of their choice. Trainers aimed to associate proximity to or orientation towards sheep with the e-stimulus, and consequently tended not to use tone or vibrate stimuli as a predictor of e-collar activation. Behavioural data was collected by the research team on two hand held video cameras. The researchers also made a note of number of chases, and recorded the number of stimulus presentations and setting. All trainers appeared to use continuous stimulus without pre-warning tone or vibration for sheep chasing. Most (n=6) dogs only engaged in one or two chases, and received a single application of e-stimulus after chasing began, which led to a relatively immediate cessation of chasing. One dog did not chase sheep during the training sessions, but received two stimuli at points when it was orientated towards nearby sheep. One dog engaged in five bouts of chasing in total, but only appeared to respond to e-collar stimuli on 4 out of 5 of these chase sequences.

Video analysis was conducted using Observer 7.0 by a trained Observer user who was independent of the research team in the field. They were not informed of the brief of the study, and were informed that this was a more general study of consistency of training programmes. They were asked to record number of chases and stimulus reactions, and based on apparent reactions to collars divide training sessions into pre-stimulus presentation and post-stimulus presentation in order to compare the two periods.

The video analysis identified the same number of chases and reactions as the research team, despite not having knowledge of when trainers would have delivered stimuli, or that all dogs were in fact undergoing e-collar training. There was some variation in the precise reaction to each apparent application of stimulus, but stimulus reaction could be broadly described as an abrupt change in locomotor activity, normally from walking or running to abrupt halt, or other distinct change in direction of travel and gait, accompanied by vocalisations.

The recall dog was trained on a lower setting than sheep chasers, and whilst an apparent response to e-collar stimulus was detected in terms of change in orientation and posture, these were less pronounced than observed in sheep chasers.

Behavioural Responses
Compared with behaviour prior to stimulus presentation, dogs showed a number of changes in the frequencies of behaviour, in the period following electric stimulus presentations. Dogs showed an increase in vocalisation, with none recorded prior to first stimulus compared a total of 13 “yelps” and 5 “whines” after exposure. There was a change in tail carriage from principally an elevated carriage prior to exposure, with only 2% of time with tail between legs, to 20% of time with tail between legs following exposure. Prior to stimuli the dogs were generally described as neutral (40% of time) or investigatory (20%) with only 10% of time described a “tense”. After stimuli, dogs were tense for 50% of time and spent only 5% of their time engaged in investigatory behaviour Figure X). A small number of yawns and paw lifts were observed after stimuli, but none seen before exposure. Bouts of lip licking and body shaking were recorded before and after exposure, at approximately the same rate. Finally there was an increase in owner interaction by the dogs after exposure to the stimuli (56% of time compared with 14% prior to stimuli), with several dogs looking towards or returning to their owners soon after application of stimulus. On returning to owners dogs received praise and attention.

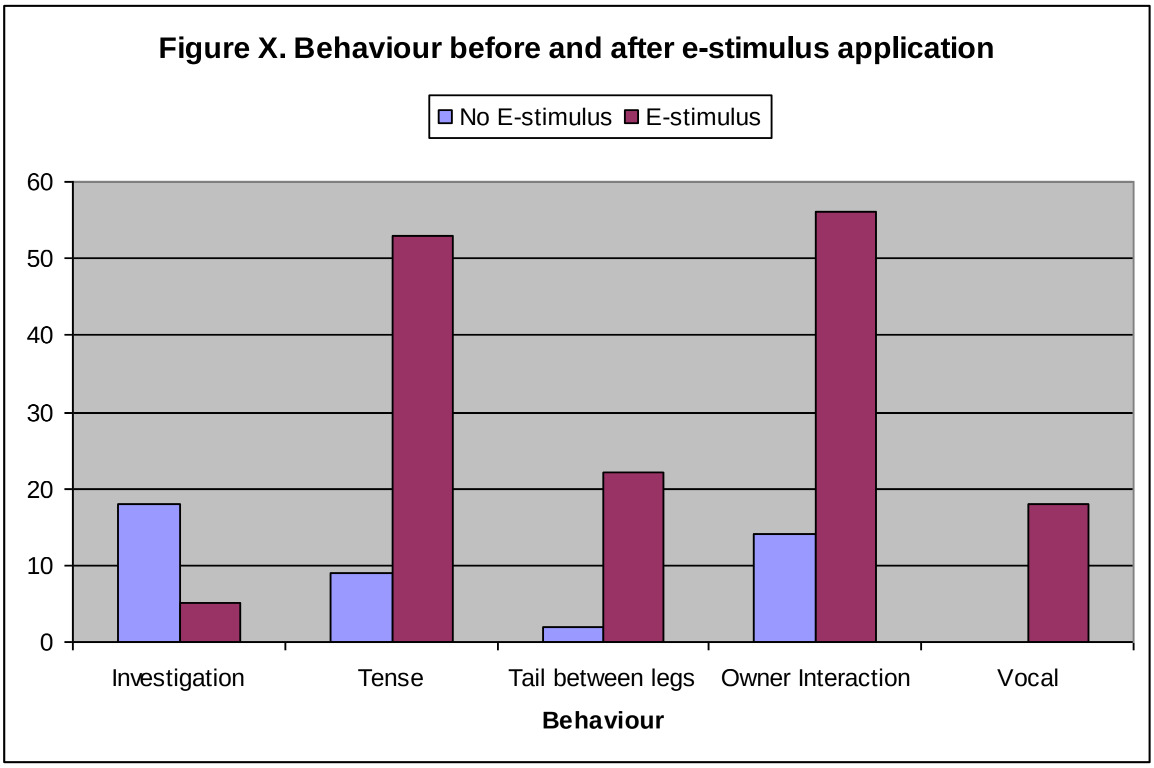

Figure X. Selected behaviours before and after application of e-collar stimulation during training. Mean proportion of time for investigation, tense, tail position and owner interaction. Total number for yelping vocalisation.

Physiological Data.

Saliva was sampled at four periods. The first following arrival at training centre prior to any formal training, the second following a period spent in the training context where dog were wearing collars but no electric stimuli were applied. The third following a period in the training context when electric stimuli were applied, and a fourth sample following a final session of training where collars were removed.

There were individual differences between dogs in salivary output, $F_{8,23} = 3.44$, $p = 0.009$, and also sample effect ($F_{1,7} = 3.29$, $p = 0.041$) with post-hoc Bonferroni test suggesting a difference between samples 1 and 2 ($T = 2.89$, $p = 0.042$), suggesting that salivary cortisol following training involving e-collar stimuli was elevated in comparison to the pre-training sample. This may be due to response to e-collar stimuli, or due to exposure to prey stimuli in form of sheep and chase behaviour prior to e-stimulation.

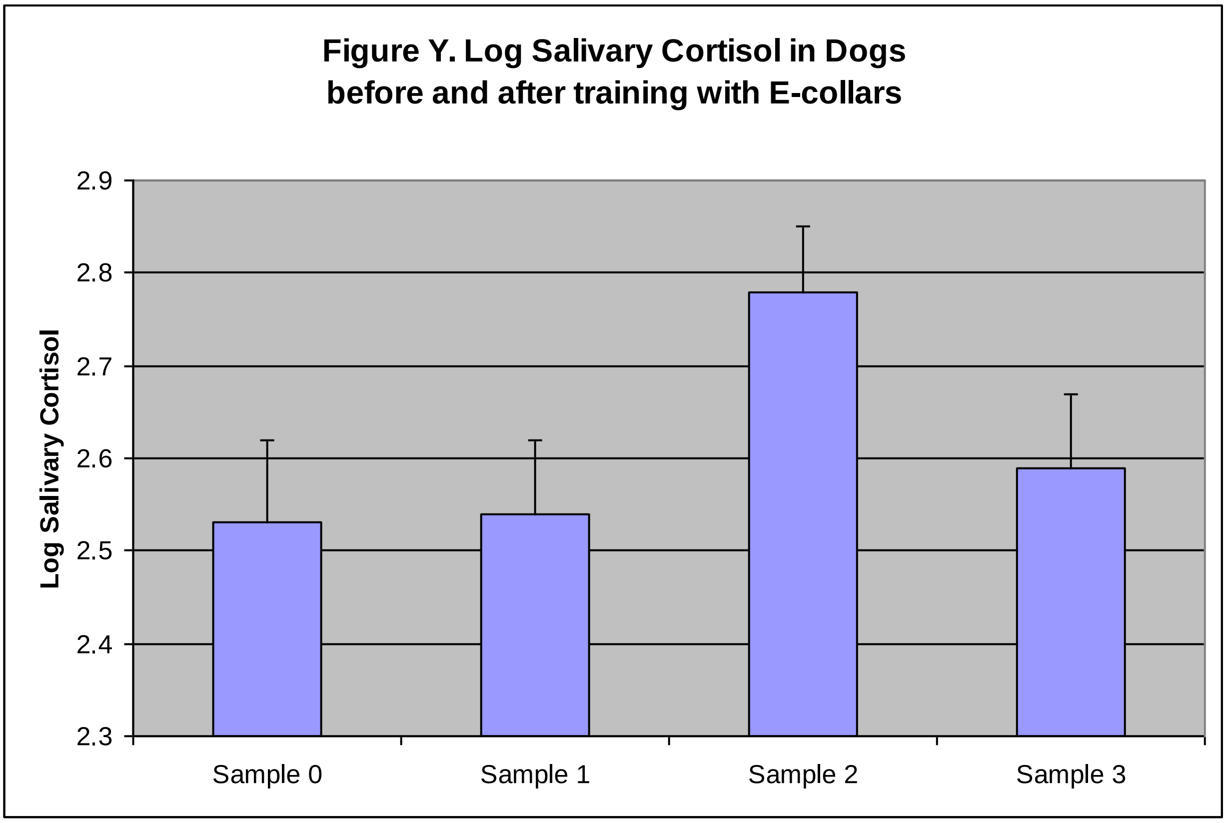

Figure Y. Log_{10} salivary cortisol (mean ± SE) on arrival at training centre (Sample 0), following training without e-collar (Sample 1), training with an activated e-collar (Sample 2), and an hour following training with e-collars when dogs were allowed free exercise (Sample 3).

Discussion and Conclusion

In this context dogs showed responses to e-collar stimuli which were clearly discernible to a “blinded” observer, and showed changes in behaviour and physiology that other studies have interpreted as indications of aversive arousal or anxiety (e.g. Beerda et al 1998; Schilder and van der Borg 2004). It should however be noted that this data was only collected from dogs undergoing training with e-collars and comparable data of dogs with similar behavioural problems in similar training contexts, but experiencing alternative corrective approaches were not collected in this study and consequently it is not possible to determine if elevated cortisol related to exposure to sheep or exposure to e-stimuli. There was evidence that trainers exhibited some elements of good practice, for example two out of the three trainers spent some time allowing dogs to habituate to the wearing of collars before presenting any electrical stimuli.

However for sheep chasing at least, no trainers assessed the dog’s sensitivity to collars prior to training, either choosing a setting they expected to be effective, or checking that the collar was operational using a low but detectable setting, then choosing a pre-determined higher setting for association with sheep chasing. In contrast the trainer working on the recall problem, initially established the dog’s sensitivity and used a low setting for the training of this particular task. In all cases, owners were encouraged to reward their dogs for appropriate responses in particular on their return to the owner. Pairing with a tone or vibration was not practised in the context of sheep chasing, as the trainers intended the dogs should associate exposure to the electric stimulus with proximity to sheep or the act of chasing sheep.